100 Years of Excellence
in
Education & Research
(Volume-II)

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(Editors)

CENTENARY CELEBRATIONS
University of Agriculture, Faisalabad
March, 2006

FOREWORD

Nations with well developed, education and quality research system aimed at meeting the growing challenges of scientific development to match and out pace their contemporaries, have gained prominence in the world. A sound education and training system which promotes investment in research and development for the enhancement of technological and economic potential of the country is the dire need of developing countries like Pakistan where literacy rate is low.

To achieve national goals, nations need enterprising seats of learning which through a modern innovative and technologically advanced research prepares versatile scientists, brilliant professionals, astute economists and forthright agriculturists. Having identified the need, the University of Agriculture, Faisalabad (UAF) since its inception in 1961, embarked upon expending the infrastructure for imparting quality education in agriculture with true sense of professionalism. There cannot be two options about the significance of quality education and research in the socio-economic development of a nation and building up of progressive vibrant and enlightened society. The UAF stands committed to reach the talented knowledge-seeking youth who want to chisel out rewarding careers for themselves.

Summaries of researches have been reported here which is just broad-brushing of activities with the intent to give an idea of the directions of studies being followed to come to grips with the complex problems the agriculture is facing today and will come across tomorrow, particularly under the intricate network of the WTO implications.

Agriculture has commanded great priority at the rhetorical level but in actual practice, especially at the time of resource allocation, it is discriminated and under estimated. Despite of all these limiting factors, the scientists of UAF deserve commendation to serve the nation in excellent way by fulfilling their mandatory duties for HRD and Research. The “100 Years of Excellence in Education & Research” is its clear proof.

In the present day world of science, change is the fundamental driving force for life. Sooner or later, it would completely break the time honoured barriers of ignorance and intransigence and moves into sunshine of change, progress and happiness. The rhythm of such social transformations, manifested in agricultural modernization and a rising output stabilizes as infusion of science and technology takes hold in their lives.

I express a deep sense of appreciation to the editorial team under the leadership of Prof. Dr. Abdul Ghafoor, which certainly did a commendable job in the compilation of Research achievements which undoubtedly is a lucid account of a multidimensional marathon of an on-going research pursuit at this campus. Everything moving out of these centers of excellence, may it be a graduating scientist, an idea or a material innovation, must be up-to-date which, of course, is indispensable to sustaining the momentum of development.

Prof. Dr. Bashir Ahmad
Vice Chancellor

The use of some trade names in this book is no way an endorsement of these products by the Editors.

1st Edition 2006

Volume – II

ISBN: 969-8237-08-9

Published by:
University of Agriculture, Faisalabad

Printed by:
University of Agriculture Press, Faisalabad

Price: Within Pakistan Rs.300/-
Outside Pakistan US$ 6.00

CONTENTS

FAISALABAD

The City of Textile & Agriculture

The excavation of Lower Chenab canal made in 1892, and in its aftermath the availability of irrigation water from the mighty river Chenab, changed the whole complexion of the vast tract of land lying between the rivers, Ravi and Chenab called Rachna Doab. With the enormous potentials around, emergence of an important city in the area seemed inevitable.

A decision was taken, and what a great decision it was, to locate a town in the area. Even those who made this decision would not have imagined that the proposed town would leap forward and one day become the second biggest city of the Punjab, both in importance and in the quantum of contribution to the economy of the province.

And then in 1896 from the plains of the Punjab arose a town called Lyallpur, named after Sir James B. Lyall, K.C.S.L, Lieutenant Governor of Punjab (1887-1892) in acknowledgement of his contributions in the process of colonization of the area. Originally a tehsil of Jhang district, it became an independent District in 1904 with Lyallpur, Samundri and Toba Tek Singh as Tehsils and Jaranwala as Sub-Tehsil. The name of the city was changed to Faisalabad in 1977, in commemoration of King Faisal Bin Abdul Aziz of Saudi Arabia who was a great lover of Muslims of the world and especially of Pakistan. The city became a Divisional Head Quarter in 1982.

The city was designed by Captain Popham Young, C.I.E., a Colonization Officer, with eight bazaars emanating from a central point, like the British Union Jack. The citizens made contributions to erect the clock Tower at the central point which was inaugurated by the then Lieutenant Governor in 1903. The structure has since become a part of a maxim-Clock Tower of Faisalabad and is used for those who try to become focus of attention in importance and stature.

The early years saw another important event, which carried the reputation of the District beyond the frontiers of the Punjab and the Sub-continent. In 1906, the foundation of the Punjab Agricultural College was laid with first admission of 9 students taking place in 1909. The college became a University in 1961 with manifold increase in its academic programmes, students enrolment and teachers employment. The research alone at the College and the University has brought a revolution in the agricultural production. The institution can thus rightfully claim to be the savior of the farmer.

The District, stretching over an area of over 15 Lac acres at a height of 450 ft. from sea level, has a population of more than 60 Lac (the city has about 26 Lac), sends 13 representatives to the National Assembly and 28 to the Punjab Assembly. Many of the representatives became Federal Ministers, State Ministers and Parliamentary Secretaries. The present Governor/Chancellor of the University, Lt. Gen. (Retd.), Mr. Khalid Maqbool, and Speaker of the Punjab Assembly, Mr. Muhammad Afzal Sahi, also belong to Faisalabad. Moreover, an old graduate of the Agricultural College Ch. Fazal Elahi, became the President of Islamic Republic of Pakistan.

Faisalabad has five Universities including University of Agriculture, University of Faisalabad, Textile

Engineering University, Govt. College University and Humdard University. The city has twelve degree colleges, taking pride in its Punjab Medical College, College of Commerce and College of Education. Apart from the Colleges and Universities, the city has four famous research institutions; Ayub Agricultural Research Institute, Nuclear Institute of Agricultural and Biology, National Institute of Biotechnology and Genetic Engineering and Punjab Forest Research Institute.

Quaid-e-Azam made historic visit to Faisalabad in 1942 in connection with the annual conference of Punjab Muslim League. He was accompanied by Khawaja Nazim-ud-Din, former Governor General of Pakistan, Miss Fatima Jinnah and other renowned personalities. He stayed for three days and spoke in various sessions held at Dhobi Ghat Ground.

Some of other political personalities of national caliber who visited the city before independence were M. K. Ghandi, veteran Congress Leader, Jawahar Lal Nehru former Prime Minister of Inida, Subhash Chander Bose former Congress President, Maulana Abdul Kalam Azad former Congress President, Sir Sikandar Hayat former Chief Minister of Punjab, Syed Ata Ullah Shah Bokhari President Ahrar Party, and a few others.

The oldest tomb in the District is that of Mirza, a contemporary of Mughal Emperor Akbar. It is located in Chak No. 585 in Jaranwala Tehsil. He is the one about whose love affair with Sahiban, a long pastoral poem "Mirza Sahiban" has been written and is sung and heard throughout Punjab with rapt attention.

Faisalabad was originally the granary of Punjab. Over the years, attention diverted to industry, especially the Textile Mills, and the city is now called the Manchester of Pakistan. The foreign exchange earned through export of the cotton products manufactured at Faisalabad is over-filling the offers of the factories etc., are providing job opportunities to several thousand persons.

The district abounds in sportsmen of different games, especially Field Hockey, who brought laurels to the country in international competitions. As many as 9 sportsmen, who captained the National Hockey Teams, belonged to this area, including Late Ghulam Rasool Chaudhry who became the Vice Chancellor of this University.

The city is adorned with two big gardens, one being Jinnah Garden where Quaid-e-Azam attended a civic reception in his honour. There are many Mosques and Shrines which now form the proud heritage of the millions living in Faisalabad, the third biggest city of Pakistan. The oldest shrine is that of Baba Noor Shah Wali of Pakki Mart.

The city is situated at 73° east Longitude and 31 north Latitude in the heart of the Punjab and has a unique geometrical setting. It is now provided with safe drinking water pumped from the River Chenab. A master plan has been prepared by the authorities to improve the drainage system, flow of traffic and Katchi Abadies. The beautification of the city is also being assigned priority. On the completion of the Master Plan involving several millions of rupees, the city will become the "beauty" tat it once was. The University of Agriculture is doing service to the town by providing much needed education to the masses, through regular degree courses and many short and vocational courses. The recent decision of the Punjab Govt. to develop "Garments City" near Khurarianwala and an "Industrial State" near Sahianwala certainly will enhance the boundaries and social, cultural, political and economic values of Faisalabad city in the years to come.

UNIVERSITY OF AGRICULTURE, FAISALABAD

INTRODUCTION

Pakistan at its birth in August, 1947 inherited only two agricultural colleges; one each in its eastern and western wings. The college in the western wing Punjab Agricultural College and Research Institute was located in the then city of Lyallpur in the Punjab Province, which since its establishment in 1909, had gained eminence, far and wide, for its teaching and research output. Most of the development in the field of agriculture witnessed during the century in this part of the subcontinent can be related to this institution.

During the first decade after independence, the pressure on land increased so much that West Pakistan once the granary of the sub-continent could no longer satisfy the demand for more food, as a result, the problem of food shortage started raising its head with all its disquieting implication. Another problem facing the nation was of education backwardness, particularly in rural areas.

In order to reorganize and improve the existing educational systems, the Govt. appointed two National Commissions one on Food and Agriculture and the other on Education for introducing the needed reforms. Both these commissions recommended the establishment of an Agricultural University in each wing of the country. Subsequently, the Government appointed a committee in October 1960, to prepare the Agriculture University plan. This committee was comprised of eminent representatives and experts from the central Ministries of Education, Food & Agricultural, Planning Commission, Provincial Agricultural and Education Departments, Pakistan Universities & Washington State University, U.S. A. The University plan prepared by this committee was scrutinized by the Federal & Provincial governments and was ultimately approved by the Economic Committee of the cabinet in September 1961. Thus the University plan was conceived, prepared and scrutinized by a host of experts distinguished in the field of education, agriculture and administration.

The Governor of then West Pakistan promulgated the Agricultural University Ordinance on the 28th September 1961 and issued the Notification establishing the Agricultural University at Lyallpur (now Faisalabad) on the 1st November 1961, defining teaching, research and extension and short courses as the major areas of its responsibility. The University was reconstituted and reorganized for the purpose of improving its teaching, research, publication and administration, safeguarding its autonomy and democratization of its constitution through the University of Agriculture, Faisalabad Act, 1973. The Act introduced for the first time since the birth of the University, the institutions of Senate & representation on its statutory bodies of the academic staff and students. The College of Agriculture Dera Ghazi Khan became a constituent college of the University during the year 1999.

LOCATION

The University is located at a distance of about 12 km. North-East of the Faisalabad Airport, about 2 km. South-West of the Faisalabad General Bus Stand and about 2 km. North-West of the Faisalabad Railway Station. The city of Faisalabad – the third largest city of Pakistan is situated at 145 km. (87 miles) to the West of Lahore at 184 meters elevation, 31^{o} N latitude and 73^{o} longitude.

ORGANIZATION

The Governor of the Punjab is the Chancellor, the Minister for Agriculture is the Pro-Chancellor, and the Vice Chancellor is the Principal Executive and Academic Officer of the University. The University includes the following faculties, Division, Institutes & Directorates in addition to constituent/affiliated institutions.

1. FACULTIES

a. Agriculture

i. Agronomy
ii. Agri. Entomology
iii. Crop Physiology
iv. Forestay Range Management & Wildlife
v. Plant Breeding & Genetics
vi. Plant Pathology

b. Agri. Econ. & Rural Sociology

i. Agri. Economics
ii. Marketing and Agribusiness
iii. Development Economics
iv. Environmental & Resource Economics
v. Data Processing Unit
vi. Rural Sociology
vii. WTO Cell
viii. Data Processing Unit

c. Agri. Engg. & Technology

i. Farm Machinery & Power
ii. Fibre Technology
iii. Structure and Environmental Engineering
iv. Irrigation & Drainage

d. Veterinary Science

i. Animal Reproduction
ii. Veterinary Anatomy
iii. Veterinary Clinical Medicine & Surgery
iv. Veterinary Microbiology
v. Veterinary Parasitology
vi. Veterinary Physiology & Pharmacology
vii. Veterinary Pathology

e. Animal Husbandry

i. Animal Breeding & Genetics
ii. Livestock Management
iii. Poultry Sciences

f. Sciences

i. Chemistry
ii. Botany
iii. Business Management
iv. Computer Science
v. Mathematics & Statistics

vi. Physics
vii. Zoology & Fisheries
viii. Islamic Studies
ix. Social Sciences & Humanities

g. Division of Education & Extension

i. Agri. Education
ii. Agri. Extension
iii. Continuing Education
iv. Rural Home Economics

2. CONSTITUENT COLLEGE

a. College of Agriculture, D.G. Khan is the only constituent college of the University.
b. Sub-Campus at Toba Tek Singh has also been established

3. INSTITUTES

a. Institute of Soil & Environmental Sciences
b. Institute of Horticultural Sciences
c. Institute of Food Science & Technology
d. Institute of Animal Nutrition & Feed Technology

4. AFFILIATED INSTITUTIONS

The University includes 30 affiliated institutions from where 1953 students of B.Com and 103 students of BCS classes appeared in the annual examinations, 2004.

DEGREE PROGRAMS

The University offers well integrated programs of teaching and research in agriculture and allied disciplines to ensure interaction and exchange of ideas among scientists of different specializations.
Under the currently operative system, each year is divided into two main semesters of 19 weeks each viz., the Winter and Spring Semesters and an additional shorter session of 8 to 10 weeks, viz., the Summer Session.

The following degree programmes, after F.Sc., have been instituted in various faculties of the University.

(a) Graduate Degree Programme

(i)	Doctor of Vety. Medicine	10 Semesters
(ii)	B.Sc. (Hons.) Agriculture	8 Semesters
(iii)	B.Sc. (Agri. Engineering)	8 Semesters
(iv)	B.Sc. (Hons.) Agri. & Resource Economics.	8 Semesters
(v)	B.Sc. (Home Economics)	4 Semesters

(b) Post-Graduate Degree Programme

(i) M.Sc./M.Sc. (Hons.) 4 Semesters
Offered in 50 subjects after completing first degree course)

(ii) M. Phil in pure Sciences 4 Semesters
(Offered in 6 subjects after completing M.Sc. in the relevant subject)

(iii) Ph.D. 4 Semesters
(Offered in 30 subjects after completing M.Sc. (Hons.)/M.Phil in the relevant subject)

DIPLOMA/CERTIFICATE PROGRAMME

A total number of 132 short courses covering agriculture and related subjects are also being offered for the award of Diplomas and Certificates by the Division of Education & Extension.

The medium of instruction and examination is English except for courses leading to Diplomas/Certificates and in the subjects of Islamic and Pakistan Studies which are compulsory for all Pakistani students working for their first degrees at this University where the medium is Urdu.

STUDENTS OUTPUT AND ENROLMENT 1961 – TO DATE

Manpower Trained

Degree	No. of Manpower trained
B.Sc. /B.Sc. (Hons.)	19372
M.Sc./M.Sc. (Hons.)	17373
M. Phil.	494
Ph.D	445
Total:	**37684**

Current Enrolment

Degree	No.
P. Phil.	234
Ph.D.	543
M.Sc./M.Sc. (Hons.)	2846
B.Sc. /B.Sc. (Hons.)	3718
Total:	**7341**

Foreign Students

Students from overseas also seek admission to various degree programmes with the clearance of the Federal Government. At present, 37 students have been enrolled.

Other Provinces

Besides, with the intent to give a helping hand, a generous and thoughtful provision was made to accommodate a sizeable number of students from other provinces of the country including FATA and Government of Azad Jammu and Kashmir/Northern Areas. At present, the total number of the students from these provinces/areas studying for various degrees in the University is about 116.

UNIVERSITY FACULTY

(a) By Designation

Professors	37
Associate Professors	100
Assistant Professors	121
Lecturers	142
Research Staff	20
Total:	**420**

(b) BY QUALIFICATION

Degrees	Foreign	Local	Total
Ph.D.	102	103	205
M.Sc./M.Sc. (Hons.)	07	190	197
M. Phil	-	12	12
B.Sc. (Hons.)/DVM	-	06	06
		Total:	***420***

TRAINING ABROAD

A comprehensive programme for the training of teachers of the University has been in progress since its establishment in 1961. In 2005-2006, 21 staff members completed their Post. Doc. and other short training programmes from abroad and 135 staff members attended the short/long courses, seminars, symposia and conferences abroad and within the country.

SCHOLARSHIPS

In order to promote competition for the pursuit of excellence among talented and deserving students, the University awards scholarship from different sources such as Educational Boards, Fauji Foundation, Pakistan Bait-ul-Mall, Punjab Zakat Department, Punjab Board of Revenue, Killa Gift Fund Trust, Higher Education Commission, Punjab Benevolent Fund Board, North American Alumni Association, Canada Pak-US Need Based Scholarships, HEC Merit/Indigenous Ph.D. Scholarships and Zila Councils including other private agencies. Approximately 32.50 percent of the total students population are benefited from this facility. During the academic session 2005-06 about 2200 students were awarded various scholarship.

RESIDENTIAL HALLS

A total number of 17 residential halls including three for female students have the facilities to accommodate more than 3,000 students. Facilities for indoor games and TV sets have also been provided. In addition to the two mosques on the main campus, facilities for offering prayers have also been provided in each residence hall/hostel/residential colony for the students/residents.

SPORTS

The University Campus has extensive and upto date facilities for major and minor sports such as Hockey, Football, Cricket, Lawn Riding, Riffle Shooting and Athletics. The facilities exist in addition to those for indoor games in the residence halls/hostels/ residential colonies for the students/residents.

UTILITIES

A post Office, two banks, a faculty club, a cooperative store, a student teacher centre, a cafeteria, rest houses, students lounges & an auditorium with a seating capacity of 1500 are located at the campus.

MEDICAL AND HEALTH SERVICES

In order to meet the health needs of the students and staff and their families, the University is maintaining three dispensaries. One Senior Medical Officer and two Medical Officers attend to the male staff and students while two Lady Medical Officers attend the families of the staff and female students. Recently, substantial improvements in the system of medical care have been made through establishment of fully equipped clinical laboratory, and E.C.G. apparatus. A Dental Unit with modern and high precession

equipments functions under the charge of a Dental Surgeon, for emergency cases of students and staff, 4 beds indoor in male wing and 3 beds indoor in female wing alongwith a labour room are available. Two Air Conditioned Ambulances are operating to ambulate the sick patients and dead bodies.

LIBRARY

The University Library is a centrally air conditioned and double storey building. It has a collection of about 2,10,875 volumes of books and journals etc. Under the Book Bank Scheme, text books are issued for considerably longer periods, i.e. upto full semester at a normal rent of five rupees per book per month. The Book Bank has about 3,438 volumes of various textbooks.

DEPARTMENT OF PUBLIC RELATIONS AND PUBLICATIONS

Department of Public Relations and Publications (PRP) consists upon two components (i) Information and Pictorial Publicity Section and (ii) University Press. The university maintains a well organized Public Relations and Publication services for projection of the institution and to highlight the achievements of the university scientists, scholars and students. A number of journals, books and bulletins including university annual report are regularly published by the university press. A news letter has been launched in the light of Higher Education Commission's prescribed criteria. Newsletter with international printing standards is being published every month regularly. Campus News usually appears once a week to keep the staff and students informed to the university activities and other information like Quotations, Situation Vacant, Ph.D thesis defences, scholarships etc. Many of these publications are in great demand among the general public and enlightened agriculturists. PRP department of the university is responsible for issuing handouts, pictorial publicity regarding functions and ceremonies arranged by the various departments of the university. PRP department is supposed to provide information about the infrastructure of university, disciplines which are being taught in the university, schedule of admission in various disciplines and other information, when it is demanded. PRP department also issues handouts to the national press and attains excellent coverage in daily newspapers of National repute. There was not any regular publication in the shape of Newsletter in the history of university. Principal Officer (PRP) Dr. Ashfaq Ahmad Maann on the advice of worthy Vice Chancellor Professor Dr. Bashir Ahmad, initiated the Newsletter on regular basis according to the National/International standard. This Newsletter is also sent to all the universities of national repute as well as to the Ministries, Federal and Provincial Secretariats, all departments relating to agriculture and livestock sectors and to the electronic and print media offices.

5. PLACEMENT BUREAU

The University maintains a Placement Bureau, to assist its graduates, to seek employment. The Bureau maintains record of the academic achievements of each graduate. It helps the graduates in finding positions corresponding to their interest and professional training. In this regard, the Bureau keeps liaison with the Government and private agencies. The Bureau arrange interviews between the employers and the graduates, on the campus, as and when required. It advises fresh graduates on the possible avenues of employment and keeps them fully informed who are already employed about further prospectus of career building in their respective fields of employment. It has succeeded to a great extent for arranging suitable employment to most of the graduates who passed various degree examinations from this University in various employing agencies of the country. "Agriculture Science Graduates in the Department of Agriculture Punjab, Forestry, Land Reclamation, Education, Pakistan Tobacco Board, Water and Power Development Authority, Zari Tarquati Bank Ltd., Pakistan Central Cotton Committee, Military Feed Laboratories, Capital Development Authority, FDA, LDA, MDA, KDA, Plant Protection Department, Institute Chemical Technology, Social Welfare Department, Local Government and Rural Development Department, Seed Supply Corporation, Non Government Organizations (PRSP), Seed Supply Corporation, Population Planning/Common Wealth Institute of Biological Control, Universities, Colleges, Schools, Banks, Pakistan Agricultural Research Council, National Agricultural Research Council, Pakistan Atomic Energy Commission, and Industries dealing with the Agricultural Products.

Veterinary Sciences and Animal Husbandry graduates in the Department of Livestock Dairy Development Punjab, Army Remount Veterinary Farms and Corps. Universities, Colleges, Stud Farms, Service in foreign countries, Agri. Development Bank and Pharmaceutical and Feed Industries. Agricultural Engineering Graduates in the department of Agricultural Engineering, the Water and Power Development Authority, On Farm Water Management Project, Agricultural Mechanization Research Institute, the Salinity Control and Reclamation Projects, Food Processing Industries, Universities, Colleges and farm machinery and equipment manufacturing industries.

AGRICULTURAL INFORMATION CENTRE (AIC)

Agricultural Information Centre previously known as Urdu Cell had been entrusted to publish Agricultural Material, including Zarii-Digest, Shaoor-i-Nau and University News since 1966. However, Shaoor-i-Nau & University News were suspended in early Nineties and presently Zarii-Digest is being published regularly upto the entire satisfaction of the farming clients.

Officer Incharge (AIC) Mr. Muzaffar Hussain Salik and his team tried to upgrade the standard of Zarii-Digest. Now the status and outlook of the Quarterly Zarii-Digest is not less than any International Digest. Comprehensive information about the International, National and local Farming Community related issues are reflected in the Zarii-Digest. Three regular issues according to new criteria have been published in the previous year.

In addition to the regular issues, special numbers, booklets & Agri. Pamphlets are also published by the Agri. Information Centre. During the last year numbers have been prepared which are being published. The AIC actively participated in Agri. Exhibitions, Kisan Melas & Book Fairs etc. During the last year i.e. 2003-2004, the Centre Exhibited its published material on the Science Conference, Zarii Exhibitions, Kisan Convention, Kitab Mela and Zarii Exhibition organized with the collaboration of District Govt. Okara and PARC at Okara City. The subscribers/readers of Zarii-Digest come from almost each part of Pakistan in addition to foreign countries.

TEACHING & RESEARCH FACILITIES/LABORATORIES ESTABLISHED IN THE RECENT PAST

a) Postgraduate Agricultural Research Station (PARS)
b) Genetic Engineering & Tissue Culture
c) Centre of Agricultural Biochemistry and Biotechnology
d) Centre of Advanced Studies in applied Genetics and Saline Agriculture
e) Wheat Genetics
f) Saline Agriculture
g) Tunnels/Greenhouses
h) Enzyme Chemistry
i) Central Hi-tech. Laboratory
j) Agro Climatology Laboratory
k) Citrus Nursery Sanitation Laboratory
l) Essential Oil Laboratory
m) Cotton Seed Chemistry Lab.
n) Epidemiology Lab.
o) Ethno-Veterinary/Chemotherapy Lab.
p) Plant Disease Diagnostic Lab.

Distinctions Awarded to the University Scholars

Tamgha-i-Imtiaz	Five
Pride of Performance	Four
Izaz-e-Fazeelat	Four
PEF National Education Award	Six
Quaid-e-Azam Gold Medal Award	Four
Star Award	Fifty five
Gold Medal for Best Scientist	Three
Best University Teacher Awards	Two each year
Misc. Awards	Two
Khawaja Farid Sangat Award	One

Moreover, 14 teachers have been awarded productivity allowance owing to their outstanding performance in their specialized fields.

UNIVERSITY AUTHORITIES

Authority	**Functions**
Board of Studies	Advises the authorities on all academic matters, research and examinations in the concerned subjects
Faculty Board	Coordinates teaching, research work in the subjects assigned to the Faculty and scrutinized the recommendations of the Boards of Studies.
Advanced Stud. & Res. Board	Advises the authorities on all research matters connected with promotion of advanced studies and research including the institution of research degrees
Selection Board	Makes selection of the university staff in B-17 and above and recommends the same to the Syndicate of the University for appointment.
Finance & Planning Committee	Considers statements of accounts, reviews periodically financial position of the University and advises the Syndicate on all matters of planning, development, finance, etc.
Affiliation Committee	Inspects the educational Institutions seeking affiliation to the university and makes recommendations on the subject.
Disciplinary Advisory Committee	Proposes regulations to the Academic Council for maintenance of students discipline.
Academic Council	Advises the Syndicate on academic matters, regulates admissions to the course of studies, conduct and discipline of the students and conduct of teaching, research and examination for submission to the Syndicate. Proposes regulations on the recommendations of the Board of Faculties and Board of Studies.
Syndicate	As the principal governing body of the University, takes effective measures to raise the standards of teaching and research. Controls, administers property, funds and investments of the University and makes appointments of staff in B-17 and above. Considers annual and revised budget estimates and advises the Senate thereon, frames regulations etc.
Senate	As the highest body of the University considers draft statutes proposed by the Syndicate, passes resolution on the annual report, annual statement of accounts & the annual and revised budget estimates.

VICE CHANCELLORS

LATE DR. Z. A. HASHMI
01-11-1961 To 31-08-1969

LATE DR. N.D. YOUSAF T.I.
(Acting) 01-09-1969 To 20-10-1969

LATE DR. ISRAR-UL-HAQ
21-10-1969 To 20-10-1975

DR. AMIR MUHAMMAD
29-10-1975 To 17-09-1978

LATE DR. G. R. CHAUDHRY
18-09-1978 To 25-09-1981

LATE MIAN MUMTAZ ALI
26-09-1981 To 13-06-1987

VICE CHANCELLORS

DR. ABDUR REHMAN T.I.
14-06-1987 To 13-06-1991

DR. MUHAMMAD RAFIQ KHAN
27-06-1991 To 30-11-1995

LATE DR. M. ANWAR-UL-HAQ
01-12-1995 To 10-12-1996

DR. AHMAD NADEEM SHERI
15-12-1996 To 28-09-1999

DR. RIAZ HUSSAIN QURESHI
11-12-1999 To 15-02-2004

DR. BASHIR AHMAD
16-02-2004 To To-date

1. College of Agriculture, Dera Ghazi Khan

The College is a constituent part of University of Agriculture, Faisalabad, which is functioning on the famous American land-grant pattern whereby teaching, research and extension are pursued in a well-integrated manner. At present, the college is working in a rented building named "Sadaat Palance" on the Muttan road in the city of Dera Ghazi Khan, The permanent building of the college is under construction at Rakh Choti Dalana just opposite to Dera Ghazi Khan Airport, where 800 acres have been transferred to the college for developing its campus and research farms. Another two hundred acres have also been provided to the college near D.G. Cement Factory to develop a livestock farm.

At present, the college offers B.Sc. (Hons.) Agriculture degree in five major subjects: Agronomy, Plant Breeding & Genetics, Soil Science, Horticulture and Agricultural Entomology. The college is equipped with analytical laboratory, library and computer laboratory for the students. The faculty'is fully trained to impart education, conducting research and extension services in various disciplines. Three classes with B.Sc. (Hons.) Agriculture degree have passed out from this college.

2. Sub Campus Toba Tek Singh

The idea of establishing University of Agriculture, Faisalabad Sub-campus, Toba Tek Singh cropped up as a result of the request made by the District Nazim Toba Tek Singh to the Honourable Governor, Punjab on September 8, 2004 during his visit to Toba Tek Singh. The Governor had the vision that the universities should develop outreach programmes for wider dissemination of modem knowledge and technology for the benefit of local population in remote areas of the Punjab.

B.Sc. (Hons.) degree programme in Poultry Science has been initiated in this Sub-Campus since September, 2005.

Keeping in view the needs of the people, it was finally decided that an Institute of Technology Transfer (presently known as UAF Sub-campus, Toba Tek Singh may be established with the following objectives:

- Training of the trainers (Agriculture and Livestock personnel)
- Training of the farmers
- Practical demonstration of technologies to the farmers

The main areas identified were livestock, crops, citrus, and poultry. It was further decided that the budget for the said institute will be provided by Punjab/Federal governments.

Second meeting in this connection was held on September 18, 2004 at UAF between the university faculty and district Nazim, Toba Tek Singh in Vice Chancellor's chamber. After thorough discussion on the subject, the following areas were identified to be covered under the Institute of Technology Transfer:

LIVESTOCK

- To install cattle feed mill
- To establish an artificial insemination center
- To provide quality semen to cattle and buffalo farmers through technicians
- To establish a beef fattening training unit
- To establish a veterinary diagnostic laboratory

POULTRY

- To establish a poultry production training unit for backyard poultry raising
- To establish a breeding center for fancy birds

CROPS

- To develop an integrated approach for technology transfer through practical demonstration and on-farm research
- To educate and train the farmers for sustainable crop production
- To conduct problem oriented on-farm research

CITRUS

- To develop an integrated approach for technology transfer through practical
- demonstrations, workshops and seminars » To educate the growers for commercial fruit orchard development
- To train the farmers about citrus orchard management and to work in a cooperative system for effectively solving their financial and marketing problems
- To establish certified citrus nurseries

FACULTY OF AGRICULTURE

DEPARTMENT OF AGRONOMY

1. WHEAT

1.1. Seed rate

Several experiments, using wide ranges of seed rate varying from 20-180 kg per hectare, were conducted. The results showed that the optimum recommended seed rate of 100 kg per hectare is a wasteful practice as the same yield of the timely sown wheat can be obtained even from a seed rate of 50-62.5 kg per hectare of healthy and viable seed. The effects of reduced plant population are easily offset by greater tillering. However, keeping in view the incidence of abnormal weather and insect pest or diseases at the seeding stage a seed rate of 60-70 kg per hectare should be used to ensure an optimum plant density in the case of wheat of medium stature.

A higher seed rate of upto 100 kg per hectare may be required for the late-sown crop depending upon the extent of lateness. The amount of preparatory tillage and the planting method had no effect on the seed rate requirement for the timely sown wheat, Maxi-Pak-65.This should dispel the erroneous belief that a higher seed rate is needed on an average farmer's land because of the relatively poor cultivation or conservative planting techniques.

1.2. Date of sowing

On the basis of many years experiments on sowing dates, it is concluded that the best planting time of long duration and early varieties is from the third week of October to the 10th of November. Mid-season varieties do well when planted from 15th of November to first week of December. Short-duration varieties are best suited for late planting in December and early January.

It was concluded from the varietal cum sowing dates experiments that V-1360, 77-88 and WL-711 possessed wider range of adaptability to planting time from October 25 to November 25, while strains V-79/353, 77-88 and V-1207 appeared to perform equally well under early, medium and late sown conditions. LU-26S responded best to a planting period from November 10 to December 10.

1.3. Seedbed preparation

Some cultural experiments carried out to prepare the seed bed for wheat after rice, using bullock and tractor drawn implements singly and in combination showed that there was no difference in the yield of wheat variety LU-26S planted on the beds prepared with different implements. However, the maximum grain yield of 38.19 quintals per hectare was obtained in plants prepared with local plough. It was evident from the data that there was no material benefit by using heavy and expensive tillage implement for preparing seed-bed for wheat after rice.

1.4. Planting depth

Studies on seedling emergence of some popular wheat varieties showed that seedling emergence decreased with increase in depth. This effect was more pronounced in the case of semi-dwarf varieties, due to their relatively shorter coleoptile length. Planting of these varieties at a depth beyond 5 centimeter under irrigated conditions should not be recommended.

1.5. Irrigation

Work on water requirement of wheat has shown that 13-acre inches of irrigation is needed for the local varieties, while semi-dwarf Mexican varieties need 19-acre inches of water. The most important time of irrigation is tillering and anthesis stage. Irrigation stress at tillering may reduce the yield by 28 per cent, while such a stress at anthesis limits production.

Conventional irrigation practice on high water-table soil is a wasteful and unproductive practice. Zero, 1 and 2 irrigations after the planting of wheat are needed on soils with a water-table depth of 2,8 and 11 feet below the ground surface. However, 4 and 5 irrigations are required for maximum production on soil with a water-table depth of 13 and 21 feet below the ground surface.

Experiments were also conducted to determine the interrelationship of wheat genotypes and irrigation frequencies on a fertilizer responsive soil. Different genotypes did not differ from one another to a significant extent, while various irrigation frequencies although produced variable yields yet the differences among them were not significant. It led to the conclusion that two irrigations, each applied at tillering and grain development stage appeared to be enough for obtaining as good yield as with three or five irrigations. In some cases three irrigations may be the optimum water requirement depending upon the yield and growth behaviour of the varieties.

1.6. Fertilizer use

Semi-dwarf Mexican varieties responded to nitrogen rates up to 135-168 kg per hectare on an average soil. On rich soils, even these varieties lodged when fertilized with higher nitrogen level, resulting in no measurable advantage over the check. Significant responses to phosphorus were also observed, suggesting that on soils in this tract phosphorus requirements of wheat should be adequately met in order to obtain higher yields. Yield responses were intensified when combined application of N and P_2O_5 were made in the ratio 1:1 or 2:1. The addition of K_2O did not improve the yield or nitrogen content of the grain.

Application of phosphorus at sowing or with first irrigation appeared to produce the best results. Split application of nitrogen at seedling and tillering is generally more efficient.

The grain yield did not increase substantially with the P alone or when applied in combination with lower doses of N over control. However, yield was enhanced to a measurable extent when P was applied in combination with higher doses of N ranging from 50 to 100 kg/ha. These trials were conducted on wheat variety LU-26S.

Effect of NP application on the grain yield of wheat grown in association with berseem was studied. The results revealed that application of P_2O_5 alone or in combination with N did not help in increasing wheat yield grown in association with berseem. The results further indicated that addition of 25 kg N/ha as a starter dose to a wheat-berseem association was very effective in increasing wheat yield.

In some other trials, response of wheat crop to varying rates was studied when 50 kg P_2O_5 was applied to all the treatments as a basal dose keeping all the cultural operations normal and uniform. The grain yield increased with the addition of N upto 75 kg/ha over the control. This, however, did not differ significantly from 50 kg N/ha. Increasing N rates to 100 kg/ha did not increase the yield further to a considerable extent.

Experiments conducted on mixed planting of berseem and wheat on a light sandy loam soil fertilized at 50 kg P_2O_5/ha in the case of wheat sown alone and fertilized at 50 kg of P_2O_5 + 75 kg of N per hectare indicating that 86 kg/ha of the biologically fixed N by berseem was available to the companion wheat

crop. Further studies are, however warranted.

In other studies, response of low 25-25-0, medium 50-50-0 and high 100-100-0 kg of NPK per hectare, fertilizer technologies comprising respectively, including check was investigated on a sandy clay loam soil. It was found that all the five varieties included in the trial responded equally well to a medium fertilizer technology within their yield potential.

For a soil having an initial harvested productivity potential of 19.95 quintals/ha, a fertilizer dose of 100 kg N + 75 kg P_2O_5/ha is required to raise the wheat yield to the level of 41.80 qintals/ha under medium late sown condition.

On the basis of three years average the highest wheat grain yield of 50.77 qintals/ha was harvested with the application of NPK in the ratio of 2:2:1(100-100-50 kg NPK/ha) compared to 47.96 quintals with NP in the ratio of 1:1 (100-100-0 kg NPK/ha) both being at par with each other. This indicated that K application did not play much role in increasing the grain yield of wheat. On the other hand incremental benefit cost 1:2 (50 kg N + 100 P_2O_5/ha) as against 3.78 for NP applied in the ratio of 1:1 (100) N + 100 P_2O_5 kg/ha).

A comprehensive study of the recommended versus conventional package of wheat production technology led to the conclusion that inclusion of a component of weed control in the conventional package of wheat production technology not only saved nutrient loss to the extent of 75 kg N and 50 kg P_2O_5/ha but also increased the net income and wheat yield to a substantial extent, while increasing either the irrigation frequency from 3 to 5 or a fertilizer dose from 65-56-0 to 140-115-0 kg NPK/ha did not contribute materially in making the conventional wheat production technology more productive and economical.

Experiments conducted on wheat-berseem association at different fertility levels indicated that wheat-berseem intercropping with a starter dose of 25 kg N when planted on flat in independent multi-row strips appeared to be the most economical proposition on a soil with initial suatus of 0.06% N, 15 ppm available P_2O_5 and 213 ppm available K_2O. On the whole wheat-berseem intcr-cropping system appeared to be feasible and highly remunerative besides being restorative in nature.

1.7. Weed control

The results of trials pertaining to chemical versus mechanical weed control indicated that on an average weeds reduced wheat grain yield to the extent of 15 to 20 percent. The most effective weed control was obtained with Tribunil at the rate of 2 kg (active ingredient) per hectare with second irrigation followed by hand weeding recording 49.55 and 48.44 quintals of grain/ha, respectively as against 34.55 quintlals/ha in case of chock. Other herbicides, Arelon at the rate of 1 kg a.i. first irrigation were trailing behind.

Weed control experiments on sunflower led to the conclusion that pre-emergence application of Stomp at 2.8 lit/ha appeared to be superior to Dacthal and Treflan in terms of seed yield of spring sunflower. It checked the growth of *Cyperus rotundus* and *Cynodon dactylon* quite effectively, while Dacthal and Treflan application controlled *Cynodon dactylon* growth only up to 15 days and became ineffective at later stages.

Similarly post-emergence application of Dicuran MA.60 at 1 kg a.i./ha to wheat crop gave the maximum weed control reducing weed population by about 53 per cent.

Two wheat crops in a year

Two crops of wheat were obtained in a year by planting first crop in the end of August or beginning of September and harvesting it by last week of November or mid-December. Premature seeds obtained

from this crop were sun dried or oven dried for second sowing in last week of December to get a regular crop. Two successful crops were, thus harvested in one year. These findings are of great value to wheat breeders in the country.

1.8. Package for "barani" wheat

Studies carried out to see the effect of immature wheat seeds on the germination, plant growth and grain yield indicated that comparable grain yields can be obtained from the *seed* harvested 20 days after awn emergence irrespective of the size of the parent seed. It was further revealed that as long as the size of the immature wheat seed does not get reduced beyond l/8th of the fully developed grain, significant difference in subsequent plant growth and yield may continue to persist. It appears that wheat seeds containing even half the normal good reserves are capable of producing normal plants and grain yield.

The effects of seed treatment, methods of fertilizer placement, and soil moisture conservation practices on the yield of two wheat cultivars were studied on a sandy loam soil under the "Barani" farming conditions of Faisalabad. Soaking the seed of a drought resistant variety and placing N and P fertilizer 5.25 cm below the seed at sowing was found to be more profitable technology for the production of dryland wheat. Soil moisture conservation by cultivation or stirring the top soil after each rain appeared to be an efficient practice.

It was concluded from the results obtained from wheat experiments laid out under the shade of "Sheesham" *(Dalbergia sissoo)* trees that there was a remarkable suppressive effect of the shade on grain and straw yield of wheat LU-26S. The depressive effect was more pronounced in the case of grain yield rather than straw yield which were reduced from 3.00 to 19.37% by an average day time shade of 3 to 5 hours per day. The yield was further reduced from 31.85 to 39.60% when the duration of daily shade was 6 to 7 hours.

2. RICE

2.1. Increasing nitrogen utilization efficiency in flooded rice

Experiments involving the use of different nitrogen rates in different sources and application techniques led to the conclusion that the N utilization efficiency was considerably increased when 60 per cent of the locally recommended N rate was applied in the form of urea 12 days after transplanting by "mud ball" technique. This finding is of significant value for obtaining high paddy yield under the tight fertilizer supply conditions in Pakistan. The results further indicated that the -N utilization efficiency was considerably improved when it was applied as ammonium sulphate before and after the puddling. Using N beyond 60 kg/ha as ammonium sulphate or urea appeared to be uneconomical and the technique of incorporating N into the dry soil before puddling operation proved to be the most effective one.

2.2. Transplanting date

Transplanting in the first week of July appeared to be optimum both for the course and fine rice varieties. Early and late transplantings resulted in decreased yield due to unsuitable temperature, humidity and photo-period.

2.3. Use of micronutrients

Application of Zn increased grain yield of rice while it had no effect on straw yield. Soil application improved the yield components and grain yield considerably over the practice of dipping nursery roots in Zn solution, foliar spray and control and thus appeared to be a more effective technique for Zn application. Application of Zn through soil appeared to be more efficient as compared to other application

techniques.

The data of some other experiments showed that although application of all the three micronutrients Cu, Zn and Fe improved the percentage of normal kernels and 1000-grain weight significantly over check yet the differences within the micronutrient treatments except Zn + Cu + Fe at 10 + 10 + 100 ppm had no effect. The results indicated that Faisalabad soils also had micronutrients deficiency.

2.4. Kernel development and ripening

Replicated field trials conducted to know the degree of ill-ripening and abnormal kernels in both the coarse and fine varieties of rice commonly grown in the country, at recommended fertilizer levels indicatd that abnormal kernels ranged from 40 to 80 in different varieties of both the groups. It was further observed - that if the sterility in a variety was increased, the occurrence of subsequent abnormalities like abortiveness and opaqueness were decreased and vice versa.

In general N application did not help improving the ripening of rice and occurance of chalkiness.

2.5. Planting density

Several field experiments using wide range of planting densities Viz. 15 x 15 cm., 22 x 22 cm., 25 x 25 cm., 30 x 30 cm., 40 x 40 cm. and NP levels 0-0, 68-34 and 134-67 kg per hectare on the ripening behaviour of a rice cultivar IRRI-6 and Basmati 370 were conducted. The results indicated that occurance of abnormal kernels was increased at wider spacing. Fertilizer levels did not show significant differences among themselves. The highest 1000-grain weight was recorded in 30 x 30 cm planting density with a fertilizer dose of 134-67 kg NP per hectare.

3. MAIZE

3.1. Fertilizer use

It was concluded from the fertilizer trials conducted under field conditions that on an average soil, a fertilizer dose of 85-114 kg N/ha was suitable to get higher grain yield with increased oil and nitrogen contents of the grain. Phosphorus also showed a positive effect on the grain yield of maize when applied before sowing.

3.2. Spacing and irrigation

Field experiments conducted on spacing and irrigation requirements of maize indicated that a 15-22.5 cm plant spacing within 75 cm apart rows resulted in the highest grain yield of maize when planted in east-west row direction. Four to six irrigations depending on the growing period of the crop were found to be enough under the Faisalabad conditions.

3.3. Tillage practices

Field studies on tillage practices of maize showed that no or minimum tillage gave as good yield as obtained with conventional practice of giving intensive preparatory tillage, provided the weed population was kept under control. This valuable information may help in reducing the cost of cultivation of this crop.

3.4. Two crops a year

Experimental studies conducted on the feasibility of raising two maize crops in a year revealed that spring and autumn crops can be successfully harvested from the same field. Optimum planting time for spring

crop ranged from 2nd week of February to 1st-week of March, whereas the optimum planting time for autumn crop was the first fortnight of August.

3.5. Planting geometry

Replicated trials were carried out to see the influence of planting geometry on the productive potential of spring maize. The planting geometry consisted of planting 60 cm apart single rows, 90 cm apart paired rows planting and planting in 60 x 60 cm hills with two plants per hill. Recommended level of NP was applied through recommended application method. The results indicated that the highest grain yield of 44.59 quintals/ha, was obtained from planting in paired rows 90 cm apart with 30 cm space between the rows. The double row planting system not only allowed easy earthing up but also resulted in substantial saving in time, labour and irrigation water by reducing the irrigation furrows by 50 percent after earthing up as the two rows of maize were earthed up at a time instead of one.

3.6. Multiple cropping

Field trials were conducted to compare the performance of different legumes including mash bean, mung bean, soybean and cowpeas as intercrops in maize grown in the patterns of 60 cm apart single rows, 90 cm apart double row strips and 120 cm apart tripple row strips. The highest grain yield of 64.49 quintals per hectare was obtained from planting of 90 cm apart double row strips. Among the four intercrops, soybean produced the highest yield (131 kg/ha). However, double and tripple row strip planting systems were experienced to be more convenient and systematic for intercropping purposes.

3.7. Planting density

The data obtained from field trials on fertilizer used and planting densities revealed that the highest maize grain yield of 46.45 quintals per hectare .was obtained at a planting density of 66,667 arranged in the pattern of 60 x 25 cm with a fertilizer dose of 150-75-75 kg NPK/ha. This fertilizer level however, did not differ significantly from 150-75-0 kg NPK/ha thereby showing no remarkable role of K.

4. COTTON

4.1. Fertilizer requirements

Fertilizer experiments on cotton indicated that application of 85 to 114 kg nitrogen per hectare to American cotton increased the yield of seed cotton by about 400 to 600 kg/ha over the control when the plant population ranged from 35,000 to 42,500 per hectare depending upon the fertility status of the soil. The response was relatively low when the plant population was increased to 57,500 plants per hectare. This lower nitrogen response at higher plant density was obviously due to inadequacy of the applied fertilizer to meet the increased nitrogen requirement of larger number of plants per unit area. In the case of "desi" cotton, 56 kg of nitrogen per hectare increased the yield of seed cotton by 300 kg per hectare when the crop was sown in rows 60 cm apart with plants spaced 22.5 cm apart.

4.2. Irrigation

Water requirements of cotton are reduced under high water-table condition and zero, one and three irrigation may be needed for maximum production on soil with a water-table depth at 60, 240 and 330-390 cm below the ground surface, respectively. This may be due to the fact that partial water requirements of the crop are met from the ground water.

4.3. Second and third fruiting cycles

Studies conducted on the second and third fruiting cycles of cotton indicated that the productivity of the second and third fruiting cycles of the perennial cotton was found to be greater than the annual seed grown crops. The maximum productivity recorded in second fruiting cycle may be attributed to more fruiting. No pest and disease build up was observed during the course of these investigations.

4.4. Biological nitrogen fixation

Feasibility of substitution of chemical N by biological nitrogen fixed through cotton-legume intercropping was studied. The biological N in intercropped plots significantly increased all the yield components and yield of seed cotton per plant as compared to check and chemically fertilized plots.

4.5. Seed treatment

Pre-sowing temperature stress on seedling emergence and yield of cotton showed that the seed of American cotton stressed at 50, 60, 70, 80 and 90°C for 24 hours before seeding germinated differently. Seed stress at 50 to 70°C had a stimulatory effect on seedling emergence and on the subsequent performance of the cotton plant, while higher temperature either caused thermal injury or killed the seed.

4.6. Cropping pattern

There is conclusive evidence that earlier planting from the middle of March to the middle of April is more productive than its conventional planting in May-June. Since 70 per cent of cotton is sown after wheat, its earlier planting is not possible. Consequently different cropping patterns were studied to suggest an alternate and more productive one. The results indicated that cotton following winter fallow or cotton is more productive as it permits earlier planting of the crop. Again, planting cotton after berseem fertilized at 56 kg P_2O_5/ha yielded more than planting it after wheat.

4.7. Relay cropping of cotton

Relay cropping of cotton in wheat was compared with the normal mono-cropping of wheat and cotton. Planting American cotton B-557 in the middle of March in wheat, sown in 60-cm apart rows, gave a total production of 13 quintals/ha of seed cotton and 29.43 quintals/ha of wheat as compared to 9.15 and 37.14 quintals/ha, respectively, of the normal mono-cropping of cotton and wheat. These results suggest that relay cropping of cotton in wheat is a more productive and efficient system.

4.8. Weed control

Stomp and Dacthal WP.75 (pre-emergence) and Buano-6 and Dowpan-M (post-emergence) herbicides were studied in comparison with cultural methods for weed control. The data obtained from the field trials revealed that the pre-emergence application of Stomp at the rate of 5 1/ha was the most effective one in controlling Kharif weeds especially the broad leaved ones, wheras Buano-6 'at post-emergence proved more effective against *Cyperus rotundus.*

4.9. Cropping sequence

Cotton was planted after sugarcane, fodder-maize, berseem, gram, wheat, cotton, raya and fallow with fertilizer applications at the rate 150-100-0, 100-75-0,75-50-0,25-50-0 and 0-0-0 kg/ha, respectively. The succeeding cotton crop was fertilized at the rate of 75-50-0 kg/ha. The results indicated a decrease in the yield of cotton planted after "raya". Cotton following wheat, berseem, and gram yielded higher than that following sugarcane, fodder-maize, fallow and cotton. Sowing of cotton after berseem and gram besides improving seed cotton yields reduced the total fertilizer expenses involved in the berseem- cotton and gram-cotton sequences to a substantial extent.

5. SUGARCANE

5.1. Planting technology

Several years experiments on planting technology comprising 90 cm apart double row strips with 30 cm space between the rows of each strip (30/90 cm) was consistently superior to the conventional procedures of planting. It excelled in cane yield by about 10-15 per cent. The new method is characterized by a series of agronomic, economic and managerial merits for adoption. Where already adopted, the new method has brought significant gains to the growers.

5.2. Seed treatment

Soaking sugarcane setts in water and 2 per cent $KMnO_4$ solution before planting accelerated the rate of germination but did not improve the cane yield to a significant extent.

Preliminary studies showed that the removal of the apical bud of sugarcane in the month of February released the lateral buds from the dominant inhibitory effects of the former, thus stimulating the growth activity. The use of stimulated buds in planting resulted in quicker seedling emergence. Similarly planting 2.5 cm long setts, each having a bud, gave quite satisfactory germinability as compared to the planting of normal 15 to 25 cm long setts. By using 2.5 cm long setts, a lot of cane tonnage lost in seeding can be saved.

5.3. Seed quality

It was observed that at harvest about 10 to 14 per cent of cane is immature and lower in sucrose contents. The studies have shown that this is enough to plant an acre and is capable of giving comparable germination, plant growth and yield of cane obtained from the mature cane. Consequently, selling of the mature cane to the mills and using immature cane for seed will not only bring more income to the farmers but also increase sugar recovery percentage, as mature canes are heavier and higher in sucrose content.

5.4. Irrigation

Planting sugarcane in ridges and applying irrigation in furrows saved irrigation water upto 12%, besides increasing the cane yield. Similarly, ridge sowing followed by irrigation water in alternate furrows further reduced the irrigation time by one half without affecting the yield as compared to the standard practice.

5.5. Intercropping

Several years experiments on intercropping in autumn sugarcane revealed that cane yield of autumn sugarcane was reduced by 9.56, 15.22 and 20.21 percent with intercropping of berseem, wheat and "purbi-raya" in between the 90-150 cm apart cane strips respectively, over roonocropped sugarcane. However, at the cost of this much reduction in cane yield an additional harvest of about 91 tonnes of berseem green fodder, 2616 kg wheat grain and 2394 kg "raya" seed/ha was obtained. The additional harvest of berseem and raya from an intercropping system compensated more than the losses in cane yield while wheat intercropping failed to compensate the loss in cane production.

Similarly, autumn sugarcane intercropped with garlic gave the highest net income of about Rs.40519 and Rs.39334 in the case of cane intercropped with berseem and monocropped sugarcane, respectively. The sucrose contents in cane were not affected significantly by various intercropping systems.

Wheat-sugarcane intercropping system appeared to be feasible and successful provided wheat is planted in 60, 80 and 100 cm apart double, triple and 4-row strips with 20 cm space between the rows of each strip, respectively instead of single rows 40 cm apart. In the light of results it is further suggested that sugarcane should preferably be intercropped in wheat in the month of January/February when wheat field is still in optimum moisture condition and wheat roots are in a developing phase and can better absorb the mechanical shocks during the intercropping operation of sugarcane. The other advantage of January interplanting is that the seed cane can be utilized earlier when it is still healthy and not affected by frost.

5.6. Planting density

Studies on planting density for four successive years showed that double sett planting system of sugarcane with a planting density of 1,08,900 two budded setts/ha gave significantly higher cane yield (145.32 t/ha) than that of single sett planting with a planting density of 54,450 double budded setts per hectare.

5.7. Fertilizer use

Studies on fertilizer use in autumn sugarcane indicated that both the stand and vegetative growth of sugarcane were increased to a considerable extent by the application of N alone, while P and K applied singly or in combination with each other had very little effect on these characters. Although sucrose contents in cane were decreased with the application of N, NP and NPK over check, yet the differences among them were non-singnificant. The results further led to the conclusion that for a soil with an initial harvested productive potential of 36.92 t/ha and NPK level of 0.029%, 7 ppm and 155 ppm, respectively, a fertilizer dose of 200 kg N/ha is required to raise the yield to the level of 84.54 t/ha.

Similarly, the yield of spring sugarcane was increased by 66.5, 96.3 and 104.8 per cent with the application of 200-0-0, 200-100-0 and 200-100-50 kg NPK/ha, respectively over check, whereas increase in yield as a result of P_2O_5 in addition to N amounted to 17.9% over N alone,while the addition of K_2O along with NP increased the yield further by 5.1 per cent. It is to be pointed out that NK interacted with each other less favourably as compared to NP and NPK combinations, suggesting that balanced application of NPK is essential to harvest maximum yield potential of sugarcane.

Application of 170 kg N increased the yield of millable cane of spring planted cane by about 22.5 t/ha over check. Keeping the N level constant, addition of 85 kg P_2O_5/ha increased the yield further by about 12.5 t/ha over N alone, while at constant NP level, addition of 85 kg K_2O increased the cane yield still further by about 2.57 t/ha and nearly doubled the yield as compared to unfertilized crop. There was significant decrease in sucrose contents of the heavily fertilized crop but sharp decline was noticed where nitrogen alone was applied, whereas phosphatic and potash fertilizer had favourable effects.

The cane yield of first spring ratoon sugarcane was increased by 11.12 t/ha over check with application of 150 kg N/ha, while addition of 150 kg P_2O_5/ha alone with N enhanced the yield further by 9.19 t/ha over N alone as against 2.77 t/ha over NP by the application of 150 kg K_2O/ha. The results further revealed that for a soil with an initial harvested productive potential of 64.07 tonnes of cane per hectare a fertilizer dose of 150-150-150 kg NPK is required to raise the cane production of 1st ratoon crop to the level of 87.15 t/ha.

Varietal studies on sugarcane on a light soil indicated that among the different varieties, CP43/33 and L.118 gave significantly higher cane yield/ha than rest of the varieties which were at par with each other, while L-S2/96 and B 4360 appeared to be the next promising ones. BL-4 and Triton did not perform well due to their high nutritional requirements.

6. OIL SEEDS

6.1. Varietal cum planting dates

Two years results pertaining to the adjustment of planting time of different rape and mustard cultivars led to the conclusion that "peela-raya" gave 16.80 and 23.07 per cent higher seed yield than Parkash and Raya L-18 respectively irrespective to planting dates and appeared to possess wider adaptability than all the rest of the cultivars under study. Ganyou-4, ORO ad NARC proved to be the next promising cultivars for extreme late planting (30th of November).

Experiments conducted on the yield potential and oil seed contents of different sunflower varieties for two successive years revealed that the highest seed yield of 22.56 with 40.11 per cent seed oil content was obtained in the case of "Shamas" when planted in the pattern of 90 cm apart double row strips with 30 cm space between the plants (30/90 cm), while the highest seed oil content of 41.91 per cent with an average seed yield of 18.09 quintals/ha was recorded for Dekalb. 894.

Spring sunflower produced almost similar seed yield/ha when planted from February 10 to March 10, which ranged between 21.81 to 23.12 quintals of seed/ha. Similarly the seed oil contents were not affected to a significant extent by various planting dates commencing from February 10 to March 10. The seed oil content, on an average, varied from 40.17 to 41.65 per cent.

As regards planting dates for the autumn crop, there was almost progressive decrease in seed yield and seed oil content with each successive planting date commencing from September 20 to November 10 at an interval of 10 days. The best planting date appeared to be September 20 which recorded the highest seed yield of 25.61 quintals/ha with seed oil content of 40.87% as against the lowest seed yield of 8.43 quantals/ha with seed oil content of 36.49 per cent for November 10 planting.

6.2. Fertilizer use

Experiments on the fertilizer requirements of sunflower revealed that the best fertilizer dose was 75-0-50 kg NPK/ha which increased the seed yield by 893 and 214 kg/ha over check and 750-50-0 kg NPK/ha treatment, respectively. Similarly, seed oil contents were decreased significantly with the application of 75 kg N alone over check, while it got improved almost to the level of check with the application of PK alone or along with N.

7. MUNGBEAN

7.1. Varietal trials

Varietal trials on mungbean for three successive years revealed that Pak.22 produced the highest yield of 882.2 kg/ha as against 842.2 quintals/ha in the case of 71-17 which appeared to be the next promising strain. The results further indicated that mungbean yield was considerably higher in spring season (826.7 kg/ha) than grown in summer season (678.3 kg/ha) which was obviously due to environmental variation in the two seasons.

7.2 Fertilizer Use

Fertilizer experiments on mungbean indicated that for sandy loam soil with an initial harvested productive potential of 798.5 kg grains/ha, there is no need of applying fertilizer as it does not help increasing mungbean yield to a significant extent. On the other hand for a soil having on an average 0.05% N, 4.71 ppm available P_2O_5 and 111.85 ppm K_2O mungbean yield was increased by 211.7 kg/ha with the application of 25 kg N/ha over check, while addition of 50 kg P_2O_5/ha along with 25 kg N increased the seed yield further by 83.33 kg/ha over N alone. Application of 50 kg K_2O/ha along with NP enhanced the

yield still further by 114.6 kg/ha over NP. The protein contents in seed and nodulation were also increased signigicantly with N, NP, NP and NPK application over check, while K application alone had non significant effect on protein contents and nodulation.

Similarly, another experiment on mungbean led to the conclusion that for a soil with an initial harvested productive potential of 523.4 kg/ha a fertilizer dose of 28 kg N + 50 kg P_2O_5/ha was required to raise the productive potential to the level of 986 kg/ha irrespective of the planting methods.

8. GRAM

8.1. Varietal trails

Among the seven different gram genotypes tested on a light soil at uniform agronomic operations for three successive yeas, genotypes 1108 and 1115 appeared to be the most promising ones in all respects.

8.2. Fertilizer use

Fertilizer experiments on gram under field conditions for two successive years showed that the application of phosphorus alone or in combination with starter nitrogen dose did not increase gram yield to a significant extent on a light soil where probably nodulation is encouraged as a result of good drainage and better soil aeration. Among the three varieties used in these studies, the highest yield of 750 kg/ha was obtained from AUG.480 closely followed by *CM.72* and C-44 recording 752 and 744 kg/ha, respectively but these were statistically at par with one another.

CROP PHYSIOLOGY

1. STUDIES ON GROWTH HORMONES

1.1. Gibberellins

Gibberellic acid (GAa) pre-treatment promoted seed germination in wheat and rate of germination was enhanced as the concenration of gibberellic acid increased. The seedling growth, both shoot and root, was also stimulated by gibberellic acid pretreatment and stimulatory effect on seedling growth, unlike germination, was independent of the concentration of the gibberellic acid. Gibberellic acid pretreatment failed to enhance the seed germination of wheat under saline conditions.

1.2. Auxins

Application of IAA caused morphological changes in wheat seedlings. The results indicated that primary action site of IAA was the hypocotyl region of the embryo as the hypocotyl region of the wheat seedlings was very much enlarged in IAA treated seedlings. The effect of IAA on wheat germination remains inconclusive; both low (50 ppm) and high (500 ppm) concentrations being inhibitory in effect.

1.3. Growth retardant-ABA

Pretreatment with abscisic acid (ABA) not only inhibited the seed germination but also supressed the seedling growth of wheat. The inhibitory effect on both germination and seedling growth increased with increase in ABA concentration and decreased with GAa but was not reversed. Growth inhibition was more in the case of radicle than plumule.

Exogenous application of ABA to wheat under water stress conditions caused reduction in all the growth parameters including grain yield. However ABA tended to enhance the flag leaf water potential showing maintenance of the leaf turgor through stomatal closure.

Urea spray, particularly 4% urea, increased the yield component, grain yield and grain protein contents of wheat grown under drought conditions.

2. WHEAT GROWTH RESPONSE TO MOISTURE REGIMES UNDER SALINE-SODIC CONDITIONS

Rate and total germination of wheat were decreased with increase in soil moisture. There was almost a 50% reduction in germination at 19% soil moisture than at 10% soil moisture. Maximum germination (>90X) was obtained at 10% moisture (half field capacity), while seeds failed to germinate in the saturated saline-sodic soil with 26% saturation percentage.

Seedlings emergence and their establishment were more seriously affected by salinity x moisture interaction and the surviving seedlings, once established, were able to make sucessful growth subsequently. This stage of plant growth is considered to be the most crucial one in saline-sodic water soils.

3. STUDIES ON SALT TOLERANCE INDUCTION IN MAIZE

Presowing seed treatment with NaCI and CaClz for different soaking periods did not improve the germination of maize *{Zea mays* L.) as compared to wet control. However, pretreatment with CaCk induced some salt tolerance in maize as evidenced by better plant growth under saline conditions. Best

results were obtained with presowing seed soaking in 4% CaCIa for 8 hours.

4. STUDIES ON WATER RELATIONS

Studies conducted under green house conditions revealed that shoot length, fresh weight, dry weight, leaf area and relative growth rate of sorghum decreased significantly with the increase in external salinity. This response is likely to be the indirect effect of salts which induce water stress. This is supported by the path coefficient analysis which showed that the growth characters had a high correlation with leaf water potential.

AGRICULTURAL ENTOMOLOGY

1. TAXONOMY

1.1. Insects

Taxonomic studies on different groups of insects were conducted and the number of new and redescribed species are given below.

One new subfamily, Kuldanagasterinae and one new genus, Kuldanagaster were added to the already known TAXA of the dragonflies.

A scientist Khalid Mahmood in 1995, worked under the supervision of Dr. Muhammad Yousuf on "Taxonomic studies of Acridoidea (Orthoptera) of Azad Jammu & Kashmir. Keys for both the higher and lower taxa had been constructed. The deviations from the published descriptions and the additional characters, if any, of all genra and species were included in the studies. The new species and allotypes had been described in detail. The measurements of various taxonomically important body parts along with their range, mean, standard deviation, ratios and illustrations were also given. The distribution maps of all the species determined had been added.

In 1995, Muhammad Saeed conducted his research work on "Taxonomic studies of Grylloidea (Orthoptera) of Pakistan" under supervision of Dr. Muhammad Yousuf. The correct identification of 17 species, which were previously misidentified by Saeed (1989), was given. A single holotype male described as *Loxoblemmus jinnahi* is synonymized with *L. hamulifer*. The identification of *Cophogryllus brevipes* and the new status of *Pachyornebius rajanpurensis* as given by the above worker were doubtful, as they were based on very immature specimens, which lack the important taxonomic characters. The illustrations of different body parts along with the genitalia and distributional maps of the species were also given. The latitude, longitude, annual mean temperature and annual average precipitation for almost all the collection localities had been appended.

Mr. Wasem Akram under the guidance of Dr. Muhammad Yousuf worked on "Systematics of Thysanoptera of Pakistan" in 2000. For this purpose, adult thrips were collected during 1996-1998 from 62 localities of four climatic regions of Pakistan. The specimens were identified into 60 species belonging to 29 genera in 4 subfamilies under 3 families of 2 suborders. Complete description, deviating characters from the published description and the new characters, if any, of all the species had been recorded. Measurements of different body parts had been recorded, mean and standard deviation of those samples had been worked out where the population size was large, while for rest of the individuals only range had been given.

In 2001, a scientist, Mr. Muhammad Jalal Arif carried out his research work on "Taxonomic studies of Syrphidae (Diptera) of Pakistan. Adult syrphid flies had been collected during 1996-99 from 50 localities of Pakistan. All the species had been described in detail in order to make future identifications easier. The measurements of various body parts along with their range, means, standard deviations and the ratios had also been included in this study. The illustrations of different parts and distributional maps of the species had been given. The latitude, longitude, altitude, annual mean temperature and annual average precipitation for all the collection sites had also been appended.

In 2001, Mr. Muhammad Ahmad under the supervision of Dr. Muhammad Yousuf worked on "Taxonomic studies on Microgasterinae (Braconidae: Hymenoptera) of the Punjab. Adult microgasterines were

collected from 1997-2000 from 18 localities of the Punjab. The specimens were identified into 36 species under 11 genera. Of these, 2 genera and 9 species were new to science. In addition, 2 genera had recorded for the first time from the Punjab. Descriptions of all the species had been given in order to facilitate their future identification. The measurement of various taxonomically important body parts along with their rages had been included. The diagrams of different body parts and distributional maps of all the species had been given.

1.2. Mites

One new sub-family, and seven new Genera of mites have been erected and established. Two hundred and eight species of mites have been described and they are NEW TO SCIENCE. In addition, 110 mite species have been redescribed with new distributional records. "Hypopi" stage of the three new species of the genus Acarus of stored grain has also been described.

In 1985, Ghulam Mustafa worked under the supervision of Dr. Wali Muhammad on Taxonomic Studies of Cheyletid Mites from Pakistan. A total 0f 28 new mite species belonging to 7 genera of the family Cheyletidae, collected from various localities of Pakistan and had been described by the scientist in that study. Identification keys for genera and species, tables showing comparison of characters and similarity matrices had been prepared. Phenograms had been constructed to study the level of phenetic among the various species of different genera.

In 1985, a study on hypopi of stored grain and stored products mites from Pakistan had been made, taking into account the conventional system of classification and applying the modern techniques of numerical taxonomy by Muhammad Ashfaq under the supervision of Dr. Wali Muhammad. A total of 28 new species belonging to the genera *Capronomoia*, *Histiostoma*, *Glyphanoetus* of the family Histiostomatidae and *Acotyledon*, *Troupeauia*, *Forcellinia* and *Caloglyphus* of the family Acaridae had been described in that study.

Amjed Parvez in 1994, under supervision of Dr. Wali Muhammad conducted research on “Predatory Mites of the Genera Euseius Wainstein and Paraseiulus Muma from Pakistan (Acarina:Phytoseiidae). In this thesis, 32 species had been included. Out of those, 27 species were new to science. In addition males of 9 new species had also been described along with their respective females in the genus Euseius. Five already described species (Euseius 3 and Paraseiulus 2) had been provided with new distribution records and new host plants. Comprehensive keys for Pakistan species collected, so far, detailed descriptions of new species with their drawings and differentiation remarks had been given in this thesis. Moreover, tables showing comparison of characters, similarity matrisces and Phenograms had been constructed to study the level of phenetic affinity among the various species of mites of genera Euseius and Paraseiulus.

In 1995, a scientist Muhammad Anwar Zia carried out his research work on “Taxonomic studies on predatory mites of the genus Euseius Waisntein (Acarina:Phytoseiidae) from hilly areas of Pakistan under guidance of Dr. Muhammad Rafiq Khan. The research investigations include in all, 32 species of mites belonging to genus Euseius collected from hilly tracts of Pakistan. Out of these, 28 species were new to science, whereas new distributional localities and new host plants had been recorded for the already known and described 4 species of hilly areas. In addition, males of 6 new species have been described along with their respective females in this research work.

In 1995, Muhammad Aslam worked under the supervision of Dr. Wali Muhammad on “Taxonomic studies on predatory mites of the genus Neoseiulus Hughes (Acarina:Phytoseiidae) from Pakistan. A comprehensive key for Pakistan species, collected, so far, detailed descriptions of new species with drawings and differentiation remarks had been given in this thesis. Pictorial representation showing geographical distribution of these mites had been prepared and incorporated in the studies.

Mr. Muhammad Afzal conducted his research on "Taxonomic studies on predatory mites of the genus Phytoseius Ribaga (Acarina:Phytoseiidae) from Pakistan under supervision of Dr. Shamshad Akbar in 1999. As a result of the research investigations, in all, 44 species of sub genus *Phytoseius* and *Pennaseius* of genus *Phytoseius* were collected from Pakistan. New species had been described in detail and their differentiating characters from already known species had been mentioned, whereas new distributional localities and new host plants have been given for the already known 9 species of both the subgenra. In addition, males of 3 new species have also been described along with their respective females in this research work.

Mr. Mansoor-ul-Hasan conducted his research on "Family Tenuipalpidae (Acarina) from Punjab-Pakistan in 2000 under supervision of Dr. Shamshad Akbar. For the dissertation the collection of mites of the family Tenuipalpidae was carried out by conducting extensive survey of different localities in different climatic zones of Punjab. The collection was made by using Sieve and Berlese's Funnel collection methods. A total of 70 species belonging to the genera *Aegyptobia*, *Phytoptipalpus*, *Raoiella*, *Cenopalpus*, *Brevipalpus* and *Tenuipalpus* of the family Tenuipalpidae had been collected. Out of these, 31 were new to science whereas 39 species were already known which came into collection. The new species had been described in detail whereas in case of already known species new distribution records had been given.

2. MORPHOLOGY

Detailed morphological studies of eight genera of insects, viz., *Thermobia, Blatta, Gryllus, Acheta, Aspongopus, Idioscopus, Syrphus* and *CoccineUa* were carried out.

Comparative external morphology of the head of three dragonfly species, viz., *Orthetrum pruinosum neglectum* (Rambur), *Anormogomphus Kiritschenkoi* Bartenef and *Anax parthenope* Selys was studied.

The anatomy of digestive and reproductive systems of *Acheta domesticus* L. and *Gryllotalpa africana* PAD was studied. The histology of these structures revealed that they were of typical orthopteran type. Comparative study of the mouthparts and alimentary canal in the larvae and adults of *Syrphus* ha/tea tus DeGeer was also made.

3. PHYSIOLOGY AND NUTRITION

3.1 Entomophagous insects

These studies revealed that pH in the alimentary canal of three entomophagous insects, viz., *Empusa pauperata P., Crocothemis servilia servilia* Drury and *Harpactor costalis* Stol. Was found to range between 5.57-6.63, 5.57-6.10 and 5.9-7.40, respectively. However, in case of *E. pauperata* and C. *serviUa servilia,* the contents of the entire alimentary canal and in *H. costalis* that of the mid- and hind-gut were weakly acidic while the secretion of salivary glands and contents of fore-gut in the latter insect were slightly alkaline.

Qualitative analysis of the digestive enzymes showed that:

(a) Carbohydrases were absent in all the parts of the alimentary canal but proteinases (trypsin and pepsin) were present in fore-and mid-gut of the three entomophagous insects.
(b) Salivary glands and hind-gut of these insects were devoid of enzymes.

Quantitative estimation of trypsin showed that:

(a) Its activity was higher in the mid-gut of *Kpauperata* and *servilia servilia* than in their fore-gut,

whereas it was reverse in *II. C. costalis.*

(b) The enzyme distribution and activity showed that most of the digestion occurred in fore-and mid-gut of these insects. Studies on the feeding habits of dragonflies on insect pests of rice and cotton were also conducted.

3.2. Pytophagous insects

3.2.1. Orthopteroid insects

Orthopteroid orders include a variety of insects of great economic importance. These are serious pests of crops and household articles and a few are known to be the vectors of plant viruses. The information on digestive enzymes is of fundamental importance for understanding the digestive processes, feeding habits, host selection and insect resistance in crop plants.

The contents of salivary glands, fore-and mid-gut of *Chrotogonus trachypterus* (Blanch.), A. *domesticus* and *Periplaneta americana* (L.) were found to be acidic, while those of the hind-guts were slightly alkaline to weakly acidic.

Qualitative analysis of the digestive enzymes showed that:

(a) The fore-gut and mid-gut produced proteinases (trypsin and pepsin) and carbohydrases in the cases of A. *domesticus* and *P.americana* as against only carbohydrases in the case of C. *trachypterus,*

(b) Amylase was present only in the salivary glands of all the three test insects, while hind-gut was devoid of any such enzymes.

Quantitative estimation of enzymes revealed that:

(a) the activity of trypsin was higher in the mid-gut of Acbeta domesticus than in its fore-gut.
(b) the activity of invertase in the midgut was higher than in the fore-gut of all the three insects.
(c) the enzyme distribution showed that most of the digestion occurred in the fore- and mid-gut of these insects.
(d) studies on the factors affecting the host preference in C. trachypterus revealed that the moisture percentage was positively and the crude fibre was negatively correlated with the food consumption, which was in turn also negatively correlated with utilization.

3.2.2. Lepidopterous insects

(a) Sugarcane borers

The contents of the entire alimentary canal of sugarcane top borer *(Tryporyza nivella* (P.), sugarcane stem borer *Acigona steniellus* (Hamps.) and sugarcane root borer (*Emmalocera depresella* (Swin.) were found to be slightly acidic<6.0- 6.8). Qualitative analysis of the digestive enzymes showed that:

(a) Proteinases and amylase were absent.
(b) Invertase was present in the salivary glands and mid-gut of the top and stem borers while in the mid-gut alone of the root borer.
(c) Maltase was present in the mid-gut of these three borers. Quantitative estimation for, invertase, however, showed that:
(d) Invertase activity was considerably higher in the mid-gut than in the salivary glands of top and stem borers.
(e) Enzyme distribution showed that most of the digestion occurred in the mid-gut of these

insects.

(b) Maize borer

A quantitative survey of the enzymes in the digestive tract of maize borer, *Chilo partellus* (Swinhoe) showed that it is adequately equipped with enzymes necessary for digesting the major compounds of the, food material available in the maize *(Zea mays).* Thus, the insect makes use of the abundant carbohydrates, which constitute more than 77 per cent of the total dry weight of the maize plant.

pH value of the stomodaeum, mesenteron and salivary glands was 6.7 as against 6.2 in the proctodaeum. The extracts of mesenteron showed the presence of proteinases, aminopeptidases, L-glucosidases, B-fuctosidases, and lipase-esterases, and a weak reaction of amino-peptidases, peptidases and L-glucosidases was also detected in the stomodaeum. However, there was no enzyme activity in the proctodaeum.

In salivary glands, proteinases, aminopeptidases and L-glucocidases were detected. Tests for carboxypeptidases, dipeptidases, amylase, cellulase, B-glucosidases, L-galactosidases and B-galactosidase were negative from all portions of the gut as well as from the salivary glands.

(c) Rice Borers

The digestive enzymes of the yellow stem borer, *Tryporyza incertulas* Walker as well as of pink stem borer, *Sesamia inferens* (Walker) were analysed. The approximate hydrogen-ion-concentration of the yellow stem borer was 6.7, 8.6, 9.5 and 9.6 for salivary glands, stomodaeum mesenteron and proctodaeum, respectively. In case of the pink stem borer, the approximate pH values of the salivary glands, stomodaeum, mesenteron and proctodaeum were 6.7, 8.6, 9.6 and 8.5, respectively. „

The enzymes detected in the stomodaeum of the test insects were amylase, and lipase. The mesenteron proved to be the main centre for the occurrence of five different enzymes, viz., maltase, amylase, trypsin, erepsin and lipase. Lipase and amylase were indicated in the proctodaeum of the yellow stem borer but only lipase was found in the proctodaeum of the pink stem borer. The enzyme amylase was detected in the salivary glands. Pepsin and lactase were not indicated in the gut reactions of the test insects.

4. BIOLOGY AND ECOLOGY

4.1. Biology

The study of biology and ecology of insect and mite pests is a pre-requisite for determining their effective, preventive and curative control measures. It was with this end in view that the biology of following insect pests of crops, vegetables and fruit plants was studied under the laboratory conditions and, in some cases, under the field conditions.

4.1.1. Insects

1. Citrus psylla, Phyllocnistis citrella Stn.
2. Mango hopper, Idioscopus clypealis (Leth.)
3. Cabbage butterfly, Pieris brassicae L.
4. Lemon butterfly, Papilio demoleus L.
5. Syrphus fly, Syrphus balteatus DeGeer
6. Field cricket, Gryllua bimaculatus DeGeer
7. 'Ak' butterfly, Danias chryaippus L.
8. Mustard sawfly, Athalia proxima Klog.

9. 'Hadda' beetle, Henosepilachna spp.
10. Bihar hairy caterpillar, Diacriaia obliqua (W1K.)
11. Codling moth, Cydia pomonella (L.)
12. Fruit fly, Dacus dorsalis Hendel
13. Onion thrip, Thrips tabaci Lind.
14. Sugarcane black bug, Macropes excavatus Dist.
15. Spotted bollworm of cotton, Earias insulana (Boisd.)
16. Cotton leaf roller, Sylepta derogata F.
17. Rice hispa, Dicladispa armigera (Oliv.)
18. Rice leaf folder, Cnaphalocrocis medinalia (Gn.)

4.1.2. Mites

Vegetable mite, *TetranychuB telarius* L.

4.2. Ecobiology

The effect of different temperatures and relative humidities on the development .of mustard sawfly, gram cutworm, field and house crickets, *Chrotogonus* sp. and *Menochilus sexmaculatus* F. was studied in the laboratory and very useful results were obtained on the development of these insects under different sets of various temperature /humidity combinations.

Studies on the effect of weather on the light-trap captures of *Tryporyza incertulaa* (W1K.) and T. *innotata* (Wlk.) showed two distinct peaks of emergence of *T. incertulas,* first in the last two weeks of April and second in the first two weeks of September. The yellow stem borer, T. *innotata* showed the peak period in the second half of September. The maximum temperature of 35°C, the minimum temperature of 20°C and the relative humidity of 158.5 per cent made an optimum combination for the emergence of T. *innotata.*

Some studies on the ecobiology of rice leaf folder, C. *medinalis* and rice hispa, *D. armigera* and on the biology of Gurdaspur borer of sugarcane, *A. steniellus* have been completed.

Studies on the population dynamics of codling moth, *Cydia pomonella* L., conducted using light traps with UV sources and sex/pheromone traps, revealed three peaks of flight activity. The first peak was recorded from fourth week of April to first week of May, the second during second and third weeks of June and the third during the second week of August. Density of larval and pupal population was estimated by banding the trunks of apple trees. The maximum population was captured during the first fortnight of June.

In addition to the biological studies on insects reported above, the research on the biology of mite species mentioned below was also conducted.

1. Schizototranychus mustafai M&C (New sugarcane mite)
2. Larvacarus tranaitans (Ewing) (Ber mite)
3. Tenuipalpus Justrabilis Chaudhri (Anar mite)
4. Eutetranychus orientalis McGregor (Castor mite)
5. Gnorimus tsbella Chaudhri (Predatory mite)

5. INSECT PEST CONTROL

5.1 Insect pests of rice

5.1.1. Rice borers and leaf folder

a) Chemical control

Diazinon 10X, sevidol 16%, furadan 10%. azodrin 5%, birlane 10% and lebaycid 5X tried in doses of 1.5 and 2.0 lbs. a.i. per acre each, except sevidol applied at 3.2 and 4.8 lbs. a.i. per acre, were tried for the control of rice borers. It was found that birlane and furadan proved to be the most effective against rice borers.

Granular formulations of ekalux, diazinon, sevidol, dyfonate, imidan, BHC and endrin were tested at the rate of 2.00, 1.6. 3.2,1.5,1.5,2.5 and 0.5 Ibs. a.m. per acre and the foliar spray of endrin, diazinon, imidan., BHC. and ekatin were tried at the rate of 0.3, 0.5, 0.75, 0.70 and 0.25 Ibs. a.m. per acre, respectively. The first and second Explications were done 30 days after transplanting, respectively. BKalux was followed in a descending r-der by diazinon, sevidol, dyfonate, imidan, BHC and endrin, in effectiveness. Endrin gave the best results, followed in a descending order by diazinon., imidan BHC and Ekatin.

Studies were conducted to control rice borers with aerial spray of dimecron 100 in combination with fenitrothion 95% using ULV technique and with sevin using conventional techniques. The results of borer-infestation recorded at weekly intervals, both from treated and untreated plots treated with dimecron 100 + fenitrothion 95% as against 3.98 to 7.13% (5.1% average) in check plots. It was further found that these treatments gave a significant control of the rice borers and ultimately resulted in a significant increase in the yield. In the plots treated with sevin, the infestation varied from 3.06 to 6.49% as against 7.25 to 14.06% in the check, thus indicating a significant control of the rice borers with this treatment. A significant increase in the yield was also found in treated plots as compard to that recorded from the check plots. Miral and curacron also increased the yield and reduced the borers attack.

The cost-benefit ratio as a result of aerial operations conducted with dimecren + fenitrothion was 1:7.2 as against 1:8.5 in case of aerial operations conducted with sevin.

The effectiveness of applications of insecticides and cultural treatments was compared in terms of the mortality of riceborer larvae. It was found that birlane and solvirex differed significantly from sowing of wheat, sowing of berseem fodder, ploughing of field, planking and ploughing of field. The cultural treatments showed a slight difference over control.

The insecticides tried against Rice leaf folder, *C. medinalis* included denitol, sumithion, thiodan, methyl parathion and larsban. These insecticides, respectively, gave 93%, 94%, 97%, 98% and 95% mortality of this pest.

Experiment was conducted in 1992 by Manzoor Ahmad Virk under the supervision of Dr. Muhmud Ayaz Wahla on “Chemical Geometry of the Comparative Efficacy of Some Insecticide-Granules Against the Stem borer complex of ‘Basmati 370’ Rice”. It was concluded by the scientist that the comparative efficacy of insecticide granules tested, varied, with the product. The chemical profile of their efficacy with reference to the composition of stem borer haemolymph as well as with that of the mature ‘Basmati 370’ stem, also varied. Based on the conclusions, the use of Furadan (Carbofuran) 3G was recommended to be preferred over that of the other test-insecticides, in the field, against the *Scirpophaga* spp. stem borer of ‘Basmati 370’ crop.

b. Physical Control:

Studies were conducted to test the possibilities of using gamma radiation (2.5 Kr., 5.0 Kr. and 10.0 kr.) tepa (20, 40, 60, 80, mg/stubble) and thermal treatments (1, 2, 3 and 5 days at 35°C and 70% R.H.) for the sterilization of the diapausing larvae of rice stem borers, Tryporyza spp. (Lepidoptera: Pyralidae) and the results achieved indicated that all the three sterilants tested, i.e., gamma radiation, tepa and thermal

treatments, showed a significant effect on the emergence of the adults but not on their sex ratio. All the three sterilants proved to have no effect on the longevity of the adults as compared to the normal individuals, irrespective of the species and the sex.

From the egg masses obtained there was no egg hatch in case of higher doses of gamma radiation and tepa. Some abnormal adults were, however, found in the case of higher dosages of gamma radiation.

c) Varietal resistance

Twenty-five varieties and selections of rice were tested in the field at the Rice Research Station, Kala Shah Kaku.

Differences of susceptibility among the test varieties were significant. Varieties 370 'basmati', 6129 'basmati', 349 'jhona', 197 'basmati', 198 'basmati' and 278 'sethra' were found to have significantly more number of egg masses and higher incidence of dead-hearts and white-heads than the other test varieties. These varieties appeared to be susceptible at both dead-heart and white-head stages.

The succulency of leaves, looseness of leaf sheath, taller height, thicker stem and wider flag leaf were probably responsible for the susceptibility of these varieties.

Different trials were made to study the resistance factors of rice varieties against the borers. It was found that chemical, morphological and anatomical characters were responsible for resistance by manifesting through antibiosis and tolerance but not through the preference of various cultivars. Of the various factors, 96.04% resistance was attributed to chemical factors, and out of this 43.18% came through the moisture contents, which were negatively correlated with the resistance phenomenon.

5.1.2. Plant and leaf hoppers

(a) Population dynamics

Population studies on plant and leaf-hoppers of rice revealed that an average population of white paddy jassid, *Cofana spectra* (Dist.) per 20 net sweeps ranged from 0.27 to 0.99 during July-October.

The population of green leafhopper, *Nephotettix cincticeps* (Uhl) started building up in August and reached its peak in October. Its population at Sohowala (Sialkot) was exceptionally high,i.e., 136.89 per 20 sweeps compared with that at other sites of the rice growing tract where it ranged from 2.46 to 30.66.

The population of white-backed planthopper, *Sogatella furcifera* (Horv.) remained very high from the last week of September to the end of third week of October. However, the extremes of its population were 2.25 to 1191.70 individuals per 20 sweeps.

b) Chemical Control

Following insecticides were tried against plant-and leaf hoppers of rice as well as against the rice hispa.

The insecticides tried against N. *cincticeps* included malathion (2.5 lit.), curacron (0.6 Lit), gusathion (1.6 Lit.), thiodan (1.25 Lit.), baythroid (0.2 Lit.), ripcord (0.4 lit.) methyl perathion (1.0 Lit.) and phosvit (0.35 Lit.). These insecticides gave a minimum control of 75% after 12 days of the treatment.

S. *furcifera* was effectively controlled with perfekthion, sumithion, phosvit and baythroid. The pest mortality declined from 80.40%, observed 24 hours after spray to 42.32%, 72 hours after the treatment.

The insecticide malathion, gusathion, ripcord, methyl parathion and baythroid gave more than 90% mortality of C. *spectra* 24 hours after the treatment, while curacron and thiodan equated with these insecticides 72 hours after the treatment. However, baythroid, ripcord and methyl parathion gave 100% mortality 72 hours after the treatment.

Dimethoate at the rate of 1.5 lbs a.m. per acre gave 91.15% mortality of the rice hispa, *D. armigra* (Oliv.) as against 90.73 and 85.76% with diazinon and carbaryl, respectively. BHC at the rate of 4 lb a.m. per acre gave 79.62% mortality of this pest.

5.2. Insect pests of cotton

5.2.1. Sucking pests

(a) Economic Threshold level (E.T.L.)

Population studies revealed that 1 to 2 jassids and 5 to 6 white-flies per leaf served as a good index (E.T.L.) for the two pests.

b) Chemical control

Out of azodrin, bidrin, kilval and nogos tried for the control of whitefly and jassid, azodrin at the rate of 0.75 Ib. a.i. per acre proved to be the most effective. Methyl parathion, when used against aforesaid pests showed a toxic effect on the pests as well as on their natural enemies.

Temik, furadan, solvirex (1.5 Ib a.i. per acre) caused a maximum mortality of whitefly, jassids and thrips within the first week of their application. The effect of insecticides lasted for 5 to 6 weeks against whitefly and jassid but was ineffective beyond four weeks against thrips.

c) Biological control

Dragonflies were evaluated as the predators of cotton pests under laboratory conditions through forced feeding. They proved to be important predators of the sucking pest insects.

d) Varietal resistance

In 1991, Amjad Ali worked under the supervision of Dr. Muhammad Abdul Quayyoom on “Physico-chemical factors affecting resistance in cotton against Jassid, *Amrasca devastans* (Dist.) and Thrips, *Thrips tabaci* (Lind.) in the Punjab, Pakistan. The factors regarding mechanism and components of resistance against jassid and thrips were studied on 10 selected cotton entries during 1988 and 1989. Host plant resistance index based on population density for each test insect was calculated for each variety for the two study years. Role of weather in the expression of resistance for both the test insects was studied by correlating the population density with weather factors. In addition, yield potential of selected cotton entries was determined by calculating reduction in seed cotton yield caused by insect pest complex.

In 1999, studies on “Physico-Chemical Factors Affecting Resistance in Cotton Against Whitefly, *Bemisia tabaci* (Gennad.) in Punjab, Pakistan” had been carried out by Mr. Muhammad Afzal under supervision of Dr. Muhammad Akhtar. The main aim of this project, was not only to explore the impact of different physico-chemical characters of some genotypes of cotton on their resistance against the cotton whitefly, but also to sort out the most important ones of them. For this purpose, 20 recent cotton releases, were screened, at NIAB, Faisalabad during 1992-93 and 1993-94, and on the basis of pooled information, thus collected, only 6 of them with wide departures in their infestations of the CWF, nymphs and adults were,

finally, isolated for further tests. After a thorough discussion of various facts, it was concluded that the comparative resistance against CWF, in Cotton, varied with their genotypes, tested. These variations, were found to be associated with the thickness of leaf-lamina, to the extent of 57.1% and finally that every unit increase in this character, would increase the CWF resistance, in cotton, to the tune of 0.0007 units.

5.2.2. Bollworms

a) Population dynamics

Population dynamics of the spotted and pink bollworms were studied on squares, flowers, unopened and opened bolls and in plant debris of AU-59, AU-14, AC-134 and B-557. The population of spotted bollworms was highest in October while that of pink bollworm was the highest in November. AU-59 was found relatively resistant while B-557 was found susceptible to the attack of spotted bollworm. Studies on new varieties were conducted and it was revealed that MNH-93 was susceptible to the attack of spotted bollworm. Studies on new varieties were conducted and it was revealed that MNH-93 was susceptible to the attack of pink bollworm. The overwintering population of pink bollworm was maximum in the bolls on cotton sticks in the fields that neither received any insecticidal application nor were subjected to goat sheep grazing after the last pick.

b) Chemical control

i) Sevin at the rate of 2.00 Ibs a.i. per acre was found to be the most effective for the control of bollworms, and 5 sprayings with this insecticide gave 56.5 per cent increase in the yield of seed cotton over the check.

ii) Hostathion at the rate of 1 Ib a.i. per acre was found to increase the yield by decreasing the bollworm population.

c) Cultural control

Studies conducted on the effect of date of sowing, irrigation and fertilizer applicaion on the population of cotton whitefly, revealed

i) higher population on early sown crop (May 10) and lower in the late sown crop (July 10).
ii) number of irrigations did not show significant difference in the whitefly population.
iii) increasing rates of fertilizers, increased the susceptibility of cotton crop to whitefly.

d) Biological control

Eight hymeriopterous parasites, six larval, viz., *Bracon* sp. *Bracon hebetor* Say., *Rogaa aligarhensis* Qadri, *Elasmus johnstoni* Fb., *Goniozus* sp. and *Apanteles angaleti* Mues. and two pupal, viz., *Brachymeria tachardiae* Cam and *Goryphus nursei* Cam were reared from the pink and spotted bollworms.

e) Varietal resistance

i) Studies on the response of 22 new varieties of cotton to jassid, whitefly and pink bollworm were carried out and it was found that early maturing and short duration varieties escaped pink bollworm infestation.

ii) Studies on the biophysical factors responsible for resistance in cotton revealed that hair density and the length of hair on mid rib contributed towards their resistance to jassids, whereas these

parameters were positively correlated with whitefly population.

iii) Quantities of phosphorus, iron, lipids and proteins were found to have positive correlation with resistance in cotton to jassid, whereas reducing sugars, moisture, calcium, magnesium and potassium showed a negative correlation.

Studies on the prevalence of pink bollworm of cotton, *Pectinophora qossypiella (*Saund.) in left-over opened and unopened bolls on harvested stacked cotton sticks, conducted from February to April, in order to find out the carry over of this pest to the new crop revealed that the mean pest population in the unopened bolls was 23.74%, 37.80% and 17.89%, respectively at top, middle and bottom levels of stacked cotton sticks in February as against 20.86%, 36.92% and 16.53 in March and 7.24% and 5.78% in April. In the opened bolls the pest population was 0.89%, 0.94% and 0.46%, in February, respectively, at top, middle and bottom levels of cotton sticks. In March, the corresponding figures were 0.17%, 0.75% and 0.2% as against 0.15%, 0.29% and 0.08% in April. The pest population per 1 kg debris in February was found to be 12.56%, 6.58% and 2.0% in February, March and April, respectively.

f) Biological control

In 2003, Abida Nasreen conducted her research under the supervision of Dr. M. Ashfaq on "Selectivity between chemical and biological agents in controlling *Helicoverpa armigera* (Hubner) in cotton". The research was undertaken with a view to maintain mass culture of predators and parasitoid and to screen out suitable pesticides compatible with biological control in IPM. The scientist developed A.M. technology for the mass rearing of bio-control agent *Chrysoperla carnea* and also integrated it with various chemicals for the control of *H. armigera*. In this technology, hard gelatin capsules (500 mg) were used for larval rearing. A rectangular (35×20×35cm) adult rearing chamber made of transparent plastic sheet with removable top was designed, to allow proper illumination and ventilation inside the chamber. Handling of adult green lace wing i.e. *Chrysoperla carnea* (sanitation, cleaning, feeding and harvesting of eggs) in the newly designed chamber proved very easy and it eliminated the use of vacuum sucker, anesthesia and chemicals like Sodium hypochlorite, Potassium hypochlorite ete. The eggs of *C. carnea* were harvested efficiently without initiation of diapause because of the microenvironment developed inside the cage with high relative humidity. They reported that if the bio-control agent *C. carnea* is mass reared and released in the cotton fields, the sprays of the insecticides would be minimized and this technology is of great importance in IPM. It will be only by dint of such developments that our agricultural products will be able to compete in the global free trade market. It is an answer to W.T.O implication in agriculture sector with special reference to insecticide free production.

g) Varietal resistance

In 1992, Muhammad Saeed worked under the supervision of Dr. M. Rafiq Khan on "Factors Affecting the Resistance of Upland Cotton, *Gossypium hirsutum* L. to *Pectinophora gossypiella* (saunders) in Pakistan". A careful view of morphological and chemical factors revealed that most of the contribution towards PBW population came through morphological factors. He suggested that leaf area, leaf/petiole, hairiness and midrib/lateral vein thickness were important traits contributing toward PBW infestation. Among the chemical characters total lipids and the presence of isoleucine may also contribute significantly as antibiotic factor to make the resistance multifacet and wider.

In 1997, Mr. Abrar Ahmad under the guidance of Dr. Muhammad Ashfaq worked on "Role of Pest-Host Interaction in IPM of *Mythimna separata* (Wlk.) in Pakistan". Studies were conducted to determine the role of pest host interaction in IPM of *Mythimna separata* (Wlk.) in terms of food consumption and coefficient of utilization. Based on the data of food consumption and coefficient of utilization from preliminary screening trials, 15 plants (our of 54) viz., chulai, dib, garlic, gram, khabbal grass, korbooti, lady's finger, maize, makoh, onion, potato, rice, sorghum, sugarcane and water grass plants were selected. These 15

plants were again offered as food to *M. separata* to confirm the order of preference through their consumption and coefficient of utilization. Multivariate models were established among various combinations of plant factors and values of food consumption and coefficient of utilization to determine their contributions and to find out the coefficient of utilization having negative and positive responses, respectively.

Studies entitled "Factors affecting resistance in cotton against *Helicoverpa armigera* (Hubner) in Pakistan" were conducted during 1997-98 under field and laboratory conditions at districts of Toba Tek Singh and Faisalabad, Pakistan by Mr. Tasneem Ahmad under the kind supervision of Dr. Muhammad Ashfaq. Three genotypes of cotton showing resistance, three susceptible and three genotypes with intermediate responses were screened out from 25 entries based on the oviposition preference by *Helicoverpa armigera* under field conditions. The selected entries were then screened for their response towards oviposition, larval population and infestation of fruiting parts by *Helicoverpa armigera* under field conditions and through consumption and coefficient of utilization by offering tender leaves to 4^{th} instar larvae under laboratory conditions. Morpho-physico-chemical characters of the leaves of nine selected genotypes were studied to find their role towards resistance/susceptibility. The selected genotypes were also studied for antixenosis and antibiosis inferences. The role of abiotic factors was also studied to determine their role in population dynamics of *Helicoverpa armigera*.

Mr. Khawar Jawad Ahmad under the supervision of Dr. Muhammad Ashfaq worked on "Factors Affecting Pest-Host Interaction in IPM of *Helicoverpa armigera* (Hubner) in Pakistan in 2002. Based on the data of food consumption and CU from preliminary screening trials, 13 plants along with two cotton genotypes were selected. Five plants were common and thus 15 selected plants in total were again offered as food to *Helicoverpa armigera* to confirm the order of preference through their consumption and CU. Various morpho-physical and chemical plant factors were correlated with the values of consumption and CU. Multivariate models were established among various combinations of plant factors and values of food consumption and CU to determine their contribution and to find out significant factors resonsible for the express of resistant. The data were also subjected for Principal Component Analysis with the objective to find the role of various combinations of factors towards resistance. Various components of resistance like antixenosis and antibiosis were also studied in vitro.

5.3. Insect pests of sugarcane

5.3.1. Borers

Sugarcane crop, growing in the Sugar Mill Zone of Faisalabad, regarding top and stem borer infestation revealed that average top borer infestation in April was 0.74%, in May 5% and in June it was 9.43%. The infestation of stem borer in April varied from 0.88 to 1.95% and in June it varied from 40 to 43.79 per cent.

a) Chemical control

Endrin 20 E.C.at the rate of 8 lbs. per acre applied against sugarcane borers, in a single dose through irrigation water during August proved effective.

Granular formulation each of thiodan, furadon, carbaryl, diazinon, endrin, dipterex and ekalux tried for the control of sugarcane borers revealed that endrin applied at the rate of 1.5 lbs. per acre proved to be the best.

5.3.2. Sucking pests

i) Pyrilla

a) Chemical control

Out of malathion, disystox and dimecron tried for the control of sugarcane pyrilla, malathion 57 B.C. applied at the rate of 2 Ibs. per acre proved to be the best. Sugarcane varieties^ COL-54 and COL-116 gave the best sugar recovery after controlling this notorious pest.

b) Biological control

Interaction between the parasites, *Epipyropa melanoleuca* and the host, *Pyrilla perpusilla* was found to be positive.

ii) Sugarcane mite:

Two pesticides, viz., omite and metasystox, each applied at 0.1% cone. proved more effective against sugarcane mite, *S.mustafai* compared to 0.05% concentration. However, the lower concentration of omite (0.05%) showed its superiority over the higher concentration of metasystox (0.1%).

5.4. Insect pests of maize

5.4.1. Pest survey and population:

i) Survey and collection of the insect pests of spring maize showed 23 insect species belonging to 5 different orders and one species of mite damaging maize at different levels during the entire growth period of the crop.

Population of maize jassid, *Zyqina* sp. on spring crop was three times higher as compared to autumn crop, as it was adopted to dry weather conditions while aphids and predators were adopted to moderate weather conditions. Percentage infestation of maize borer was higher at the beginning as compared to the crop near its maturity.

ii) Economic threshold level of maize borers was worked out to range from 5 to 10 per cent.

5.4.2. Chemical control:

i) Diazinon 10 G applied at the rate of 5 kg per acre gave better results as compared to sprays against borer infestation. Populations of aphid and jassid were also reduced.

ii) The application of curator, disyston, ekalux, furadan and temik against maize shootfly attacking a synthetic variety of maize "AKBAR", significantly reduced its infestation.

iii) The application of granular formulation each of endrin, B1IC and dipterex at the rate of 0.6 , 3.00 and 2.00 Ibs. a.i. per acre, respectively, at 9 days interval gave effective control of maize borer.

iv) Out of all the pyrethroids applied against maize borers, ambush and sumicidin at the rate of 55cc a.i. per acre at 20 days interval, gave better results than others.

5.4.3. Cultural control:

i) Intercropping of maize with sorghum reduced the borer infestation which resulted in an increase in the grain yield.

ii) The application of nitrogenous fertilizers increased the susceptibility of maize crop to maize jassid

and maize aphid. However, the application of phosphatic fertilizers did not affect the susceptibility of maize crop to its pests significantly.

5.4.4. Varietal resistance:

Seventeen morphological factors were studied for the resistance of some maize cultivars to the attack of Sorghum Shootfly, *Atherigona* spp. It was found that the thickness of leaf-sheath wrapping was positively correlated to resistance to the attack of maggots of this fly and this factor alone was responsible for 99.916% resistance.

Moisture contents were found negatively correlated to resistance against this fly and they contributed 83.007% of the changes in this phenomenon and that every unit-decrease in this character increased the shootfly-resistance in maize to the tune of 29.82 units independently.

In 1990, studies were carried out by Ijaz Parvez on “Factors Affecting the Resistance of Different Maize Cultivars Against *Chilo partellus* (Swinhoe). From the studies, he concluded that the TRIO of 37 morphological, anatomical and chemical characters of maize, was responsible for 95.86% of their resistance against the *Chilo partellus*. Of these, the morphological ones were found to be the most important and accounted alone for 60.64% of the resistance phenomenon. The length of hair on the leaf-lamina, which was positively correlated to the maize-resistance, was the most important of the various morphological factors and accounted alone for 57.36% of the changes in borer-resistance of maize.

5.5. Insect pests of fruits.

5.5.1. Mango hoppers

a) Chemical control

Out of 7 insecticides, viz., gusathion, lebaycid, metasystox, lebaycid 50 B.C. at the rate of 1.0 lb a.i. per 100 gallons of water proved to be the most effective.

5.5.2. Mango mealy bug

Application of perfekthion, sumithion, diazinon and dimecron through Injection method at the rate of 0.4 to 0.6 ml a.m. per cm girth of the tree trunk gave 100% control.

a) Mechanical control:

The pest has been prevented economically and effectively from climbing up the mango tree with 6" strip of polythene sheet, wrapped tightly around the tree trunk just before the nymph emergence. This method consequently protected the fruit from the infestation of this bug.

b) Chemical control:

Spreading of BHC and DDT dusts around the base of the stem of mango tree, just before the nymph emergence effectively controlled the pest. The application of insecticides through injection method as against mango hopper also gave 100% control of the mango mealy bug.

c) Mango malformation:

The newly emerged nymphs of mango mealy bug were exposed to the soil, treated with BHC, Sevin, thiodan or heptachlor at I", 2" and 3" depths. The average nymphal mortality at 1" depth was 51, 71 69.5

and 93%, respectively, with BHC, Sevin, thiodan and heptachlor, 24 hours after their application. The corresponding mortalities at 2" depth were 59,72.5, 67 and 89% as against 60.5, 74.5, 66.5 and 8X at a 3" depth of soil.

The application of parathion, nuvacron, sumithion and malathion in sprayable concentration of 1:500 against first instar nymphs gave, respectively, on an average, 100%, 87%, 96% and 84% nymph mortality after 72 hours of application. The sprayable concentration 1:300 of the aforesaid respective insecticides gave 98, 84, 92 and 72% mortality of second instar nymphs while a concentration of 1:100 gave 100, 83, 93 and 74% mortality of third instar nymphs after 72 hours of application.

The combined application of dimecron, omite, virazole, terramycin nutrient solution, venlate and temik reduced mango malformation up to 40% and leafy type of malformation up to 100 per cent.

5.5.3. Citrus psylla

Application of diazinon 0.1% at 10 days interval proved effective against citrus psylla.

5.5.4. Codling moth

Sumicidin 0.05% and ripcord 0.07% were sprayed thrice at 15 days interval against codling moth of the first generation and the third application supplemented with banding and ploughing was applied against 2nd generation of the pest. The insecticidal treatment supplemented with banding and ploughing resulted in 97 to 100 per cent healthy fruits in case of sumicidin, 92.34% in case of ripcord as against 87 9% and 84.8% healthy fruits, respectively, with sumicidin and ripcord when supplemented with ploughing only.

5.5.5. Peach fruit fly

Methyl eugenol 85% (male sex lure) in combination with 10% sugar and 5% naled (a killing agent) used as a trap against males of peach fruit fly, gave effective control of the pest."

Investigations carried out by Mr. Liaqatullah Khan in 1987 on “Bionomics and Control of the Melon Fruit Fly, *Dacus Cucurbitae* (Dipt.: Tephritidae)” under the supervision of Dr. Manzoor-ul-Haq. During that investigations, melon fruit fly was found attacking on 17 hosts- 12 cucurbits, 3 rutaceous, 1 solanaceous and 1 moraceous. Based on the cost:benefit ratio, the best control technique was by dusting ash (cost:benefit ratio 1:9), followed by growing spongegourd or squashmelon in melon as trap crop(1:7.9), by using pheromone traps (1:4.36), and by using poisoned cut-melon (1:2.69).

5.5.6. Jaman leaf miner

Out of 4 insecticides, viz, folidol, dimecron, roxion and nuvacron tested against jaman leaf miner, folidol 0.12% proved to be the most effective, followed by dimecron 0.03%.

5.6. Insect pests of vegetables

5.6.1. Brinjal borers

Insecticidal trials against brinjal borers saved 55.6% of plants.

5.6.2. Cabbage butterfly

Among sevin, phosvit, zolone and tamaron tested against cabbage butterfly sevin, proved better than the others after 24 hours of its application.

5.6.3. Mustard sawfly

Laboratory studies showed that there was no significant difference in the development of grubs of mustard sawfly at the temperatures between 19 to 28°C

5.6.4. Aphids, jassid and thrips

Out of all the insecticides used against sucking pests of vegetables, tamaron 25 E.C. proved to be the best for the control of aphids, while furadon 10 B.C. gave the best control of jassid and thrips. Studies conducted to control potato leaf roll virus (PLV) through insecticidal application against its vector, *Myzus persicae* revealed that seed furrow application of temik 10 G applied at the rate of 1.6 kg a.i./ hectare and 6 sprays with malathion 75 E.C.8 0.05% conc. at 10 days interval, starting just after 50% germination of the crop, gave a significant control of the pest and consequently brought a significant reduction in PLV.

5.6.5. Mites

To control the mite, *TetranychuB telarius,* attacking beans, 3 pesticides, viz., plictron, akar and nogos were used. Akar proved better than the others.

Nuvacron and plictron each applied at 0.05% and 0.1% concentrations tested against cucurbit mite, T.cucurbitee attacking bitter gourd showed that 0.1% nuvacron gave 100% nymphal mortality as against 84.19% with 0.05% concentration. The concentrations of 0.05% and 0.1% of plictron, respectively, gave 76.71 and 87.70% nymphal mortality. Maximum mortality of adult mites (98.12%) was achieved with nuvacron 0.1%, followed by plictron 0.1% (85.26%), nuvacron 0.05% (80.75), plictron 0.05% (74.92%) after 96 hours of their application.

5.7. Insect pests of tobacco

Dipel *{Bacillus thuringiensis),* lannate and thiodan were used for the control of tobacco cutworm and tobacco budworm. All treatments gave a significant control of these pests.

5.8. Insect pests of stored grain.

5.8.1. Insect pests survey

A comprehensive survey of different parts of Pakistan was made and the incidence of insect pest attack on stored grain was studied and is reported as under:-

The insect pests found attacking the stored grain in god owns of the local dealers and those of Food Department included *Trogoderma granarium* Everts., *Rhizopertha dominica* (Fb.), *Tribolium castaneum* (Host.), *Sitophilus oryzae* (Linn.) *Sitoroga cerealella* (Olev.) and *Callosobruchus* spp.

5.8.2. Infestation under different storage conditions

The incidence of pest attack on stored wheat was found to vary from 5 to 15 per cent depending upon the type of godowns, type of storage and the period of storage. Out of the five types of godowns, viz., (a) Bins and Silos (b) House-type godowns, (c) Lahore type sheds, (d) Hired private godowns and (e) godowns owned by the dealers used for the purposes of storage, Bins and Silos proved to be the best, and house-type godowns proved to be only satisfactory. The incidence of pest attack in these (two) types of godowns was generally 1 to 2 per cent except in a few cases where wheat had become wet before storage, due to rains and was stored without drying. This was found to be true particularly in case of

godowns belonging to the Department of Food. Another additional advantage in these (two) types of godowns was the performance of regular fumingation operations by the Department of Food. The incidence of pest attack in Lahore type sheds and in hired private godowns of the Department of Food was also low, i.e., up to 2% since effective control measures had been carried out well in time. In House-type godowns the incidence of pest attack varied from 1 to 3 per cent. However, in godowns owned by the private dealers, the damage was found to vary from 5 to 15 per cent.

Regarding the effect of type of storage, the wheat stored in bags was found to be damaged more than that stored in bulk. In certain cases, where the period of storage of wheat was 1 1/2 years in bins owned by the Department of Pood, the damage was found to be 4 to 5 per cent but such cases were very few. The infestation was more in 2 years old stocks than in the one year old stocks. So the policy "First stored first released" must be adopted. Further emphasis should be laid on the construction of Silos-type godowns, because beyound aeration and temprature control, Silos are economical and easy in filling and release of grains.

The study of the incidence of pest attack on rice and pulses remained restricted to private godowns. In the private godowns owned by Commission Agents or Local Dealers the incidence of pest attack was found to vary from 5 to 15 per cent in rice and 5 to 7 per cent in pulses. However, the survey of rice godowns in Sheikhupura and Gujranwala indicated no loss by the insect attack because of the short storage duration maintained by the Rice Export Corporation.

On an average, the indicence of insect pest attack was found to vary from locality to locality and from commodity to commodity. It varied from 0 to 18 per cent in wheat, 1.6 to 7 per cent in rice, 10 percent in pulses and 2 to 10 per cent in maize, sorghum and bajra depending upon the type of godowns, type of storage (bulk or bag), whether treated or untreated and on the period of storage.

5.8.3. Varietal susceptibility

a) Wheat

Researches carried out on the susceptibility of eight wheat varieties to T. *c&staneum* (Hbst.),J& *domiaica* and T. *granarium* revealed that Nortino wheat proved to be the most susceptible and Barani-70 the most resistant to the attack of these insects. The study of loss on monthly basis showed that it was the highest during the month of June caused to all the varieties by different insect pests. *T. granarium* proved to be the most disastrous of the three insect pests to all the wheat varieties.

Studies carried out on the susceptibility of five wheat varieties, namely, AU-44, Panjamo, Larmarojo, C-273 and Mexi-Pak (white) to T. *granarium, R, dominica* and to the combination of the two insects by initial introduction of 30 insects in each variety revealed that the percentage loss in weight on annual basis varied form 4.66 in case of C-273 and to 6.22 in case of AU-44. The other varieties of wheat, namely, Mexi-Pak., Panjamo and Larmarojo showed an annual loss of 4.88 5.22 and 5.44 per cent, respectively.

The percentage of damaged grains was found to be 9.84 and 11.96 in C-273 and AU-44, whereas it came to 11.05, 11.22 and 11.49 in Panjamo, Mexi-Pak and Larmarojo, respectively.

The most susceptible variety with regard to the percentage loss in weight as well as to the percentage of damaged grains was found to be AU-44, while C-273 was comparatively the least susceptible. The loss was found to increase to higher level from April onward till it reached its maximum during July. No variety under the present studies was found to be completely resistant to the attack of the two insects.

Investigations carried out to study the effects of physical and biological factors on the relative susceptibility of 5 wheat varieties, namely, Chenab-79, Blue Silver, V-1283., LU-26S and SS-6 to the

attack of *Latheticus oryzae* under laboratory conditions at 30°C and 70-75% R.H., revealed that SS-6 was highly susceptible and V-1283, the least susceptible variety. The former was the softest and the latter was the hardest. As such, the hardness proved to be positively connected with resistance. The same was true for crude protein and crude fibre. Further, the varieties with higher moisture contents suffered more.

Studies on qualitative losses in wheat in five selected districts, viz., Faisalabad, Multan, Sargodha, Sheikhupura and Gujranwala, were conducted. In all 1575 samples were selected and analysed. It was revealed that the trade samples were lower in foreign matter, number of insects, un-threshed grains etc. than the others. However, the other two parameters, viz., moisture %age and black tipped grains were the highest in the trade samples. *T. granarium* was prominent as stored grain pest in the districts of Multan and Bahawalpur while *Rhizopertha* and *Tribolium* dominated in other 3 districts.

b) Rice

Work on the susceptibility of 7 rice varieties to the attack of *S. oryzae* and T. *castaneum* revealed that 'Basmati' -198 proved to be the most susceptible and 'Jhona' 49 the most resistant.

Studies on the determination of losses caused by T. *castaneum* and *R. dominica* to rice stored in coarse cloth bags, were made for different storage periods varying form one to four months at two infestation levels and the losses were found to be proportional to the level of infestation and the period of storage.

c) Gram

Work on the susceptibility of 58 gram varieties to *CallosobrUchus chinensis* and *C. analis* revealed that varieties 6136, 6551 and 150-4 proved to be the most resistant to them, as against variety 6565 which was the most susceptible to both the species and variety 6523 which was susceptible only to C. *chinensis.*
The susceptibility of 30 gram varieties to the attack of *C. maculatus* was studied taking into consideration:

(a) the number of eggs laid on 20 grains of each variety,
(b) the number of adults emerged out of eggs laid on 20 grains,
(c) the number of infested grains and
(d) loss in weight on percentage basis.

The results achieved revealed that out of all the varieties, variety 6506 was the least susceptible and variety 6508 was the most susceptable to the pest.

5.8.4. Host specificity

Research conducted on the host range/host specificity of T. *castaneum* and *S. oryzae* on 30 agricultural commodities revealed that the maximum loss of 4.83 per cent in weight was recorded in yellow-desi variety of maize due to the infestation of *S. oryzae.* Gram (black variety), 'mash,' *{Phaseolus mungo* Linn.), `moong' *(Phaseolus aureus* Roxb.) 'toria' (Brassies *compestris* var( toria), 'sarson' *(Brassica compestris* Linn.) 'raya' *(Brassica juncea* Linn.) and castor seed were not altogether infested. T. *castaneum* rendered the maximum loss of 3 to 8 per cent to `suji' (Middlings).

Studies conducted on the host range/host specificity *of, S. ccrealella tor* the various commodities revealed that out of maize, barley, gram, wheat (Mexi-Pak, SA-42 and Chenab-70), 'bajra', oats, rice (fine and coarse), sorghum, 'moong,' starch, 'suji' and paper pieces, the last three mentioned commodities did not prove conducive for the development of this pest. Wheat (Mexi-Pak and SA-42), proved to be the best host. The percentage loss that occurred to these commodities by the pest varied from 0.27 per cent in gram to 6.42 per cent in wheat (Mexi-Pak) in 25 days and 2.01 per cent in gram to 16.29 per cent in

wheat (Mexi-Pak) after 70 days.

5.8.5. Biology
(a) Rhizopertha dominica P.

Studies on the development of different stages of *R. dominica* revealed that the highest duration of egg stage was 10.43 days at 25°C and 52% R.H. and the lowest was 3.93 days at 35»C and 75% R.H. The longest duration of 12.54 days of first larval stage was recorded at 25°C and 52% R.H., whereas the lowest duration of was recorded at 25°C and 52% R.H., whereas the lowest duration of 7.32 days was found at 35°C and 75% R.H. The longest duration of second larval instar was 9.59 days at 25°C and 52% R.IL, and the shortest durauon of this instar was 4.37 days at 35°C and 75% R.H.

The maximum duration of third larval instar was recorded as 8.80 days at 25°C and 52% R.H. and the minimum duration of 4 days was found at 35°C and 75% R.H. The longest duration of fourth larval instar was 12.47 days at 25°c and 52% R.H., and the shortest was 3.85 days at 35°C and 75% R.H. Pupal stage varied from a maximum duration of 6.20 days at 25°C and 52% R.H. to a minimum duration of 3.83 days at 35-C and 75% R.H.

(b) *Sitophilua oryzae*

Studies on the biology of 5. *oryzae* at different temperatures and on different types of food grains were made. The development period of the insect was significantly affected by different temperatures but the effect of food was non-significant. The longest incubation period was 7.30 days at 27°C on sorghum and rice and the shortest was 5.10 days at 35°C on maize. Prepupal stage lasted only for one day on all foods and at all temperatures.

(c) *Callosobruchus maculatus*

Studies on the oviposition of C. *maculatus* at various combinations of 4 temperatures and 6 relative humidities were made. The lowest mean number of eggs was 55.83, 13.00 and 14.00 recorded at 25°C, 35°C and 40°C and 100 per cent relative humidity, respectively, whereas, it was 28.00 eggs at 30°C and 100 per cent relative humidity. The oviposition period was 3.3, 3.5, 3.9, 3.7, 4.0 and 2.9 days recorded at 0, 30, 52, 75, 90 and 100 per cent relative humidities, respectitely. No significant differences in oviposition period were recorded at 0, 30, 52, 75, 90 and 100 per cent relative humidities, respectively. No significant difference in oviposition period were recorded due to varied relative humidity.

(d) Callosobruchus analis

Studies on the biology of *C. analis* on gram and maize, under different ecological conditions, revealed that the insect pests laid, on an everage, 127.67 eggs on gram at 32°C. and 90% relative humidity, the most suitable for oviposition purpose. The longest oviposition period of 8 days was recorded at 27°C and 30% R.H. and the shortest oviposition period was 1.3 days at 40°C and 90% R.H. on gram. The highest mean incubation period of 8.3 days was recorded at 27°C and 30% R.H. The maximum larval duration was 14.6 days on gram at 27°C and 90% R.H. The pupal duration of 10.6 days on gram and 11.0 days on maize were recorded at 27°C and 100% R.H., whereas the durations of 4.6 days and 5.3 days were recorded at 40°C and 75% R.H. on gram and maize, respectively.

(e) Latheticus oryzae

The biology of long-headed flour beetle, *Latheticus oryzae* was studied at two temperatures, 30°C and 35°C and two relative humidities, viz., 52% and 75%, using two types of foods, i.e., wheat flour of LU-26 and rice flour of Basmati-370. It was revealed that wheat flour was a more suitable diet at both

temperatures. However, the developmental period decreased at 35°C. 5.8.6. Chemical control:

Studies conducted on the effectiveness of three insecticides, viz., diazinon, malathion and nogos each used in 0.50% and 0.2% concentrations at 25, 30 and 35°C in combination with 52 and 75% R.H. against larvae of T. *granarium* revealed that malathion 0.1% proved to be the most effective as protectant of stored wheat. Similarly, BHC, diazinon, sevin and malathion were each tried in 0.05, 0.75 and 0.1% concentrations at 25, 30 ad 35°C against the adults of *R. dominica* and all the three concentrations of BHC gave 100 per cent mortality of the pest for more than 35 days.

Studies conducted on the effectiveness of five insecticides, BHC, diazinon, gardona, sevin and malathion each used at the rate of O.I Ib and 0.2 Ibs. a.m./ 100 sq. ft. surface area at room temperature revealed that sevin at 0.2 Ib a.m./1000 sq.ft. sjurface area proved to be the most effective insecticide on rice and it continued to give 100 per cent mortality of all the insect pests of rice for three days. Out of the four insecticides, namely, gardona, actellic, detmolin-M and nogos, the last mentioned insecticide proved to be the most effective against *T. castaneum* and *R. dominica* within 24 hours of the treatment. Similarly, out of malathion, garden a, diazinon, baythion, actellic and detmolin-M, tested against *S. cerealella,* gardona appeared to be the most effective.

Studies on the effectiveness of malathion, diazinon, gardona and BHC for the control of *C. chinensia* at 25°C gave varying results with different concentrations. The highest average mortality of 65.70 per cent at 25°C and 61.60 per cent at 35°C was obtained with gardona at the rate of 0.5 Ib a.m. per 1000 sq.ft. area.

Baythion at the rate of 4 oz. in 4 gallons of water per 1000 c.ft. area was found effective for the control of different insect pests infesting wheat.

The effect of four insecticides, DDT, BHC, malathion and nogos, was studied in four different concentrations- against *R. dominica* at 25, 30 and 35-C. Three insecticides, BHC, malathion and nogos were tried each in concentrations of 0.05, 0.1, 0.15 and 0.2 per cent, whereas DDT was used in concentrations of 0.5, 1.0,1.5 and 2.0 per cent. The results achieved revealed that at 25°C the highest mortality of 71.1 per cent of the pest was obtained with 0.2 per cent malathion and the lowest mortality of 4.2 per cent was obtained with nogos 0.05 per cent. At 30°C, again malathion at the rate of 0.2 per cent gave the highest mortality. At 35°C, malathion 0.2 per cent was found again to uphold first position and it gave 85.5 per cent mortality as against the lowest mortality of 34.4 per cent obtained with DDT 0.5 per cent. Malathion and nogos were found to have positive temperature coefficient as against negative temperature coefficient found in case of DDT and BIIC. The overall effect of time interval was found to be significant and the mortality percentage was found to increase with the passage of time after the removal of the insects from the treated surface. The effect of time interval on the treatment showed significant interdependence of the two factors.

In another experiment, out of the four insecticides, tried for the control of *S. cerealella,* gardona in a concentration of 15 ppm proved to be the most effective and gave a cent per cent control within 24 hours. This was followed by diazinon, malathion and actellic used in the same concentration.

Fumigation of infested wheat with phostoxin (Aluminium phosphide) at te rate of six tablets per ton under laboratory conditions and 30 pellets per 1000 c.ft. volume for commercial storage, proved effective for the control of *Callosobruchus* spp. infesting various pulses.
The mortality of different stored grain insects by the fumigants and insecticides was found to be best with phostoxin followed with that by E.D.C.T., malathion and 'gardona. The susceptibility of insects to fumigants and insecticides was found to be maximum in *T. castaneum* followed with that of *R. dominica* and T. *granarium.*

Phostoxin at the rate of 6 tablets per ton and E.D.C.T. at the rate of 20.00 Ibs per 1000 cu.ft. volume, gave an effective control of the insect pests, whereas malathion and gardona •rf- continued to kill the insects even after a number of days of the treatment because of their residual effect.

6. WILD PIG CONTROL

A survey of 22 villages of Faisalabad district indicated on an average 5X damage of sugarcane on account of wild pig, *Sus sacrofa.* The following control measures were tested against this pest.

6.1. Poison bait

Pioson (C1080, temik and arsenic trioxide) based substrates, viz., wheat grains, boiled maize, guava chips, rotten apples and fish meal were used successfully against wild pigs. Wheat grains although proved as a good substrate but killed many wild birds particularly partridges which fed on these piosoned grains and, therefore, the use of wheat grains for the purpose was discontinued. Addition of full cream dried milk or roots of 'deela' (*Cyprus rotendus)* in the poison bait increased the efficacy of the bait.

6.2. Sex attractants

The vaginal extract of the female wild pig in the heat period used in the poison bait increased the mortality of male pigs three times than the check.

7. APICULTURE

Beekeeping is the most important cottage industry in Pakistan. Out of three species of honey bees found here. *Apis cerana* P., the Indian honey bee has been found fit for domestication on scientific lines while the other two species i.e., *Apis florea* P. and *Apis dorsata* P. are wild in nature.

7.1. *Apis mellifera* L. an exotic domesticated species of honey bees, has been introduced in Pakistan. A few colonies of the species are being maintained in the Department. It reared significantly more brood than *A, cerana.*

7.2. Centrifuge method proved to be the most efficient for the refinement of honey and mosquito netting method proved to be the best for refining the beeswax.

7.3. Different bee management practices were found out to increase brood rearing and honey production and the same are given as under:-

a) Two-queen system:

Two-queen colonies proved superior in brood and honey production to overwintered requeened, and single queen colonies.

b) Re-queening:

The practice of requeening proved best, just prior to the main nectar flow.

c) Swarming:

Provision of restricted space to bees during the period of high brood production was found effective in inducing swarming.

d) Queen supersedure:

It was found that queens deficient in pheromone and those which were poor layers were usually superseded. It was found imperative to replace older queens with the younger queens just prior to the main nectar flow.

e) Stimulative feeding:

Feeding royal jelly to honey bee colonies and crushed younger larvae to queen bees was found to increase brood production which ultimately proved conducive to their survial during summer.

7.4. Honey bee toxicity:

Organo-phosphates, the most commonly used group of insecticides for the control of insect pests of agricultural *ctppa* were found highly toxic to bees visiting the blooming cro): s, treated with such insecticides.

7.5. Control of large wax moth (Galleria mellonella L.)

Application of a bacterium *Bacillus thuringiensis* on the comb was found highly effective against large wax moth.

7.6. Insect pollination

a) Studies conducted to find out different insect pollinators and their role in the pollination of different agricultural crops, fruits and vetgetables, revealed that the insects collected from the flowers of lucerne crop indicated 86 different species representing 37 families of 7 orders of class Insecta. However, Hymenoptera constituted 73.67 per cent of the total insect visitors of the lucerne flowers.

b) It was further found in case of plants of `raya', *{Brassica juncea* H.F. and T) covered with polythene bags, number of pods and seeds formed per inflorescence and number of pods per plant were significantly lower as compared to plants under natural conditions. Seeds formed in bagged plants were bigger in size and heavier in weight.

c) The Indian honey bee, *A. cerana* F. increased the seed yield of radish *(Rhaphanus satiws* Linn.) by 18.7 per cent and that of cauliflower *(Brassica oleracea)* by 23.6 per cent.

d) Out of 27 insect species that visited 'phalsa' *(Grewia asiatica* Linn.) flowers for nectar/pollen collection, only 13 including honey bees were found to be good pollinators.

e) Pollination studies revealed that significantly more fruits were set and matured on Kinnow Mandarin *{Citrus reticulata)* branches accessible to insect pollinators including honey bees than from where they were repelled or excluded. Similar results were achieved in case of sunflower, *Helianthus annuus.*

8. SERICULTURE

8.1. Investigations carried out to find out some suitable semi-synthetic diets for silkworm rearing revealed that asparctic acid and or glutamic acid were essential constituents of the silkworm diets. Further, inclusion of sucrose, glucose + fructose or glucose or fructose had a similar effect on the development of silkworm larvae. Cholesterol, soybean oil and B. vitamins were also found to be essentially required as survival on diets lacking these constituents was signigicantly lower than those containing these

constituents. Minerals were found essential for the development of first three instars while non-essential in the later instars. However, use of the 36 diets tested could not be relied upon for successful rearing of the silkworm. Chemical composition of mulberry leaves and the excreta of silkworm larvae has also been determined with a view to develop synthetic diet.

8.2. Nutritional Studies showed that *Morus leavigata* proved better than Af. *alba* for Japanese strain of silkworm because of the presence of more crude protein. The space 10 x 10 cm. per 30 larvae was found optimum upto 4th instar, while the optimum space for other instars was found to be 10 x 20 cm. per 30 larvae.

Studies were carried out on the growth pattern of silkworm in relation to nutritional requiremtnts. Negative correlation was found between dry matter of mulberry leaves consumed and coefficient of utilization. In addition to mulberry leaves two plant species, viz., osage orange (Afaclura *aurantiaca)* and lattuce (Lactuca *sativa* L.) proved suitable for silkworm rearing.

Studies on quantitative and qualitative feeding effects on silkworm, *Bombyx mori* L. were carried out. It was- found that silkworm larva fed on 37.5 gm mulberry leaves (Morus *alba laevigata)* during entire life. The mulberry leaves treated with 0.2% N proved best for growth, development and cocoon formation.

FORESTRY RANGE MANAGEMENT AND WILD LIFE

1. FORESTRY

1.1. Poplar-hybrid *(Populus euramericana)*

1.1.1. Water use efficiency

To determine the water use efficiency of *Populus euramericana* under field condition an experiment was laid out by planting a year old entire plants with ball of earth in mid July and observations were continued till the close of growing season to the end of October.

The biomass produced by one year old plants was 12 g of oven dry weight in 14 weeks from July to October. Evaporation from soil surface was over 66 per cent of the total water loss by evapo-transpiration. Evaporation from open water surface was nearly twice the evaporation from soil furface. Plants consumed 192 g of water per gram of biomass.

The water loss by poplar stand, as calculated from the biomass production, increased rather slowly upto 4 years of age. After 4 years, consumption-cum-transpiration by poplar takes off at a fast rate, reaching approximately 20 - acre - centimeters per annum. Maximum water loss by poplar stand is during the 10th year.

1.1.2. Biomass, wood density and nutrient distribution

The biomass, wood density and nutrient dynamics in 10-12 yeara old *PopuluB euramericana* were determined at plantations of Gatwala and Bhagat, in Paisalabad district. The total tree biomass was 10.4 metric tons per acre, in 10-12 years. The roots constitute only a small portion (12.9X) of the total biomass. The specific density of the wood varied from 0.25 - 0.56 g/cm^3 with a weighted average of 0.3 mg/cm^3.

Gross uptake of nutrients from the soil was estimated to be 228.5 kg/acre. Annual net uptake of nutrients from the soil comes to 117.6 kg/acre.

1.2. Fodder trees

The fodder materials of four browse species, namely Ipil-ipil *(Leucaena leucocephala),* Jand *(Prosopis spicigera)* Phulai *(Acacia modesta)* and Jantar *(Sesbania sesban)* were analysed for dry matter, crude protein, crude fibre, ether extract and nitrogen free-extract contents, Digestability was estimated by invivo/vltro technique using fistulated goat.The results are tabulated below:

Name of Browse species	Dry matter	Crude protein	Cruid fibre	Crude fat	Mineral Matter	Nitrogen Free extract
Ipil-ipil	62.0	73.5	50.6	80.7	82.7	24.6
Jantar	70.3	77.4	68.8	87.8	81.5	58.0
Jand	34.3	56.8	37.5	61.7	58.0	17.6
Poplar	45.0	51.6	37.5	78.2	54.6	43.4

It is obvious from the Table above that Jantar and Ip4 -ipil fodders have the best digestibility of all the consitituents, except nitrogen-free-extract. Thus these two browse species should be encouraged in the

rangeland areas.

1.3. Forest Economics

Bamboo production in Sargodha district

The cost benefit analysis of three major Bamboos *Uendrocalamus hamiltonii* (Kala baans), *D.strictus* (Char baans) and *Phyllostachys bambusoides* (Sabz baans) was worked out. It was found that *D. hamiltonii* has the highest cost of production with an average of Rs. 31,235 per acre per annum. While the average cost of production of Rs. 16.836 was observed in P. *bambusiodes.* Similarly the highest avrage profit per annum per acre was Rs. 9688 in the case of *D. hamiltonii.* It was about 2.5 times greater than either of the other two kinds. The average profits for *D.strictus* and *P.bambusiodrs* were, Rs. 3593 and 3472 per acre per annum, respectively. *D. hamiltonii* is, therefore, considered as the must profitable bamboo, grown in Sargodha district.

2. Range management

2.1. Effect of gamma radiations on range plants

2.1.1. Germination and growth of *Cenchrus ciliaris* (Buffel grass)

Gamma radiation at 15 KR positively affected germination of Buffel grass. It was noted that maximum germination of 56X was recorded at 15 KR as against 47 percent for the control and 44 percent for 40 KR. Statistically, the difference among various doses were not significant.

Stimulation in plant growth occurred with radiation in respect of height, tillering and dry matter, which gradually increased as compared to control upto 10 KR dose, after which a decrease was noted upto the 40 KR. The 10 KR dose was the best dose for increased forage production with no detrimental effect on any of desirable characters of the plant.

2.1.2. The yield and nutritive value of Sorghum sudanense.

The seeds of *Sorghum* sudanense Stapf, were irradiated with 0, 4, 6, 8 and 10 KB gamma radiation before sowing. The 10 KR dose at prebloom and 6 KR at maturity stage, gave apparently higher yield than the control. Other treatments showed reduction in yield. Different doses of gamma . radiation did not show any influence on crude protein content. All doses of gamma radiation under study at both stages of growth showed significantly higher digestibility co-efficient of crude protein, as compared to control. Crude fibre was higher at maturity stage and lower at prebloom stage.

2.1.3. The different vegetative characteristics of *Sorghum sudanense* (Sudan grass)

The differences among the various doses of gamma irradiation were found to be highly significant (based on analysis of variance) in respect of germination, plant height, tillering, average leaf area, head emergence and green matter per plant.

Maximum germination (88 percent) was observed at 15 KR and minimum of (60 percent) at 100 KR as compared with control (81 percent)

Maximum plant height (116.5 cm) was recorded for 5 KR as compared to 109 cm of control. In case of ratoon crop however, plant height was maximum at 30 KR (214.1 cm) as compared with the control (193.1 cm).

Average number of tillers per plant were 14 at 5 KR and only 7 for 80 KR as compared with control which was 13.

The average leaf area was significantly more in the case of the plants under the irradiation upto 30 KR. It was 110.6 sq cms. at 15 KR and 99.7 sq cms. at 30 KR.

The maximum pre-blooming period of 59 days was recorded for 5 KR as compared to 62 days for the control. Blooming was delayed at higher doses.

Maximum green matter of 65 gm per plant was produced from 15 KR, as against 59 gm for the control. The dose 15 KR proved to be the best and significantly better than all other doses. The green matter per plant was significantly decreased by higher doses.

2.1.4. On the chronic and acute irradiation effects on the germination and growth of *Sorghum* sucfanense (Sudan grass)

The dry seed of *Sorghum sudanense* was subjected to 12 different acute and chronic doses of gamma irradiation. Most doses of irradiation had generally a delaying effect on seed germination upto 7 days. Maximum grmination (56%) was with 15 KR.However, difference in growth after 9 days was non-significant.

2.2. Productivity of ranages

2.2.1. Effect of clippings

Range grasses viz, *Cenchrus ciliaris* Linn., *Thalaris minor* Itetz., and *Dicanthium annulatum* (Forsk; Stapf.) at different stages of growth were clipped at preblooming, blooming and seed setting stages of growth and compared with undipped control. Observations were made on height and forage yield of once-clipped-plants at different stages of growth.

The height and yield were reduced in *C.cilaris Linn., D. annulatum* (Forsk) Stapf., and *P.minor* Retz., respectively.

The plants showed marked decrease in the number of tillers, basal area and crown diameter of once-clipped-plants different stages of growth in the following order: *D.annulatum, C.cilaris* and *P. minor.*

The early clipping stage is probably the best as regards the nutritive value and total forage production. Better results can be obtained by reducing the severity of clipping or grazing of these range grasses.

2.2.2. Effect of fertilizers

An experiment .was laid out on randomised design for nitrotgen and split plots for phosphorus, at Pabbi Hills Range. The net size of each plot being 12.2 x 3.05 meters. The results showed that green and dry forage yields increased with increasing application of nitrogen and phosphorus fertilizers. The maximum yield was obtained when 48 kg, of nitrogen and 36 kg of phosphorus per hectare was applied.

Nitrogen use efficiency increased with increasing dose of phosphorus: the maximum 83% which was achieved with application of 36 kg/hectare.

2.2.3. Effect of growing mixtures of fodder species

2.2.3.1. The effect of growing mixture of Oats and Brassica on forage yield.

The effect of 5 treatments i.e (a) pure oats, (b) pure Brassica, (c) Brassica 75% + oats 25% (d) Brassica 50% + oats 50% and (e) Brassica 25% + oats 75% on fodder yield was studied under field conditions. The total green fodder yield was more in pure Brassica than other mixtures and pure oats. The total dry fodder weight varied with the treatment. Brasica (75%) and oats (25%) mixture yield was higher than any other mixture and both Brassica and oats grown in mixture or alone, did not affect the height of individual crops.

Quality of forage mixture was improved with the increasing proportion of Oats as compared to pure Brassica.

2.2.3.2. The effect of mixing bajra and guara on forage yields

Pure bajra, pure guara, and 3 mixtures i.e.50% bajra + 50% guara, 67% guara + 33% bajra and guara 33% + bajra 67%; were compared for fodder yield under field conditions. The results showed that the total green and dry fodder yields were considerably increased in bajra and guara mixtures than pure stand of individual crops.

The crude protein contents of bajra increased in the mixture with the increase in proportion of guara. But the bajra -guara mixture did not increase the crude protein content of guara. Height of both plants remained unaffected.

2.2.3.3. Effect of legume Sratro *(Macroptillium atropureum)* and Dhaman grass *(Cenchrus ciliaris)* intercropping.

The combination of a grass and a legume was compared in 5 treatments i.e. (a) pure grass, (b) pure legume, (c) 35% grass + 65% legume (d) 65 % grass + 35% legume and (e) 50% grass + 50% legume to study the possibility of improving yield and quality of ranges. The data indicate that the yield of green and dry matter of various grass-legume combinations was significantly lower as against pure grass. The maximum yield was obtained in 120 days after planting.

Crude protein was the highest in pure legume crop (14%) and least (0.1%) in pure grass. The highest value of crude fibre (41.9%) was of pure grass. These values were. Significantly different from all other treatments. The least crude fibre (34.7%) was in pure legume.

2.2.3.4. Effect of spacing on growth of *Panicum maximum*

The effect of different spacings i.e. 20, 40, 60 and 80 cm on growth of *Panicum maximum* showed that the average green forage yield and number of tillers at 20 cm and 40 cm spacings differed significantly. With 80 cm spacing, the green forage yield and number of tillers and height increased, fresh root biomass was maximum at 40 cm spacing while the effect of other spacing was inconsistent.

2.3.1. Nutritional value of forage grasses and other Forbes

A study was conducted to detect the nutritive value of buff el grass *(Cenchrus ciliaris* Linn.) cut at the following four different stages of growth: (i) when six inches high: (ii) at flowering stage: (iii) seed formation and (iv) late stage of phonological cycle. Biological evaluation was done with the nylon bag technique using two fistulated steers at 24 and 48 hours digestive periods.

The crude protein content decreased with the advancement of growth, the lowest value reaching at late stage of growth while the reverse was true of crude fibre.

Totalash content was maximum in the early stage and decreased gradually to flowering and seed stages. The digestability co-efficient was maximum at the early stage of growth and minimum at the late growth stage.

Thus the stage of growth between early stage to the flowering, is probably the best in nutritive value.

2.4. Range surveys

2.4.1. Prospects of range development in Thai area

A number of villagers and government officials in Thai Range Management Division were interviewed to investigate the prospects of range development in Thai tract.

It was found that major source of income in this tract was livestock rearing. Main problems faced by majority of the graziers were the low carrying capacity of range land; lack of drinking water points and protection measures enforced by the Forest Department. Other factors which affected the development are: (a) low precipitation, (b) lack of funds, (c) inadequate research; (d) insufficient range staff and non-cooperattion of 30 percent of graziers with local range personnel, and (e) lack of incentives for range staff. These problems are largely responsible for the poor development of range lands in this tract.

3. WILDLIFE

3.1. Feeding habits of wild pigs in Faisalabad district

Wild pigs were mostly vegetarians as is revealed by the examination of their gut-contents. Animal food is taken ony if the herbaceous material is not available.

The plant materials recovered from the gut content analyses included: bark of trees, herbage (leaves, twigs, fruiting parts of pleints), cotton, maize, sugarcane, wheat, sorghum, bajra, rice, lucerne, spinach, potatoes, sweet-potato, deela tubers, khabbal grass, aira roots.

The Animal material were: crickets, earth-worms, snails, egg-shells, mollasses scum, mice, fish, lizards, dead animals and human flesh, etc.

3.2. Breeding habits of wild pigs

The main rutting season of wild pigs is January - February with secondary breeding season around June - July, each year. The gestation period is about 113 - 117 days. The litter size goes on increasing with the age the female. The number of piglets ranges between 2-13 pups.

3.3. Population census

Wild pig census was taken in May and June when there were no crops in the fields. Drive-out and count method was used to estimate animal population in some representative plantations and marshy areas i.e. Gatwala plantation, Chaku plantation, R.B Canal Side Plantation, J.B. Canal Side plantation, Kala Pathana marshy area, etc. On the basis of these counts, it has been estimated that approximately 20 to 25 thousand animals are herding in Faisalabad district (2261 sq. miles acres).

BIOMASS, WOOD DENSITY AND NUTRIENT DISTRIBUTION IN *POPULUS EURAMRICANA* TREES (1980).
Abdul Majeed/Masood A.A.Quriashi

The total tree biomass was 10.4 metric tons per acre of which root, and foliage contributed 12.9 and 1.23% respectively. The harvestable portion was 73.75% of the total weight. The specific density of the wood varied from 0.25 gm/cm3 to 0.564 gm m3 with a weighted average of 0.385 gm /cm3.Leaves had the highest total concentration of all nutrients followed by that of twigs fibrous roots and woody roots. Branches weight was 110.9kg per acr through the turn over of 3.95 metric tons biomass whereas annual removal through harvest of stem + branches was 45.3 kg per acre.

WATER USE EFFICIENCY OF *POPULUS EUAMERICANA* (1980).
Akhtar Ali/Dr.Masood A.A.Quraishi

Plants consumed 343 and 291 grams of water to produce one gram of biomass during spring and summer respectively. Mulched plants are less efficient user of water. The overall estimate of water consumption per gram of biomass produced by hybred poplar under Faisalabad environment was 317 grams. An 11 year old popular tree consumed and transpired approximate 18773 liters (4210 gallions) of water during 12 years of its life.

EFFECT OF SHADE ON WHEAT CROP (1980)
Aman Ullah Shah/Ghualm Sarwar Khan

Plant height and number of tillers slightly increased under full light conditions. There was no remarkable differences on the disease effects and spike formation. The yield of grain and total dry weight of the grain was abundantly higher under full light intensity than all other treatments. But on the other hand NPK contents were quite high under 75% shade. However, it was recommended that the shade should be reduced in field crops for getting good yield.

STUDY OF GROWTH BEHAVIOR OF POPULUS EURAMERICANA UDER FARM CONDITIONS IN FAISALABAD DISTRICT (1980).
Shahid Yaqub/Ghulam Sarwar Khan

Height and diameter increased rapidly during first 7-10 years whereas cumulative volume increased very slowly up to the age of 4 years that it increased rapidly. Age for maximum volume production was estimated to be around13-15 years. For economic rotation it appeared that maximum income per price is decreased due to hollow stem. Rotation for maximum biomass production was estimated to be 17 to 18 yeas.

EFFECT OF NPK ON THE GROWTH OF DALBERGIA SISSOO STUMPS (SHISHAM) (1985).
Muhammad Akram / Ghulam Sarwar Khan

All the treatments showed significant effects by increasing height diameters and dry matter of the plant. There were no effect of NPK on the number and branches of leaves. Chemical analysis showed that nitrogen contents of leaves and shoot were more with the application of NPK. Effect of NPK on phosphorous and potassium contents of leaves. shoots and roots of the plant was different in different treatments.

THE EFFECT OF TREES ON THE YIELD OF WHEAT CROP(1986).
Liaqat Ali/ Ghulam Sarwar Khan

It was observed that shisham and kikar both had detrimental effects on wheat to certain limits after that there was beneficial effect. In case of shisham the detrimental effect was up to 6.0 meters, whereas it was up to 8.5 meters in case of kikar. Beyond these limits there was no significant difference between control and other observations. In some cases the yield at 8.5 and 11.0 meter was more than control. The yield at one meter distance was affected more than3.5 and 6.0 meter. The man cause of reduced yield at

1.0 and 3.0 meter due to edge effect, root competition of trees, and losses through birds etc. In case of younger trees, the effect was not more than 6.00 meter, whereas bigger trees affected to the last limit.

EFFECT OF WEED CONTROL ON THE FORESTS(1986).
Munir Ahmed Dar/ Main Shahid Yaqoob

Weed control improved the growth of forest trees. seventy of springs damaged the tree growth. Rain of the chemical sprays had declined its beneficial effects. Helicopter application of chemical showed gord weed control. (an assignment not thesis).

THE EXTENT OF DAMAGE TO COTTON MNH-93 BY SHADE AND ROOT COMPETITION OF DALBERGIA SISSOO (SHISHUM)(1988).
Tariq Iqbal Khan/ Ghulam Sarwar Khan

It was observed that –shisham had more deterimental affect on cotton crop on northern side as compared with southern side to a certain limits then after that there was beneficial effects. The determintal effect-of shisham was up to 8.5 meter in northern side and 3.5 meter an southern side.

The yield at one meter distance was affected more than 3.5 +6 meter . the main cause of reduced yield at 1.0+3.5 meter was edge effect root competilion of trees and shade. The size of the trees also affected the crop. In case of younger trees the effect was more than 6.00 meter whereas bigger trees affected to the last-limit.

EFFECT OF TREE SHADE ON YIELD AND YIELD COMPONENTS OF WHEAT CROP(1989).
Noman Bashir Lone/ Rashid Ahmad Kahn

Gyermintaion, plant beight, number of grain per spike, straw weight\$m^2$, grain weight and total biomass\$m^2$ was significantly decreased at decreased distances from tree boles and under trees of increased bole diameter.

EFFECT OF SHADE OF EUCALYPTUS CAMALDULENSIS ON THE YIELD OF RICE (ORYZA STIVAL.)(1990)
Muhammad Akhtar /Rashid Ahmad Khan

Number of panicle bearing tillers per unit area. plant height, number of grains per panicle, grain weight per panicle, 1000,grain weight and granyield per hectare decreased progressive by with increasing in-tensity duration of shade. There was a remarkable suppressive effect of the shade on the grain yield of rice which amounted to 8.47 to 15.56 percent- by an average day time shade of 3 to 5 hours. the reduction in yield was further tensified from 20.89 to 32.40 percent when the duration of daily shade was 6 to 8 hours.

CONTRIBUTION OF AGRO-FORESTRY TO WOOD PRODUCTION IN TEHSIL LODHRAN OF DISRICT MULTAN (1990).
Muhammad Saleem/Dr.Masood A.A.Quraishi

Major species present in the farmlands were D.sisoo, A.nilotica, Eucalyptus spps.,S.malabarica and Zizyphus which were planted during last five years.

Average no. of trees felled during last year were 5.25,4.20 +2.60 respectively. Percentage of felling was higher n D sisoo while A. mibrica + other species were also felled to some extent. A reasonable amount of profit was attained from the sole trees among large and medium sized respondents gained very little i.e.Rs.986.D.sisoo was the principal species used for fuel.

STUDIES ON THE SHADING EFFECT OF SIMBAL (SALMALIA MELABARICA) ON GUARA (CYAMPOSIS PSORALIOIDES) (1990).
Shabbir Ahmad /Muhammad Akram

Data on fresh weight of plants \m^2 had demontrsated that T_4 (control) produced significantly more fresh weight than T_2 (12 m)and T_1(10m) while it stood at par with T_3(16m) which had occupied next best position.T_3(16m) and T_2(12m) and T_1(10m) behaved significantly

Information procured on dry weight of plants/m^2 ennunciated that T_4 (central)had excelled T_2(12m) and T_1(10m)while it stood at per with T_3 (16m).T_3 (16m) behaved significantly.

Data had indicatd that peresnce of shade had not interrupted with the sequence occurring for the duration of light because the T_4 and T_3 (16m) behaved in a similar manner.

EFFECT OF SHADE AND BENEFIT COST ANALYISIS OF DALBERGIA SISSOO AND ACACIA NILOTICA GROWING IN WHEAT FIELD (1990).
Wahid Rasheed /Rashid Ahmad Khan

Cost benefit analysis (CBA) indicated that growing of trees on farmlands effected the crops. But income from the trees was more than that of their negative effects on crops. It was estimated that net profit of growing Dalbergia sissoo trees in wheat crop was Rs.443/-for six months and Rs.712/- for Acacia nilotica respectively.

SOME STUDIES ON THE CURRENT USES OF EUCALYPTUS IN PUNJAB (1991).
Din Muhammad Zahid Khan/Rashid Ahmad Khan

The study showed that new species like Ecualyptus, simal and popular were versatile raw material for the industries like sports goods match industry furniture paper pulp plywood chipboard rail way sleepers and packing material with growing industrialization in Pakistan wood based industries will also expand and we will require about 60,000 hectares of Ecualyptus plantations upto year2000 in Punjab for different end uses linear plantation along roads, canals, dams and field boundaries in irrigated cropland area and compactr plantation on wastelands and degraded area was emphasized in the province. Growth rate of Eucalyptus (av.16%per annum) was suitable for getting early returns to farmer with in 6-8 years.

ESTIMATING ROLE OF FARM FORESTRY IN WOOD PRODUCTION IN DISRICT SAHIWAL (1991).
Imdad Hussian /Rashid Ahmad Khan

To meet the domestic energy requirements main source of fuel consumption were trees cotton sticks/ agricultural waste /cow dung and commercial fuel such as gas cylinder and kerosene oil . Dalbergia sissoo was the principal species used for fuel.

Total number of standing trees of state forestry of district sahiwal was 2607797 having value Rs.36,59,38,565. in agro forestry Total number of standing trees was 398018 of value Rs.5572252 and their annual felling was 36721 with a value of Rs.5490460 Various problems which hinder to grow more trees were lack of awareness about for trees as a cash crop.

More trees were small size of holdings inadequate irrigation facilities lack of transport.

FARM SURVEY TO ESTIMATE CONTRIBUTION OF FARM LANDS TO WOOD PRODUCTION IN TEHSIL TOBA TEK SINGH (1991).
Mobin Afzal Khokhar/Dr.Masood A.A.Quraishi

The types of plantation were linear (74.68%), scattered (1.53%) and compact (23.79%) Major species in the farmlands were Dsissoo, S, Malabarica, A.nilotica, and Populus species. Other species such as MAlba, Melia azadarach,Zizyphus spp., Eucalyptus camaldulensis, Albizia lebbek were also grown successfully. Tree branches and tree leaves were the principal types used for fuel i.e.39.16%. A small proportion of timber wood was also purchased occasionally from the market. For door, windows poles and furniture.

PROSPECTS OF URBAN FORESRTRY IN FAISALABAD CITY AREA (1991).
Muhammad Azeem Akhtar/ Tahir Siddiqui

There are 171503 trees growing in various sectors of Faisalabad city which was equal to 7 trees per acre 394.2 acre of forest . as many as 332252 trees were estimated for additional planting in the different sectors of Faisalabad city. The potential of planting addition number of trees was equivalent to 763.7 acres of forest. These 1158 acres of forest would be a great additional to the forest resources of Pakistan.

SHADE EFCT OF SALMALIA MELABARICA(SIMBAL) ON YIELD AND YIELD COMPONENTS OF TRITICUM AESTIVUM(WHEAT)(1991).
Syed Muhammad Hussian/Mian Muhammad Akram

The significant detrimental effect of Salmalia malabericai for number of graimper spike,and number of tillers was found upto4-10 meters, whereas the same was true for plant height. At harvesting stage, total biomass, straw weight, grain weight and 1000 grain weight up to 7 meter distance form tree was recorded.

PROSPECTS OF SOCIAL FORESTRY IN EDUCATIONAL INSTITUTIONS (HIGH AND HIGHER SECONDARY SCHOOLS FOR BOYS) OF TESIL FAISALABAD(1991).
Zulfiqar Ahmad/Dr.Masood A.A.Quraishi

Average volume of wood per acre showed that Dalbergia sissoo constituted 87.4 cu. feet, Eucalyptus camaldulensis 9.3 cu. feet, Salmalia malabarica 11.0 cu. feet, popular spp.6.0 cu. feet and Morus alba 5.5 cu. feet, in educational institutions. In future, administration of the educational institutins will prefer Eucalyptus camaldulensis to other species. It was concluded that Euclyptus would be grown 55 percent as compared to Dalbargia sissoo, and populus respectively. Average number of additional trees possible per acre was found 30 and 39 in urban and rural educational institutions.

PRESENT PRODUCTION AND POTENTIAL OF ROAD SIDE PLANTATION (A CASE STUDY OF TEHSIL FAISALABAD)(1991).
Zulfiqar Ali/Dr. Masood A.A.Quraishi

Total volume obtained from district council roads(1946090 c.f.) would be high than high ways (245898 c.f.) Additional market value obtained from roads of Faisalabad tehsil was 7524027 and district council roads were 836055 and 6418992 respectively. Additional trees possible along high ways and district council roads were 54644 and 69050 per kilometer respectively.

PROSPECTS OF SOCIAL FORESTRY IN INDUSRTRIAL UNITS OF DISTRICT LAHORE(1991).
Zaheer Ahmad/Dr.Masood A.A.Quraishi

The average distribution of tree species like Shisham, Sufaida, Kikar, Poplar, Neem, Dharak, Mulberry and Simbol in industrial units was 36.3,12.0,11.0,9.5,9.4,8.3,8.3,and 7.2 percent respectively. Average volume of wood per acre showed that Dalbergia Sissoo (shisham)constituted 56.0cu.ft.,Acacia nilotica (kikar) 23.5cu.ft,Poplus spp.23.5cu.ft, Eucalyptus camaldulensis (Sufaida) 63.68cu.ft Azadirachta indica

(Neem) 18.5cu.ft,Salmalia malabarica (Simbal)11.7 cu.ft, Melia azedarach (Dharek)23.8 cu.ft,and Morus alba (Mulberry)15.8 cu.ft.in all industrial units. It was concluded that (on average basis) Eucalyptus will be grown by 35% in industrial units.

STUDIES ON EXTENT AND PROBLEM OF AGRO-GRAZING IN DISRICT VEHARI(1991)
Zahid Naveed/Muhammad Ishaque

The problem faced by the grazing people were lack of forage, lack of veterinary facilities, high prices of fodder, diseases to animals and shortage of grazing lands. It was concluded that if the government provided grant, veterinary facilities and land for forage/fodder production the agro grazing especially in district vehari and generally in Pakistan will be promoted and ultimately livestock population will increase at quantum jump.

EXTENT,TYPES AND EVALUATION OF AGRO-FORESTRY IN DISTRICT SAHIWAL (1992).
Amjad Aziz/Dr. Masood A.A Quraishi

It was noted that farmers got lower income from interplanted areas of cotton, wheat and fodder crops as compared to pure agricultural crops. However, a trend was observed that from small farmers to very large farmers the net return from interplanted areas was increasing. It was concluded that if proper extension services about agro forestry and better marketing conditions were provided to the farmers, then agro forestry will be promote more vigorous in district sahiwal.

EVALUATION OF COMMERCIAL FORESTRY IN DISRICT JHANG(1992).
Zafar Iqbal/Dr.Masood A.A.Quraishi

The results indicated that private commercial plantation was more profitable that the government plantation Net present worth (NPW),benefit cost ratio (BCR)and average annual benefit (AAB)for private commercial plantation were Rs.57668.00, 3.76, 74.97.00 and govt. plantation Rs.46300.00,3.64 and 6019.00 respectively. The higher income of the private commercial plantation was due to vergin, fertile and permeable soil, more number of irrigations and more space given among the trees.

TREE FARM CROPS INTERCULTURE IN DISTRICT FAISALABAD (1993).
Amer Hussain Shah/Dr. Massod A.A Quraishi

The average increases in profit by trees along with farm crops was 23%. The best one tree + farm crop combination was observed in case of salmalia malabrica with wheat in rabi and cotton in kharif season which increased net profit upto 56%. The best tree for compact plantation was observed populus deltoids which increased the income 11 times more than the farm crops.

DETERMINING GROWTH AND PRICE CURVE OF FARM GROWN *EUCALYPTUS CAMALDULENSIS* IN PUNJAB (1993).
Hafiz Muhammad Ayyoub Tanvir/Dr.Masood A.A.Quraishi

Prices of the trees did not increase in proportion to tree volume per year. So the price/cubic ft. decreased with increase in volume per year. This suggested that trees should be harvested during early years (before 9 years) for getting more income per annum.

Rotation of 9 years was good only if the purchaser paid same price per cubic feet for all sizes otherwise it should be harvested whenever the chance of selling is available.

DOCUMENTATION AND EVALUATION OF AGRO-FORESTRY IN DISTRICT JHELUM (1993).
Naseem Ahmad/Dr. Masood A.A.Quraishi

The average income from farm crops in creased over border planting. It was observed 34 percent. The average increase income of trees over farm crops in case of *populus eurimericana, Acacia nilotica, Salmalia malabarica, Dalbergia sissoo,Eucalyptus camaldulensis and Morus alba* was 59,42,41,23,21,and 19 percent respectively. First best farm crop +tree combination was observed of populus eurimericana with farm crop wheat and Bajra. The first best tree species observed under compact plantation was also populus eurmericana.

TREE FARM CROPS INTERCULTURE IN DISTRICT KHANEWAL (1993).
Tariq Hussain/Dr. Masood A.A.Quraishi

The average increase profit by trees planted alongwith farm crops was obtained 29%. The average increase in profit in case of *Dalbergia sissoo, Eucalyptus camaldulensis and Acacia nilotica,* was 25,24 and 20% respectively when raised in combination of farm crops like wheat, cotton maize and sugarcane. In case of compact plantation ,average increase in income was 7 times more than farm crops. Compact plantation of *Dalbergia sissoo, Eucalyptus camaldulensis , Acacia nilotica and Salmalia malabarica* gave 6,7,10and 7 times more income than farm corps. The best one tree species in compact plantataion ws Eucalyptus camaldulensis which increased in net income upto 10 times more than farm crops. The best one tree farm crop combination was observed in case of Salmalia malabarica with wheat in Rabi and cotton in Khrif.

SOCIO-ECONOMIC IMPACT OF FOREST PLANTATION ON THE ADJOINING FARMERS IN DISTRICT FAISALABAD (1993).
Syed Sohial Abbas (Bokhari)/Abdul Rehman Qazi

On the basis of this study. Following suggestions/recommendations were made.
First of all educate the people.
Make sure the effective use of extension services.
Improve the socio economic standards of the people.
Social forestry approach should be under taken.
Provide the people free/least cost infrastructure + other incentives.
Make model farm at various.
There should be more and more research in the field of forestry.

TREE FARM CROPS INTERCULTRUE IN DISTRICT SARGODHA (1993).
Hameed Ullah/Dr. Masood A.A.Quraishi

The average increase in profit by trees planting along with farm crops was observed 101.6%. The profit was 216,85,63.39 and 33.5 percent in Acacia nilotica, Populous eurimericana, Eucalyptus camaldulensis and Dalbergia sissoo respectively. The best one tree + farm crop combination was observed in case of Salmalia malabarica with oat in rabi and bajra+ sorghum in kharif which increased net profit upto 154%. Land tenure system, small holding inadequate irrigation facilities, expensive planting stock and far away located nurseries were the major problem faced by tree growers in the region.

STUDIES ON MARKETING AND UTILIZATION OF SMALL SIZED TREE LOGS ANDSTUDIES ON THE AFFORESTATION OF SALT AFFECTED SOILS ECONOMICS OF BAMBOO PRODUCTION IN SARGODHA DISTRICT (1985).
Muhammad Ajmal Khan/Ghulam Sarwar Khan

The cost benefit alanysis showed that Dandrocalamus hamil tonii (Kana Banns) has highest cost of production with an average of Rs.31235.28 while the lowest cost of production Rs.16836.40 was observed in phyllostyachys bumbusodes (sabz banns).Similarly highest average profit of Rs.9688.06

was observed in Dhamilltonii which was 2.5 times greater than either of the two kinds.

RETURNS TO INVESTMENTS IN BABOO CULTIVATION WITH SPECIAL REFERENCE TO SARGODHA DISTRICT (1986).
Maqsood Hussain/M.Aslam Chaudhry

The highest net profit per acre per year was found to be Rs.15860.50 in Dandrocalamus hamiltonii (kana banns) followed by phyllostyachys bambusoides (Sebz banns) and Dandrocalamus strictus at Rs. 8907.78 , Rs.7625.6 respectively.

The per acre average cost of bamboos cultivation was also different in three varieties the profitability of bamboo crop was found to be significantly higher at progressive farms relative to traditional farms. More importantly the profit of bamboo farming has been observed considerably higher as compared to other major crops grown in the region.

SURVEY OF TIMBER MARKETING AND UTILIZATION IN KASUR DISTRICT (1995).
Muhammad Imtiaz Ali Zahid/Dr.Masood A.A.Quraishi

Farmlands and state forests as being the major sources supplied 8154(65%) and 4412 tons(35%) wood respectively against annual demand of 15147 tons during 1995. the average gap in supply and demand during the year was 22% against the estimated supply & demand gap upto the year 2000.

The annual utilization and disposal of wood in kasur district was 12566 tons out of which wood utilized by industries, saw mills, shuttering poles and fuel was 4375 (35%), 1234 (10%) and 2866 tons (23%) respectively.

Overall expenses incurred by the timber merchant/;40kg of wood were Rs. 12.00 in district kasur e.g. felling, loading, unloading taxes and other charges. The average rate/ 40 kg of wood was Rs.40 in 1995 which might be 45 during 2000.

SURVEY OF TIMBER MARKETING AND UTILIZATION IN MIANWALI DISTRICT (1995).
Muhammad Manzoor/Dr.Masood A.A.Quraishi

Average annual supply of wood was about 11808 tons out of which about 9000 (75%) and 2807 tons (25%) were contributed by farmlands and state forests respectively of the Mianwali district.

Total supply of wood during the year 1995 was 11808 tons against the annual demand of 14562 tons which was 23% more than supply of wood. The gap in supply and demand might be more than the double (53%) up to the year 2000.

The annual utilization of wood was 11808 tons out of which wood utilized by industries. Saw mills, shuttering poles and fuel was 3248 (28%),4360 (37%),1191 (10%) and 3009 tons (25%) respectively.

The overall expenses/40 kg were 11.80 against an income of Rs.24 during the year 1995.

ECONOMIC OF EUALYPTUS CAMALDULENSIS IN DISTRICT FAISALABAD (1995).
Tahir Majid/Dr. Masood A.A.Quraishi

For impact weighted average of B/C calculated of tehsil Jaranwala, Summundry and Faisalabad was 5.137, 10.818 and 6.083/plantation, weighted average net profit worth (NPW) was Rs.221956.56,Rs.572646.93 and Rs.130519.33 and Rs.79372.452 while weighted average Internal Rate of Return (IRR)/plantation was 95.215 , 93.058 and 71.4 percent respectively.

Average B/C,NPW, AAB and IRR per acre calculated of compact plantation for district Faisalabad are Rs.3.215, 90234.86, 23733.93 and 82.97% respectively. whereas these figures for linear plantation were Rs.166, Rs.38.7 and 62.46% respectively.

SALT TOLERANCE STUDIES ON IPIL IPIL (Leucaena leucocephala) (1985).
Mian Akram Ullah Khalid/Ghulam Sarwar Khan

Germination percentage, stem height diameter and sodium contents in leaves increased with increasing salinity whereas dry matter yield and potassium and Ca + Mg contents decreased with increasing salinity.

THE EFFECTS OF VARIOUS DOSES OF NITROGEN AND PHOSPHOROUS FERTILIZER AND OF THEIR COMBINATION ON GRASS YIELD AND QULAITY (1980).
Irshad Ahmad Khan/Dr. Masood A.A.Quraishi

Green and dry forage yield increased by increasing application of nitrogen and phosphorous fertilizers. The maximum yield was obtained when 48 kg of nitrogen and 36 kg of phosphorous per hectare. The concentration of nitrogen increased with increased application of nitrogen and phosphorous fertilizer whereas phosphorous concentration decreased and increased as a result of nitrogen an phosphorous fertilizer application respectively. The nitrogen efficiency was also increased on increased nitrogen application.

STUDIES ON EXTENT, PROBLEMS, AND POTENTIALS OF AGRO-GRAZING AND COMMERCIAL RANGE MANAGEMENT IN PUNJAB EFFECT OF GAMMA RADIATION IN CILLARIS (BUFFEL GRASS) (1972)
Ghulam Sarwar Khan/Dr. Daud Ahmed Khan

Maximum germination of 56% was recorded for 15Kr as against 47 percent for the control and 44 percent for 40 kr. maximum dry matter of 11.94 grams per plants was obtained for the 10kr against 5.3 grams per plant for the control. The dry matter contents declined with higher doses. The doses ranging from 7 to 15 KR have been found to be favorable for the increased growth of this grass. The 10 kr dose gave the maximum values for plant height, tillering and dry matter.

IN VIVO-VITRO EVALUATION OF CENCHRUS CILLIARIS (LINN) AT DIFFERENT STAGES OF GROWTH WITH SPECIAL REFECNCE TO CELLULOSE DIGESTION IN RUMEN (1972).
Malik Hussain Hamid/Dr. Daud Ahmed Khan

The proximate analysis showed that the crude protein contents decreased with the advancement of growth, coming to the lowest value during late stage. The crude fiber on the other hand showed a reversed trend to that of protein. The ether extract content of the grass during flowering stage was found to be maximum followed by the early stage and the seed stage. The NFE Nitrogen free extract content of the frass was observed to be maximum during late stage minimum during the seed stage. The digestibility coefficient of dry matter was maximum at the early stage of growth but decreased with the advancement in may be concluded on the basis of these studies it may be concluded that the stages of growth falling between the early.

CLIPPING EFFECT AND CHEMICAL COMPOSITION OF RANGE GRASSES IN HAY AND GREEN FORM (1973).
Arshad Zahoor/Dr. Daud Ahmed Khan

It was concluded that amongst the clipping treated stages the early stage is probably the best one as regards the nutritive value and total forage production, no doubt that all the stages were influenced by the

clipping affect which are 100 percent. The better results cab be obtained by reducing the severity of clipping or grazing of these range grasses.

PREPARATION OF SILAGE FROM SORGHUM SUDDENENSE (PIPER) STAFF. (SUDAN GRASS) AND COMPARISION OF ITS NUTRITIONALSTATUS WITH HAY & GREEN FODDER(1973).
Zahoor Hussain Khan/Dr. Daud Ahmed Khan

The moisture contents, total ash contents, phosphorous contents, protein and crude fiber contents were found highly significant whereas ether extract contents and calcium contents non significant in green forage, hay and silage of sudan grass. The green forage of crop was most nutritious at early stage whereas the nutritional value of silge compared with hay was more nutritive.

EFFECT OF GAMMA IRRADIAION ON THE YIELD AND NUTRITIVE VALUE OF SORGHUM SUDONENSE (1975)
Asghar Munir/Dr. Daud Ahmed Khan

The green mass, crude fiber and cellulose were higher at maturity stage whereas crude protein and cellulose digestibility was higher at pre-blooming stage. Gamma radiation dose of 10kr at pro-blooming and 6kr at maturity stage gave apparently higher yield than control. Different doses of gamma radiation did not show any influence on crude protein contents, cellulose digestibility coefficients at pre-blooming and maturity stage were observed to be lesser for different doses of gamma radiation.

EFFECT OF GAMMA IRRADIATION ON DIFFERENT VEGETATIVE CHARACTERISTICS OF SORGHUM SUDANENSE PIPER STAFF, SUDAN GRASS (1975).
Muhammad Anwar/Dr. Daud Ahmed Khan

The differences among the various doses of gamma irradiation were found highly significant in respect of germination, plant height, tillering, average leaf area, head emergence and green matter per plant.

Maximum germination, green matter and plant height, average number of tillers and reduction in pro-blooming period was observed at 15 and 5kr respectively. 30 kr gave maximum ration crop and average leaf area.

STUDIES ON THE CHRONIC AND ACUTE IRRADIATION EFFECTS ON THE GERMINATION AND GROWTH OF SORGHUM SUDANENSE (SUDAN GRASS) (1975).
Muhammad Asghar/Dr. Daud Ahmed Khan

The acute and chronic application of gamma, irradiation did not show any significant difference on any of the plant characters under study. Most doses of irradiation generally had a delaying effect on germination. The seedling height showed a decreasing, trend with increasing dose rate. Higher doses of irradiation showed a depressing effect on the number of tillers as it have no effect on green matter per plant. Lower doses seem to have an increasing effect on dry matter weight. 80kr and 100kr proved lethal doses for this grass.

STUDIES ON THE EFFECT OF MIXING OATS AND BRASSICA ON FORAGE YIELD (1982).
Akhtar Mahmod Bazai/Massod A. A. Quraishi

The salient features of this study are summarized below.

The total green fodder yield was increased impure brassica than other mixtures and pure oats. The total dry fodder weight was increased in brassica oat mixture than each crop grown in pure stand both

brassica and oat grown in mixture or pure did not affect on the height of individual crop. Overall brassica crop gave good and stable yield than oats.

PROSPECTS OF RANGE DEVELOPMENT ON THAL AREA (1985).
Muhammad Ishaque/Ghulam Sarwar Khan

Grazing problem faced by majority of the graziers was low carrying capacity of rakh, lack of drinking water and the protection measures enforced by the forest department. The major constraints in the way of range development tasks were lack of funds and interest of the range personnel working in the field. Other constraints were half hearted implementation of existing range management regulations and inadequate research as well as in sufficient staff and poor precipitation rate. In order to improve the community owned ranglands etc. large and medium farmers should be provided with financial assistance. Better health care and marketing facilities for the livestock of local people should be made available near each rakh.

EFFECT OF SPACING ON THE YIELD OF PANICUM MAXIMUM(19850).
Muhammad Tahir Siddiqui/Ghulam Sarwar Khan

Sixty and 80cm spacings appeared to have beneficial effect on green matter yield, number of tillers and height of plants of panicum maximum. On the other hand, the yield was maximum with 20 cm. spacings followed by other spacing when calculated on per hectare basis.

THE EFFECT OF SOIL MOISTURE ON THE ROOT/SHOOT RATIO OF DIPLACHNE FUESA AND PANICUM MAXIMUM (1986).
Munir Ahmed Dar/Ghulam Sarwar Khan

It was observed that relatively low level of soil moisture adversely affected the root/shoot ratio. Leaf stem ratio and other morphological characters considered to be the components of yield directly or indirectly. The biomass production increased with increase in sol moisture upto 30% soil moisture. The maximum biomass production on dry weight basis was 60.68, 44.73 and 28.44 g per plant at 30, 18 and 9% soil moisture level respectively. Diplachne fusca consumed 106.51 grams of water to produce 1 gram biomass whereas panicum maximum 80.70 grams to produce the same weight of biomass.

EFFECT OF SPACING ON THE YIELD OF PANICUM ANTIDOTALE (1987).
Muhammad Arif/Ghulam Sarwar Khan

The following table clearly indicae the effect of spacing on panicum antidotale.

Comparative statement

Parameters	Maximum	Minimum
Plant height	2.66 (T4)	2.21 (T1)
Number of tillers	22.52 (T4)	12.25 (T1)
Seeded stalks	13.60 (T4)	5.52 (T1)
Green forage yield (Frash)	1701.12 (T4)	1499.72 (T1)
Dry forage yield	67.02 (T4)	597.97 (T1)
Root shoot ration (Frash)	0.748 (T4)	0.50 (T1)
Root shoot ration (dry)	0.705	0.57 (T1)
Leaf stem ration (Frash)	0.512 (T1)	0.68 (T4)
Leaf stem ration (dry)	0.545 (T1)	0.60 (T4)
Crude protein	8.75% (T4)	7.88% (T1)

It was concluded that 50cm spacing is the best for increased yield of this grass.
The spacing/ treatments were as such

T = cm
T = cm
T = cm
T = cm

EFFECT OF SOIL MOISTURE ON THE GROWTH BEHAVIOUR OF RANG GRASS, PANICUM ANTIDOTALE (1988).
Afif Nasir Nawaz/M. Shahid Yaqoob

Number of roots, weight of roots, root/shoot ratio, leaf/stem ration, crude protein decreased with increasing moisture level whereas all other growth parameters shoed significant increase with increasing moisture. Therefore it is concluded that 18 percent (75% of F.C.) water levels are the best for the increased yield of this grass.

PROSPECTS OF RANGE DEVELOPMENT IN KHARIAN (PABBI) (1988).
Majid Hameed Bajwa/Ghulam Sarwar Khan

Grazing problems faced by the majority of graziers were low carrying capacity, lack of drinking water, unpalatable vegetation and other problems including lack of shady trees, topography of the area, more distance covered by animals during grazing of livestock and the protection measures forced by the forest department. The major constraints in the way of range development tasks were lack of funds and interest of range staff working in kharian tract. For proper range development the following range recommendations may prove useful.

allocation of sufficient funds by Govt.
opening of new educational institutes
reseeding of undeveloped areas of
arrangement for improved health blocks and availability of marketing facilities.

Range improvement operations should be adopted maximum in the pabbi area, reseeding of grasses, fertilization, erosion contrl, watering points, water spreading control burning, construction of check dams, construction of culverts. These are very helpful in the development of pabbi area.

EFFECT OF CLIPPING INTERVALS AND INTENSITIES ON THE FORAGE YIELD OF PANICUM ANTIDOTALE (1988).
Muhammad Zafar Iqbal/Ghulam Sarwar Khan

It is found in this project that lower interval will advesly affect the plany with reduce the root production and ultimately killing the plant after some time. Increased intercal than 30 days or charge in internsity from 5 cm to 20cm will deteriorate the fresh forage by reduced forage production with increased crude fiber. This situation will be responsible for poor quality and quantity of forage produced at these intervals.

EVLAUATION OF SOME RANGE GRASSES THROUGH FEEDING AND DIGESTIBILITY TRIALS IN MALE GOATS (1990).
Muhammad Ayub/Masood A.A. Quraishi

Maximum weight grain was obtained with canchrus cilliaris. Similarly feed consumption was maximum with cenchrus ciliaris (53.17% Kg) and (40.80% Kg). Feed efficiency in various grasses was maximum

with Panicum antidotale (12.89%) whereas Cynodon dactylon showed a minimum efficiency. The digestibility was worked out from each goat. The result showed that goats fed on Cenchrus ciliaris has a digestibility coefficient values of 78.06, 85.38, 82.59, 69.81 and 77.66 for dry matter, crude protein, ether extract, crude fiber and nitrogen free extract.

EFFECT OF DIFFERENT SPACING ON FORAGE PRODUCTION OF MALAI (PANICUM ANTIDOTALE) (1990)
Sarfraz Hanif/Dr. Masood A. A. Qureishi

Data on height of plant, seed stalk, average green forage and fresh weight root per shoot indicated the variation found among treatments highly significant. The spacing of M5 (60 x 60 cm) gave plant height, seed stalk, average green forage and fresh weight root per shoot maximum as compared to other treatments M4 (50 x 50 cm) , M3 (40 x 40 cm), M2 (30 x 30 cm) and M1 (20 x 20 cm). Data in relation to fresh weight, leaf per stem ratio also indicate significant results. Data on tillering capacity have indicated that the number of tillers was much less that the number of tillers was much less in M1 (20 x 20 cm). as compared to other treatments.

STUDIES ON EXTENT AND PROBLEMS OF AGRO-GRAZING IN DISTRICT MULTAN (1991) Shaukat Naseem/Muhammad Ishaque

The major problem faced by the graziers was non cooperative attitude of farmers, non availability of medicines, high prices of concentrates and diseases to livestock. All the herders needed grant for the purchase of veterinary care, fodder, water resources and shelters for the livestock. The respondents suggested that the above mentioned problems should be solved as soon as possible.

STUDIES ON EXTENT AND PROBLEMS OF AGRO-GRAZING IN DISTRICT BAHAWALPUR (1991)
Muhammad Berjees Azam/Mohammad Shahid Yaqoob

Following problems were identified during the studies.
Big herd size in the adjoining range areas (94) than interior farm lands (50).
Lack of marketing and veterinary facilities were reputed.
Grazing problems faced by majority of the graziers were lack of forage, animal disease, high prices of fodder and lack of water.
Number of agro-grazing animals 79127 worth Rs. 61.6 million.

STUDIES ON EXTENT AND PROBLEMS OF AGRO-GRAZING IN DISTR4ICT FAISALABAD (2002)
Muhammad Shahid/Shahid Yaqoob

The contribution of farmlands for providing grazing and browsing was about 38% whereas the contribution of road side, canal side and river side was 39%. Share of state land and village waste lands for providing grazing was 24.3%. there was feed shortage in the months of January, February and July and the supplementation was maximum (26%) in the interfere and minimum (10%) in river sides. The average income per respondent was Rs. 30108, 18000 and 20000 along road side, river side and canal side respectively.

STUDIES ON EXTENT AND PROBLEMS OF AGRO-GRAZING IN DISTRICT DERA GHAZI KHAN (1993).
Allah Wasya/Shahid Yaqoob

Average income of grazier was only Rs. 14947/year. The major problem was the non cooperative and hostile attitude of forest and canal department personnel which restricted the grazing. Lack of veterinary and marketing facilities coupled with prevalence of diseases made the situation more miserable. Govt.

financial assistance, veterinary facilities and granting land for their own fodder production was recommended.

STUDIES ON EXTENT AND PROBLEMS OF AGRO-GRAZING IN DISTRICT SAHIWAL (1993).
Amjad Ali/Dr. Masood A.A. Quraishi

The major problems faced by the graziers were lack of good quality feed throughout the year, non cooperative attitude of the farmers, inferior breeds of livestock, high prices of concentrates, frequent diseases of livestock, and non availability of medicines. All for the purchase of fodder, medicines development of water resources and shelter for the livestock. If all these problems are solved, agro grazing will flourish and be able to play pivotal role for producing livestock and their production.

STUIES ON EXTENT AND PROBLEMS OF AGRO-GRAZING ALONG RIVERS DISTRCIT JHANG (1993).
Maqbool Shahbaz/Shahid Yaqoob

Lack of water, low carrying capacity. Poisonous vegetation, lack of improved breeds and lack of credit were the grazing problems faced by the graziers in the study area. The average distance traveled by the graziers for selling their animals and animal products was 5.3 km. The graziers avoided to get load from the government or private agencies. They wanted grant to spend for water resources, seed for fodder and veterinary care.

PLANT BREEDING & GENETICS

I. WHEAT

1. GENETIC STUDIES

1.1. Heritability

Heritability which plays a useful predictive role in a breeding programme was calculated both in broad and narrow sense from populations derived from crosses involving promising parents e.g. HD 2009, 1050, Sanine, LU26, LU75, Yecora, Pak81, LU60, LU31, 71-6, WL711, C273, Barani 83, DSN4.DSN24, DSN25 to mention the most prominent. Heritability estimates were calculated from crosses largely for the grain yield and the components of yield including also the plant height. The results obtained are presented characterwise.

1.1.1. Plant height

Heritability estimates for plant height in all the crosses under study were usually high ranging from 65.38 to 93.39 per cent. The cross between 1050, a local strain with high yield potential and Sanine, a drought tolerant exotic variety, yielded the highest heritability with obvious breeding implications. There were many other crosses which showed a reasonably high heritability for plant height, although there were some which showed quite low values. Overall, it appeared from the materials under study that it should not be difficult to breed for different levels of plant height by usual selection methods.

1.1.2. Tillers per plant

This character too was found to be quite variable with heritability range not as wide as that for plant height. Heritability range being 32.73 to 63.16, the character seems more vulnerable to environmental factors. The cross was made between HD 2009 an Indian introduction once resistant to all the three wheat rusts, and 71-4, a local semidwarf strain characterized by more grains/spike.

1.1.3. Spike length

Heritability for spike length varied from 3.57 to 76.36 per cent. Usually low estimates of heritability were obtained from this character, which could indicate the need for caution in selection for spike length.

1.1.4. Grains per spike

The contribution from this component of yield to total grain yield is always considered significant. Most semidwarf cultivars released recently were developed, generally incorporating higher levels of this yield component and achieving highly rewarding results. In the present studies quite a few crosses were identified with heritability falling upward of 60 percent, which provides evidence of the fact that the existing wheat materials possess a wide spectrum of genetic variation that could be exploited for further raising the yield ceiling of the current cultivars.

1.1.5. 1000-grain weight

This is yet another important yield component which attracts the attention of wheat breeders in designing their selection procedures. It may be mentioned that the wheat programme of the University is inclined

more towards evolving varieties with bolder and heavier grains, assuming that a boldgrain variety is less susceptible to various ecological constraints. There were some crosses with high heritability even exceeding 80 per cent which showed that the material in hand has good merit for prospective use in combination breeding.

1.1.6. Yield per plant

It is a complex character made up of a number of component parts which are inherited independently of one another. Even though heritability of grain yield per se should be accepted with reservations, estimates were computed in the present studies which showed a wide range. The cross involving LU60, a local short statured strain with bold grains, and V 80305, an exotic type carrying a reasonable level of rust resistance, showed the highest heritability among the crosses approaching 90 per cent. The figure seems to be inflated; it nonetheless shows high prospects of breeding high yielding wheats based on such crosses. LU60 has consistently proved itself to be a better combiner and should therefore be increasingly used in hybridization programmes.

1.2. Character associations

Grain yied per plant is a rather complex character. It is determined by the outcome of interaction of the environment with several morpho-physiological characters contributing to the grain formation and development. Direct selections for yield enhancement often do not end up in higher yields which indicates the need for an increasing emphasis on investigating and quantifying the contributions of the most prominent components of yield and closely associated characters.Correlation and path coefficient analyses can precisely reveal the inter-relationships involved and help understand the extent of the influence of individual characters on the final yield. Genotypic and phenotypic correlations between characters of economic importance were calculated for populations representing a large number of wheat varieties/strains. Generally, the genotypic correlations were higher than the corresponding values of phenotypic correlations with obvious selection advantages.

Plant height, number of tillers, 1000-kernel weight had positive and highly significant genotypic and phenotypic correlation with yield, while phenotypic correlation between number of spikelets per spike and yield was positive but not signigicant, whereas genotypically it was negatively related with yield. Number of grains per spike also showed positive correlation with grain yield. These associations provide a measure of the limits within which concurrent improvement of these characters can bring about a desired yield elevation as also the information so derived provides an indication as to which of the yield components should receive more attention to gain a greater and faster yield advancement.

But selection made entirely on the basis of information about genotypic and phenotypic correlations may not be so effective as it could be when cause-and-effect relationship is also known. For this purpose the path analysis was conducted to partition genotypic correlation coefficients into direct and indirect effects. The results showed that number of grains per spike had a maximum direct and positive effect on grain yield, followed by number of tillers and 1000-kernel weight while negative direct effects were indicated for plant height and number of spikelets per spike. It may be concluded that in a breeding programme based on the materials analysed, yield enhancement can be achieved by focussing selection on number of grains per spike, tiller number and 1000-kernel weight as these characters appeared to contribute directly and positively to grain yield.

In a separate investigation, phenotypic and genotypic correlations were also computed for all possible combinations of various stress related morphophysiological characters like flag leaf area, number of stomata, stomatal march, leaf venation, number of spikelets per spike, number of grains per spike, 100-kernel weight and yield. Flag leaf area and stomatal march had positive and significant genotypic correlation with grain yield, indicating that yield could be increased possibly through selection for a large

flag leaf area with expanded stomatal activity .In the entire leaf canopy the flag leaf is perhaps the most vital due to its obvious role in intercepting photothermal radiant energy. Consequently, its size and morpho-anatomical features like denser venation and stomatal size, arrangement and activity should also recieve attention for developing high-yielding varieties.

Number of stomata also showed positive correlation with yield both at the genotypic and phenotypic levels and so did leaf venation, 1000-grain weight and plant height. Path coefficient analysis indicated that stomatal inarch had a maximum positive and direct effect on grain yield, followed by plant height, leaf venation, 1000-grain weight and spike length while characters like flag leaf area contributed to grain yield through its high indirect effects via stomatal march and leaf vention.

1.3. Stomatal march

Stomatal frequency on the foliar surface, the size of its aperture and the period of their function are closely linked not only with the routine physiological processes but also are reflected in the moisture stress tolerance and biosynthesis of the plant. The transpiration pattern of different varieties/lines was studied to ascertain its relationship with the known performance of these varieties. The variaties/strains, LU26, Sandal, Barani 83, PAK 81. 1407-1-10. C 518 and Barani 70 were included in the experiment. The differences for stomatal march among the various varieties were highly significant. The stomatal activity started at about 7.00 a.m. and continued uninterrupted with differential frequencies of stomatal opening till 6.00 p.m. Variety Pak 81 had the highest mean value of stomatal opening (91.30X) while the minimal opening of 77.93 was recorded for variety Barani 70 (Table 5). The highest number of open stomata was observed in the variety Pak 81 at 9.00 a.m. (99.52%) whereas the minimal opening of 48.28 percent was noticed in variety Barani 83 at 6.00 p.m. Higher stomatal openings in the variety, Pak 81, at least partly explains the high yield potentaial of this variety fts a more vigorous transpiration indicates a higher metabolic activity leading to better carbohydrate synthesis and accumulation while shy opening of stomates in Barani 70 and Barani 83 is the likely manifestation of an attempt to conserve moisture by applying a stricter control on stomatal activity.

2. BREEDING

2.1. LU26- A versatile wheat

Evolution of new versatile wheat variety LU26, was the most outstanding discovery from our wheat laboratory. The variety was developed from the Blue Silver and Khushal 69 cross and was approved by the Government of Punjab for general cultivation during 1976 and ever since it has maintained productivity. It is a bold-grain stress tolerant variety which has done well particularly in mid season and late plantings. Besides having an excellent baking quality, the variety has shown a remarkable stability in time and space. This is a short-duration variety widely adapted to stressful environment.

2.2. Heterosis

Exploitation of heterotic effects for more yields had largely remained confined to cross-polinating crops. Increasing evidence is now also available to confirm the presence of such effects in self-pollinators like wheat, thus suggesting the possibility of a commercial exploitation of this phenomenon in this crop. But there is a long way to go yet. The cultivation of hybrid wheat on a commercial scale would present problems of hybrid seed production unless of course satisfactory mechanisms of male sterility and restoration are identified and incorporated properly in commercial wheat varieties. Exploratory studies were planned to estimate heterosis and inbreeding depression in some crosses irvolving local wheat varieties with promising results. Heterotic effects to varying degrees were noticed for yield and about all components of yield.As might be expected, inbreeding depression in F2 also occurred in several crosses but in some of the crosses it was not much pronounced which would indicate a greater involvement of

epistatic effect in creating heterotic effects. One such cross was LU60 x LU19 which was highly heterotic in F2 for number of grains per spikelet, number of grains per spike, grain weight and yield per plant. Confronted with such situations, a breeder would be well advised to choose his selection tools very carefully.

2.3. Combining ability

Evolution of wheat varieties for various agro-ecological situations is a continuous process demanding a constant inflow of new germplasin into the genetic improvement process to meet new breeding contingencies. The breeders are therefore always on the look-out for fresh sources of variability. All promising genotypes have differential breeding values and must be carefully tested for combining ability before being used in hybridization programme.

Techniques have been recently developed, which can provide information on the combining ability of parental material right in the Fl generation to help in an early choice of parents for a crossing programme. Early generation rejection of the undesired material makes possible for the breeders to keep prospective populations under a close focus for accelerated improvement.

General combining ability analysis was conducted on the promising breeding material in stock by the top-cross and diallel techniques to identify parents of high breeding value. The ten varieties so tested by using the top-cross method were as follows:

1005, 1050a, 973-1, WL711, LU31, LU16E, LU34, Pavon, BHP79 and C591. The plant characters included in this analysis were: tiller number, spike length, grains per spike, 1000-kernel weight and grain yield per plant. On the basis of the combining ability effects of the varieties/lines used in this study it was concluded that Pavon was the best combiner for tillering, LU31 for spike length, 1050a for grains per spike and BHP79 for 1000-kernel weight and grain yield. The studies indicated that additive genetic effects were important in the genetic variability available for these characters and can be utilized with relative ease for further improvement of the material. Particularly, the varieties BHP79, LU312 and Pavon hold much promise as sources of further progress.

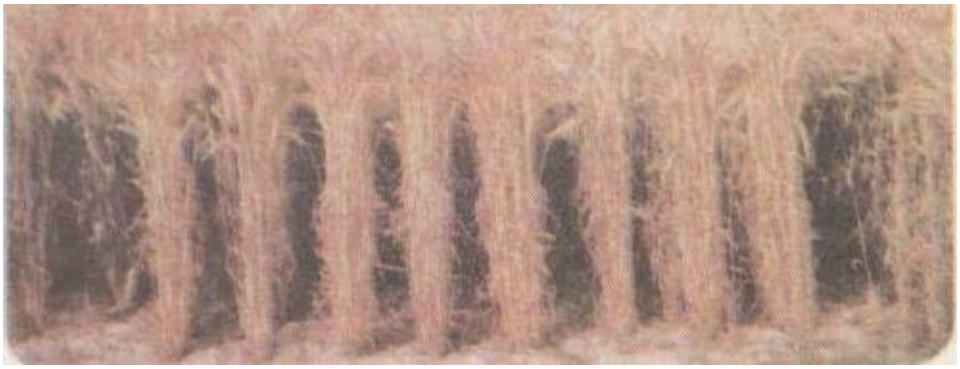
In another study of a similar character, general and specific combining ability effects for various characters like plant height, tillers per plant, spike length, peduncle length, kernels per spike, 1000-kernel weight and grain yield were determined by a diallel cross of 4 wheat varieties, LU16, HD 2009, Sanine and NA6.

Both general and specific combining ability effects were important in the expression of the characters under study. (General combining ability effects were highly significant for all the characters except grain yield per plant and peduncle length while specific combining ability effects accounted more significantly for plant height, spike lenght, penduncle length, number of spikelets per spike, number of grains per spike, 1000-kernel weight and grain yield. The reciprocal effects were nonsignificant for all the characters.

As evident from high GCA effects, the line NAG had high general combining ability for 5 important characters concerned with grain yield and was the best general combiner among the parents while Sanine was the 2nd best combiner as it showed positive GCA effects for three characteristics.

Field testing of elite wheat genotypes

LU 31 - a high potential semidvarf wheat



LU 26 S - a stress tolerant wheat

A fertilizer responsive wheat

Specific combining ability effects for the crosses, Sanine x NA6, Sanine x LU16E, Sanine x LU14 and LU16E x HD2009, were positive for most characters with the cross. Sanine x HD2009 showing the highest SCA effects for plant height, number of tillers per plant, spike length, number of spikelets per spike and grain yield per plant. Reciprocal effects for all the characteristics wore nonsignificant. The two varieties, NA6 and Sanine appeared to be most desirable parent material for breeding new wheat varieties. These two varieties combined with other promising genotypes may provide a wide spectrum of hybrid material for further selection and improvement. The diallel cross developed in recent years by Hayman (1954) and Jinks (1954) provides reliable information during early segregating generations on the type of gene action involved in the expression of various quantitative characters. In a 4 x 4 diallel involving varieties, C591, LU26, 1050 and LU61-4 it was observed that additive genetic variance was expressed predominantly for plant height, spike length, yield per plant, number of kernels per spike although partial dominance effects were also present. Overdominance was observed for number of tillers per plant and 1000-kernel weight but none of the characters showed epistatic effects. The parents, LU26 and 1050, were found to be good general combiners. The variety LU26 with a maximum number of dominant genes combined well for kernel weight and yield and obviously affords promising parent

material for breeding for increased productivity. The preponderance of additive variance in this material and a lack of interaction component suggested that selection for most yield components in early generations should lead to fruitful results.

In yet another five-parent diallel including LU26, C518, LYP73, Blue Silver and Sandal gene action for some physiological and agronomic characters was ascertained. Vr/Wr regression analysis indicated the presence of additive variance for number of tillers, while plant height and spike lenght also showed a degree of partial dominance. Coleoptile length showed complete dominance whereas number of stomata, flag leaf area, and yied per plant exhibited over-dominance. As evident from their relative positions on the *Vr/Wr* graph, the wheat variety, C518, had the maximum number of dominant genes for germination, coleoptile length, tiller number, plant height and flag leaf area while Lyp73 possessed most dominant genes for spike length. Since interaction component of variability was absent in these crosses, it appeared in view of the presence of considerable additive variance, simple selection procedures could be usefully employed.

2.4. Breeding for stress tolerance

Almost all the wheat growing area in Pakistan is vulnerable lo a variety of environmental stresses like drought, temperature and salinity which occur during the growing period of the crop. Such stresses usually take a heavy toll in the 'Barani* tracts where the wheat crop is perpetually deprived of supplemental irrigation. Although a large collection of commercial varieties is available for irrigated wheat culture, very little attention has been paid to the development of appropriate technology for stress environments. Not only are wheat varieties adapted to such conditions in short supply but also germplasm needed for breeding such varieties is hard to come by.

In view of this, research programme was designed to identify and to further exploit the resistance sources in collaboration with the Saline Agriculture laboratory, University of Agriculture, Faisalabad. More than 1000 varieties/lines were screened by the salinity laboratory under solution culture, soilbed and field conditions both at Faisalabad and Bangor, U.K. As a result, the following lines have been identified to be resistant to high levels of soil salinity.

1. S-100	11. S-629	21. 1407-1-11
2. S-97	12. S-149	22. 1407-1-13
3. S-880	13. S-1041	23. 1407-1-14
4. S-1043	14. S-691	24. 1407-3-4
5. S-123	15. S-1019	25. 1407-1-10B
6. S-1020	16. S-135	26. 1407-1-18B
7. S-445	17. S-1172	27. 1407-36B
8. S-1018	18. S-131	28. 1407-40B
9. S-870	19. S-SIANO-79	
10. S-1175	20. Control(LU26S)	

Among the screened material a new line, LU26S, derived from the versatile variety LU26 has consistently shown a high degree of salt tolerance giving the highest grain yield and grain-straw ratio, followed by Blue Silver and Lyp73. Distinctly better behaviour of resistance to salinity and soil and atmospheric moisture stress of LU26S has found further confirmation from replicated field trials conducted under simulated stress. The salt tolerant varieties differ in the manner they react to salt. The variety LU26S appears to exclude salts at the root membrane level as it maintains a low concentration of intracellular Bait solution, which permits the variety to grow well even under excessive salinity. The whole set of lines/varieties identified for salt and drought resistance have since been hybridized with other suitable material. In this regard some sixty crosses were attempted.

The early segregating material is under evaluation and is likely to yield at the proper time some genotypes, particularly suited to moisture and salinity stress areas of our wheat belt. Resides promising lines in the recenely established drought screening nursery have been crossed with locally developed strains/variaties of good agronomic merit like LU26S, LU31, Lyp73, SS3, SS4, SS5, 1407-1-16, 1407-5-66,1407-40, Barani 70 and PAK 81 etc. The segregating material so generated is being tested in a zero irrigation drought block to select desirable genotypes for direct use and for further breeding.

2.5. Studies on moisture stress

Studies were initiated to investigate the effect of prolonged soil moisture stress on the growth pattern of wheat plant. The basic information on pathways of stress can greatly help in devising an effective strategy for stress breeding. Influence of a progressing soil moisture stress on important yield components like tillers, spikes, grains per spike, and grain weight was recorded through a replicated trial on 4 varieties viz. LU26S, Barani 83, Lyallpur 73 and Pak 81 known for their differential response to soil moisture stress. The daily stomatal march was also monitored from 7.00 a.m. to 6.00 p.m.on an hourly basis during 5 clear days in the month of March when the crop was in the grain filling/formation stage. The yield reduction under stress environment varied from 7.39 per cent to 34.36 per cent, while decrease in tillers and spikes per foot ranged from 8.80 per cent to 14.93 per cent and 10.30 per cent to 19.59 per cent respectively. There was an obvious addition to the barren tillers which resulted in yield depression. Most of the yield reductions seemed to derive from losses in grain weight rather than number. Verieties resisting stress had significantly longer periods of stomatal activity.

2.6. Multiline development

Work on the development of a new multiline in the LU26S background also continued. The 96 different genotypes initially included in this programme have now converged into 6 composite crosses after the fourth year of crossing among these lines. The material thus developed will likely yield promising segregates for further evaluation. The alternative approach of developing a multiline through backcrossing has also been progressing satisfactorily. The backcross-derived lines are fairly uniform with regard to most agro-morphological characters of the parent. These lines are being backcrossed for another cycle and thereafter will be composited for field evaluation.

1. (LU26 x K 343) X $LU26^4$
2. (MT LU26 X V79301) X $LU26^4$
3. (LU26 X 1407-1-9) X $LU26^4$
4. (LU26 X WW15) X $LU26^4$
5. (K343 X LU26) X $LU26^4$
6. (LU26 X V1207) X $LU26^4$
7. (LU26 X V79353) X $LU26^4$
8. (LU26 X A24) X $LU26^4$
9. (MT LU26 X WW4) X $LU26^4$
10. (LU26 X P.M.Hari X $LU26^4$ constant stay)
11. (LU26 X V79501 X X $LU26^4$ K343
12. (LU26 X RS16) X $LU26^4$
13. (MT LU26 X Pak81) X $LU26^4$
14. (LU26 X WW9) X $LU26^4$
15. (LU26 X Bobwhite) X $LU26^4$
16. (LU26 X V80305) X $LU26^4$
17. (LU26 X 1407-1-15) X $LU26^4$
18. (LU26 X Vire's' X $LU26^4$ PM202)
19. (LU26 X Pak81) X $LU26^4$
20. (LU26 X V79143) X $LU26^4$

21. (LU26 X V79523/X LU26[4] K432)

2.7. Effect of foliar canopy on grain yield

Pleiotropic effects of awns in wheat have often been reported but there is scarce evidence about a combination effect of awns and the foliage. A preliminary study was made to investigate the consequent drop in yield caused by the loss of awns, flag leaf and both. Four awned varieties viz. PARI 73, LU26S, 1407-1 and 1407-5 were used in the experiment. Clipping of awns showed a significant drop in yield compared with control, the value being 2.10 and 2.51 gins per spike, respectively (Table 7). Disposal of flag leaf also caused significant yield reductions. The quantum of reduction in both cases was almost equal. However, the removel of the awns and the flag leaf together had a drastic effect and caused a greatci ^Aold reduction (27%). The value was significantly the lowest among all the treatments. The results suggested that these two appendages, namely awns and flag leaf, are directly linked with grain yield in wheat. Any serious injuries incurred by them is likely to lead to significant yield losses.

Total foliar surface and the arrangement of leaf canopy are ultimately linked with morphological development and grain yield of wheat plant. Reduction of foliar surface due to disease or physiological stress is often reflected in the yield performance of this crop. Studies were therefore initiated to ascertain the effect of forced partial leaf shedding on four varieties of wheat viz. LU26S, Bahawalpur 79, WL 711 and Sandal. The following treatments were administered to the three tillers retained from each of the 10 randomly selected guarded plants from the 4 replications of the experiment.

1. T_0 = Control (no defoliation)
2. T_1 = Lower three leaves removed.
3. T_2 = Upper three leaves (excluding flag leaf) removed.
4. T_3 = Flag leaf removed
5. T_4 = All leaves (except the flag leaf) removed

Rffect of various intensities of defoliation were recorded on the following imoortant morpho-economic characters.

1. Height of the plant.
2. Spike length.
3. Number of spikelets per spike.
4. Number of grains per spike.
5. 1000-kernel weight.
6. Yield per plant.

It was observed that flag leaf played a significant role in the development of grain yield and accounted for more than 50 per cent yield reduction when removed alone (Table 8). Table 8. Effect of folliar canopy on various characters averaged over varieties/treatments.

Varieties/ Treatments	Plant height (cm)	Spike length (cm)	No.of spikelets per spike	No.of grains per spike	1000- grain weight (gm)	Yield per plant (gm)
LU26S	96.13	13.87	21.50	70.75	42.25	9.42
WL711	94.25	14.97	22.96	85.60	39.73	9.57
Bahawalpur	92.61	15.49	25.28	85.79	36.39	8.86
79						
Sandal	93.14	14.59	25.07	86.33	38.10	9.48
T_0	94.72	15.20	25.15	86.99	50.41	12.71
T_1	94.48	14.56	22.53	82.80	48.85	11.48

T_2	93.91	14.48	22.68	80.36	55	10.48
T_3	93.20	14.56	22.62	79.12	24.78	6.12
T_4	93.88	14.75	22.53	78.14	24.00	5.87

Conversely, the flag leaf controlled 50 per cent of the total grain yield. Injury to the basal leaf seemed relatively less damaging as compared to the upper one. The studies also provided evidence for differential response of variety of varying degree of leaf damage suggesting a possible genetic basis of tolerance to such losses.

2.8: Performance of biblends of wheat genotypes.

Five wheat varieties / lines viz. LU26S, 6500, Chakwal 86, Pasban 90 and Rohtas 90 were sown in a diallel fashion. There were ten biblends and five pure stands. The experiment was laid out in a randomized complete block design with three replications. There were 15 plots each of 1x3 m size, randomly assigned to 5 uniblends and 10 biblends in each replication. Inter-row and inter plant distance was kept at 15 cm. Regularity of spacing and uniformity of sowing depth was achieved by sowing with the help of a template. The genotypes exhibited differential behavior for all the morphological characters i.e., plant height, tillers per plant, spike length, spikelets per spike, grains per spike, 1000-grain weight, biomass and economic yield per plant. The LER values were 1.154 and 1.187 for the two combinations namely Rohtas 90-Chakwal 86 and 6500-Chakwal 86 indicating 15.4 and 18.7% increase in grain yield over their mid parents, respectively. However, the remaining mixtures decreased their grain yield. It was observed that the differences between component genotypes may produce differences in their competitive ability, but the competitive and yielding ability of genotypes are not always synonymous. The high yielding genotype LU26S manifested decrease in yield in most of the combinations. It was evident from these investigations that certain genotype combinations can utilize environmental resources more efficiently than their pure stands. The varietal mixtures do have potential as a means of increasing crop yields but identification of correct genotype combination and density is very important.

2.9: Disease resistance

The crop season was fairly suitable for disease spread and development and provided good opportunity for selection against fungal disease complex. Emphasis generally remained centered on the selectin of material showing durable resistance while the lines exhibiting high resistance score were also selected for their breeding value. About 14lines viz., 8453, 8454, 8460, 8464, 8466, 8467, 8439, 8470, 8475, 8479, 8482, 8491, 8499 and 8512 have shown an acceptable resistance to disease complex and were selected for further laboratory and field evaluation.

2.10. Drought tolerance

Programme on breeding for stress tolerance is in progeress. The following treatments were used to determine the individual and combinational effects of drought components under simulated conditions through a drought machine.

1. High temperature + Low soil moisture + Low humidity
   (40^{o} C) (25%FC) (12%)
2. High temperature + Low soil moisture + Normal humidity
   (60-70%)
3. High temperature + Optimal soil moisture + Low humidity
   (50% FC)
4. High temperature + Optimal soil moisture + Normal humidity

About 24 lines/varieties were passed through the drought machine for the survival rates under various

combinations of drought components. Same lines were also sown in field under artificial moisture stress to study the various morpho-anatomical and physiological characters such as root-shoot ratio, root density, leaf venation, stomatal frequency, stomata size, hygrophilic colloids, osmotic pressure, epidermal cell size, tillers per plant, flag leaf area and grain yield per plant. Varieties/lines viz., Rawal 87, Chakwal 86, Rohtas 90, LU26S and 8499 have shown a fairly good resistance to drought complex through better rate of survival under various stress conditions. Genotypes showing better survival rate also had higher stomatal frequency, root-shoot ratio, root density, stomata size, hygrophilic colloids, flag leaf area, osmotic pressure, leaf venation, tillers per plant and grain yield per plant. The promising stress tolerant material will be field tested during the coming crop season under induced moisture stress conditions to further select promising genotypes with potential for better productivity under stress environments.

2.11 Locating genes for drought resistance in wheat using Random Amplified Polymorphic DNA

An F_3 population (cross between Pak.81 and low ABA 18) developed from an F_2 population which segregates for drought resistance traits such as net photosynthesis, stomatal resistance, water-use-efficiency, osmotic adjustment, relative water content and excise leaf water loss was grown to develop sibling lines. The plants were grown in plastic bags filled with 500 g of air dry 1:1 sand and soil mixture. Water potential of the soil-sand mixture was monitored and controlled by a simple filter paper technique in this experiment. After measurement of the above mentioned traits at the 3rd leaf stage, the plants were transplanted in big pots and were grown to maturity to harvest tratis shows that they are genetically controlled and highly heritable. The present data of the F_3 population would be regressed on the F_2 population data to confirm the previous findings of heritability. The parents has already been screened for DNA polymorphism using Random Amplified Polymorphic DNA technique. In total 87 DNA polymorphisms have been found between the parent genotypes. The sibling lines developed (in F_5 generation) would be screened for finding DNA marker genes for the drought resistance traits.

2.12 Salt tolerance

Soil salinity is also one of the most major constraints to our wheat productivity. The research material pertaining to morpho-genetic studies comprised of 15 wheat varieties/lines viz. Chakwal-86, Pasban 90, Rohtas 90, Inqalab 91, Tobari-66, SARC-I, 243/1 KTDH-19, 1697-1, 6039-1, 6120, 4770, LU26S, and 6500. The material was evaluated for salt tolerance at 4 salinity levels (1.6, 5.0, 10.0 and 15.0 dsm^{-1}) in a pot culture experiment.

Data were recorded for fresh shoot weight, dry shoot weight, Na^+ and Cl^- accumulation in leaf cell sap, yield and yield components. However, for brevity data for grain yield at various salinity levels is presented. The results indicated that Na^+ and Cl^- content of leaf tissue increased and grain yield was decreased with increasing the salinity levels.

Tolerant varieties/lines i.e. Pasban 90, LU26S and 243/1 accumulated low Na^+ and Cl^- in their leaf tissues. These genotypes also gave better performance for grain yield per plant at higher salinity levels as compared to other entries included in the test. Genotypes 243/1 also showed good tolerance to NaCl stress at moderate to high salinity levels for tillering capacity and some other yield components like grains per spike and 100-grain weight.

Genetic variability and heritability estimates were also computed for all other traits under study. High heritability (71%) was associated with plant height followed by Cl^- content (61%). Whereas it was moderate for Na^+ content (59%) and spikelet per spike (51%). Low heritability estimates were found for rest of the traits. These studies indicated that low Na^+ and Cl^- accumulation in leaf tissue could be used as selection criteria to screen salt tolerant wheat genotypes at seedling stage.

2.13 Wide hybridization

Wide hybridization is an important adjunct to a stress breeding programme. Wheat varieties like Inqalab 91, Pasban 90, KTDH 19, 4770 and 6500 was crossed with derivatives of *Thynopirum bessarabicum,* which is an important source of salt tolerance for wheat. These F_1s will be further backcrossd and selfed to develop stable salt tolerant wheat genotypes.

2.14 DNA markers for brown rust resistance

Conventional breeding approaches depend on the selection of plants on the basis of phenotype. The plant phenotype is the result of genotype and the environment interaction. Favourable environmental conditions for the rust causal organism vary in different years resulting in efficient selection process in the breeding programmes. Selection based on DNA markers closely linked to the disease resistant gene would increase the efficiency of selection.

The experimental material comprising 22 F_3 families (raised from 11 resistant and 11 susceptible F_2 plants) from a cross between rust susceptible and rust resistant lines were screened during the year 1999-2000 in the experimental area of the department of Plant Breeding and Genetics, University of Agriculture Faisalabad for rust resistance. Two leaves were excised from each selected plants (one plant from each of the parents, the F_1 and each of the resistant and susceptible family in each replication) and were frozen and kept at-80^o C. DNA extraction was carried out by the following method.

The samples were ground in liquid nitrogen in a mortar an pestel until it converted into fine power which was transferred into a microfuge tube. Hot (65^{o}C) 2 x CTAB buffer was added and incubated in water bath for 10 minutes. Then added one volume of chloroform/isoamyl alcohol (24:1) and mixed thoroughly to form an emulsion. The samples were centrifuged in a microfuge for 30 seconds (at 13000 rpm). The supernatant from the top phase was transferred to anew microfuge tube. The lower phase was discarded. Then added 1/10 volume of 10% CTAB solution and mixed. The chloroform/isoamyl alcohol extraction was repeated. Then an equal volume of CATB precipitation buffer was added and mixed gently, centrifuged for 30 seconds. The supernatant was discorded and added 1 ml of cold 80% (stored in freezer) ethanol and centrifuged for 5 min. the supernatant was discarded. The pellet was dried in a desicator for 20-30 minutes or until the liquid has evaporated. The pellet of DNA was dissolved in 0.1 x TE. and treated with Rnase.

Bulked Segregant Analysis and Random Amplified Polymorphic DNA Technique was applied to find DNA markers linked to brown rust resistance. One hundred and sixty oligonucleotide primers were used in PCR. The primer J-14 amplified a DNA molecule of 1840 nucleotide, found to be linked to brown rust resistance. This DNA marker can be used for marker assisted selection for brown rust resistance in wheat or to clone gene for brown rust resistance gene in wheat.

2.15 Marker assisted genetic diversity studies in wheat.

The DNA of seven wheat varieties / lines namely 27 HTN/1-54, 7 HTN/1-54, 3 WLRG/1-8, 12 WLRG/1-12, WL-23, WL-43 and Chenab-70 were successfully extracted and run on 0.8% agarose gel. DNA of seven varieties of wheat was amplified with 15 different random primers. Seven wheat varieties could be identified with a single primer. Therefore, RAPD markers can be used for identification of wheat varieties. Out of seven wheat genotypes, line 3 WLRG/1-8 produce maximum number of DNA amplified fragments (110), while minimum number (93) was produced by variety Chenab-70. The genetic similarities of seven varieties were high, ranging form 93.0% to 86.2%. The lines 12 WLRG/1-12 and WL-43 had the greatest similarity of 93.0% the two lines differed from each other only in seven bands with 15 different primers. The genetic similarity between lines 27 HTN/1-54 and 7 HTN/1-54 was the second highest (91.61%). The lines WL-23 and 3 WLRG/1-8 were also in the same range (91.60%). So they all show very close genetic similarity. The variety Chenab-70 was found genetically more dissimilar than the other genotypes. It

scored 86.29% similarity.

II. COTTON

After the establishment of cotton section in the old Punjab Agriculture College and Research Institute, research work on cotton was started on systematic lines. Since then there had been considerable improvement in yield and quality of cotton crop of this region, and Punjab cotton has earned a respectable place in the international market. After the promulgation of Agricultural University Ordinance in 1961, the breeding work on cotton plant started in the old Cotton Section was shifted to Ayub Agricultural Research Institute, Lyallpur (now a Faisalabad). However, the main mandate of the newly created department i.e. Plant Breeding and Genetics in the West Pakistan Agricultural University, Lyallpur remained teaching. The research work on cotton plant was only of academic nature, with the purpose for imparting training to the post-graduate students. Since the establishment of the department, very valuable research work on cotton crop has been done by various workers, and their findings have been published in local and foreign journals. This work has benefited the cotton breeders working for improving seed cotton yield and quality of the crop. Here the salient features of the previous work are given.

1. GENETIC STUDIES

1.1. Character inheritance

Inheritance of the main stem height number of monopodial and sympodial branches per plant, number of bolls and boll size, boll weight, yield of seed cotton, seed index, lint index, ginning outturn percentage, staple length, fineness, strength, percentage of oil and protein in the seed, was studied in several diallel crosses. In addition, genetic analysis of the components of growth.i.e., leaf area, net assimilation rate, relative growth rate, inheritance of hairiness, response to spacing and various fertilizer doses was also made.

The varieties used in these crosses included desi (*Gassypium arboreum* L.) and Pak Upland cottons (*Gossypium hirsutum* L.), namely, 231R, 447R, 39M, 465D, DC92, DC110, (G.arb.L.) and 4P, LSS.362P, Pak-81, L-ll, AC134, AC307, AC321, M4, 149F, AU9, AU14, AU34, AU38, AU59 and 406F.The exotic types belonging \o *G.* hirsutum L. which were used in these studies were 15170, Dixi King, Acala 4-42, Acala 63-75 Acala-63-69, 625V, Empire Red Leaf, Deltapine Smooth Leaf, Acala 1517D, G.S.P., A7273, Bobshaw, Stone Ville 213, A8100, A8104, Loan Star, Delfox 4258, Roger Tex Acala, A6476, Paymaster, Coker Turdish, Russian Mutant, Hope Acala, Auburn 56, 1517 Br2, A619, McNair 210,Sahel 53, Varamin 53, FC4244, Dunn 56A, Locket 4789A, Paymaster 101A ,Blanco 3363,Super Okra, Hybee 200, Delfos 8274, Delfos 531, Ding Dung, Deltapine 15A, PC 4944, Rex S.L. Carolina Queen, Mex 12, Pox, Austin, S-12, DPL-6127, Dos-56, HG 496. B2(67)1470, Allepo-45, Royal Smooth okra, Coker 5110 III, 272/79, Brace 81/6, CIM-70, Coker Improved MCV-7, ALK-4219/362, DPL-70,Imperial Acala, CP 15/2,129/77, BJA.LRA 5166, DPL-61, Acala-SJ4, HL-1,BPA-66, BARSP-84, SRT-1, Acala 1517V, Coker 201, DPL-16, Fox-4, 1038, Genetic cotton-181, A-6473, AMSI-48, AET-5, Coker 100/2(69-62) Coker 315-790, Srt-1, 956/81, Arizona-6218, E-288, Reba B50, Pregfobract, DUN 56A, Blaco-3363 and H499.

The results indicatied that in the case of G. *arboreum* L. types overdominance gene action was involved in the inheritance of time of flowering, boll opening, number of monopodial and sympodial branches, height of the main stem, yield of seed cotton and seed index while additive gene action was important for ginning outturn percentage with partial dominance present in staple length and lint index.

The results pertaining to Pak upland types *G. hirsutum* L., indicated that additive genetic effects were more inportant for characters like number of sympodial and monopodial branches per plant, height of the main stem, number of bolls per plant, boll weight, yield of seed cotton, ginning outturn percentage, staple

length and fineness. However, in some crosses yield of seed cotton, ginning outturn percentage and even for staple length, fineness and fibre strength showed overdominance. The gene action for oil and protein content that was studied pickwise involved both additive and nonaddive effects, but for seed and lint indices additive effects were more prominent.

1.2. Heritability estimates and path-coefficient analysis

Heritability estimates for economic and quality characters showed moderate to high values. The path coefficient and correlation analyses made in advanced generations (F4 and F5) revealed that boll number, boll weight, ginning outturn and number of seeds/boll had high direct and positive effect on yield of seed cotton while lint index had positive and medium effect on yield.

1.3. Genetic analysis of response to spacing and fertilizer

Expression of various genetic characters was also studied under variable environments of fertilization and spacing. Such factors were observed to have significant effect on characters expression particularly the ones showing quantitative inheritance. Gene action in some varieties appeared to be quite variable. Certain genes were dominant under one environment while they showed expression under the other. The role of the environment thus appeared to be considerable and versatile and demands proper attention in planning of breeding experiments.

1.4. Genetic analysis of components of growth

In order to understand the physiological basis of yield a comprehensive information on the genetic mechanism controlling components of growth is of crucial importance.

Prom the genetic analysis of components of growth it was observed that during the early stages the phenotypic manifestation of most of the componets of growth was conditioned by different types of gene action varying from over-dominance to partial dominance for dry weight, overdomincance to dominance with interaction for leaf area, and dominance to additive with partial dominance for relative growth rate.

Over-dominance was also observed in a set of diallel crosses where most of the progenies excelled their parents expressing hybrid vigour.

i. Genetics of developmental plant characters

Keeping in view the changing cropping pattern in the province, the plant breeders also changed their breeding philosophy, and diverted their attention on the development of short statured, early maturing, and heat tolerant cotton plant. Therefore in order to make selection of such genotypes in the breeding population it became imperative for the breeders to have genetic information about the pattern of inheritance of these characters. The workers in the department conducted genetic experiments using diverse germplasm in hybridization. These studies showed that inheritance of main plant stem, number of bolls, average boll weight and seed cotton yield was controlled by the genes acting additively and non-additively, however additive variance was predominant in the heritance of these characters. In other studies variance due to non additive genes was found to be greater than due to additive genes for the developmental characters. This suggested that action of the genes was different due to the nature of the genetic material tested over the years under Faisalabad conditions, and thus estimates of heritabilities of plant height, number of bolls, boll weight, number of monopodial and sympodial branches and seed cotton yield also varied. The estimates of narrow sense heritability was 37% for plant height, 30% for number of bolls, 62% for boll weight and 40% for ginning percentage. This information may be used advantageously by the other breeders for bringing improvement in these characters through selection and breeding.

ii. Inheritance of fiber quality characteristics

Genetic studies involving germplasm differing in their genetic make up and origin showed that staple length, lint index, fiber fineness, fiber strength and fiber elongation were predominantly effected by the genes acting cumulatively and non-cumulatively, and thus the estimates of narrow sense heritability were moderate e.g. these were 45% for fiber fineness, 47% fiber strength, 25% for fiber elongation. In some other experiments the fiber characters appeared to be control by additive gene effects and thus estimates of narrow sense heretibility were high e.g. it was 88% for fiber fineness and 98% for fiber uniformity. The different magnitudes of these estimates suggest that before making selection for the desired plant the research workers should substantiate the present findings using appropriate genetic material.

iii. Inheritance of oil and protein content in cotton seed

Due to the booming pressure of population in the country, the demand of edible oil has increased significantly. Cotton seed is the biggest source of oil and contributes about 72% to the total oil obtained by crushing oil and non oil crop seeds. But despite the fact, research work has not been done by the breeders to exploit the genetic potential of cotton oil content for increasing in seed. Keeping in view the importance of cotton seed for oil content, the research work done in the department was financed by the University Grant Commission, Government of Pakistan during 1992-95. In these studies about 275 strains / varieties of upland cotton were analyzed for oil and protein contents. The results of the studies revealed that significant amount of genetic variation in these two characters existed. The biometrical analysis of the data showed that both additive and non additive genes controlled the variation, but influence of the genes having cumulative effects was important. Estimates of heritability for oil and protein were 53% and 23% respectively and suggest that further improvement in these characters may be possible making selection from the plant material. A promising breeding material has been developed through hybridization which had significantly higher oil and protein content in cotton seed.

In another study, financed by Pakistan Science Foundation, during 1997 to 2000, 300 accessions collected from various research centers were tested for seed oil and protein, yield of seed cotton ginning percentage, seed index, staple length and fibre fineness. Using 10% selection intensity 36 lines were identified as promising lines which possessed higher oil content alongwith desirable level of another economic characters. At present this material is being screened out to identify the potential genotypes combining good number of bolls, improved average boll weight, and seed cotton yield.

iv. Genetic basis of stress tolerance in cotton

These studies were under taken in the department in order to study the response of *Gossypium hirsutum* L. to stress environments. As a step forward to this direction the plant material developed through crossing local and exotic germplasm was grown under less nitrogen supply. The objective of this investigation was to study the genetic mechanism controlling the growth of the plant under partial nitrogen supply. It was revealed that number of bolls and seed cotton yield were largely controlled by non additive genes in F_1 and F_2 generation. However, for staple length both additive and non additive genes appeared to control the characters under partial stress environment. Fibre fineness was conditioned by the additive genes. Under normal nitrogen supply as recommended by the Agriculture department, inheritance of number of bolls, yield of seed cotton and other characters were controlled by the genes showing additive properties in F_1, but in F_2 genes showing dominance properties were important. Theses results suggest that selection of plants may be done for bringing improvement in their response to partial nitrogen stress conditions. The work done may be useful for developing varieties suitable for the area of where farmers / growers cannot afford the escalating cost of nitrogen fertilizer.

Inheritance studies of salt tolerance in *Gossypium hirstum* L. were made measuring root length at

seedling stage. The analysis of the genetic data revealed that root length was controlled by the genes acting additivley and non additively in salinized conditions developed by adding NaCl in growing medium. Estimates of narrow sense heritability was 37%. These results suggest that salt tolerance in the species may be improved further by selecting the plants having longer root length of the material grown at maturity under NaCl stress. There are evidences reported that root length is a better indicator of measuring genotype response to slinity**,** and therefore the information obtained may be rewarding.

v. Genetic analysis of components of growth

In order to understand the physiological basis of seed cotton yield, a comprehensive information on the genetic mechanism controlling components of growth is of crucial importance. From the genetic analysis of components of growth, it was observed that during the early stages the phenotypic manifestation of most of the components of growth was conditioned by different types of gene action varying form over-dominance to partial dominance for dry weight, overdominance to dominance involving non-allelic interaction for leaf area, and dominance to additive with partial dominance for relative growth rate (RGR). Over-dominance was also observed in a set of diallel crosses where most of the progenies excelled their parents expressing hybrid vigour.

2. BREEDING STUDIES

2.1. Synthesis of breeding material

A sizeable new genetic material was developed with sharp focus on yield, G.O.T., quality, heat tolerance, and resistance to disease and insect pests along with response to fertilizer. This material has throughly been tested under various ecological conditions and the new strains like AU5, AU9, AU14, AU34, AU38, AIJ59 and AU60 have turned in excellent performance. Of these elite strains, AU59, is the best and has peformed very well in the trials conducted by the Punjab Agricultural Research Coordination Board and Pakistan Central Cotton Committee.This variety has already been approved by the Punjab Agricultural Research Coordination Board for the districts of Sargodha, Sheikhuprura, Mianwali and Jhang.

2.2. Generation advancing

About thirty elite parental lines are annually planted in greenhouse during winter season for hybridization. Fully developed healthy Fl seeds ae harvested and planted in the field during normal season. Some important hybrid material is also pliintd in greenhouse for generation gene action advancing. This technique has not only appreciably reduced the breeding time but has also made some crosses easier to accumplish under controlled conditions.

Development of breeding material

The main focus of the cotton researchers in the department has been to develop potential cotton material by exploiting local and exotic genetic resources available to them in the germplasm. The objective of these efforts is to identify genotypes / lines possessing high seed cotton, high ginning out turn, longer staple length. In addition, keeping in view the prevailing environmental conditions, efforts were also made to screen genotypes showing resistance to heat insect pests and diseases. As a result, several strains like AU5, AU9, AU14, AU34, AU38, AU59 and AU60 were developed. Of these elite strains, AU59 exhibited excellent performance in the zonal trials conducted by the Punjab Agricultural Research Coordination Board and Pakistan Central Cotton Committee, Karachi. This strain, AU59 was approved by the Punjab Agricultural Research Coordination Board for planting in the District of Sargodha, Sheikhupura, Mianwali and Jhang.

Spotted bollworm attack

In recent years Cotton Research Team of the department has developed plant material which showed appreciable performance in various screening tests. The performance of two strains of cotton i.e. PB-894 and PB-899 was examined under non-sprayed conditions for two years, and both the bulks showed better tolerance to sucking pests i.e. jassids, whitefly and thrips, and average boll worm infestation. Consequently the two lines gave 2675 kg and 2458 kg seed cotton per hectare respectively, and scored 2nd and 4th position in ranking of other 12 strains of developed by other breeders in the Punjab. In order to strengthen the screening programme against insects and CLCuV, DNA markers have been identified using the available germplasm on cotton. In pursuits of developing cotton varieties with improved seed cotton yield nine bulks i.e. B-893, B-3, B-4, B-5, B-6, B-8, B-9, B-10, and B-11 were screened out as potential genotypes during testing of the breeding material. The increases of seed cotton yield of these bulks ranged 7-32% as compared with that of NIAB-999 (standard variety). In another study cotton genotypes DNH-40, ST-322, CIM-243, CIM-240, B-581, B-622, B-667 and B-796 were revealed to contain higher oil contents, and this material may be useful to develop a breeding programme aimed to increase oil content in cotton seed.

2.3. Development of new strains

The improvement of genetic architecture of commercial crops is vital for their economic viability. A large number of crosses involving local and exotic types (G.hirsutum L.) were attempted keeping this objective in view and the breeding material thus developed was screened under the prevalent production e+nvironments. The best adapted homozygous lines bulked into new strains showing values for various genetic parameters are listed below.

Name of the Bulk	G.O.T.	Staple length	Fineness
B-5	37.5	28.5	3.3
B-16	38.5	28.0	4.2
B-54	39.5	26.0	4.2
B-57	37.0	25.5	3.9
B-75	37.0	25.5	4.2
B-109	36.0	28.0	5.2
B-132	40.0	26.0	4.2
B-133	39.5	26.0	4.7
B-161	38.7	28.5	4.3
B-164	36.2	25.0	4.5
B-183	36.0	25.7	4.2
B-184	38.0	26.0	3.6
B-193	38.5	27.0	4.6
B-216	38.4	26.0	4.6
B-232	42.0	27.7	4.3
B-284	36.5	25.0	3.8
B-318	37.5	27.5	4.6
B-323	35.0	28.0	3.9
B-327	35.8	29.5	4.2
B-339	36.0	28.4	4.0
B-349	37.2	27.5	4.5

In order to develop a cotton variety combining high yield of hirsutum and quality from barbadense, a programme of back-crossing involving AC-307 *(G. hirsutum* L.) and Karank *(G. barabudense* L.) was developed. Repeated backcrossing with hirautum has resulted in the development of the under listed four elite bulks showing values for various genetic characters of economic importance.

Sr.#	Name of the bulk		G.O.T. staple		Finenes

	Origin				**s length**
1.	B-360	AC307 x Karnak AC307	39.07	29.00	3.53
2.	B-368	-do-	34.07	30.00	4.23
3.	B-373	-do-	35.65	29.37	3.49
4.	B-380	-do-	33.97	28.12	3.27

In this hirsutum barbadense hybridization programme, efforts were made to combine high yields, high ginning outturn and maximum staple length (28.00 to 30.00 mm), with increased adaptability to the local conditions.

There is a dire need of developing genotypes of cotton possessing characters like short-stature, big boll size, nectariless, okra-type leaf alongwith high yield potential and response to fertilizers. Extensive programme of cotton breeding using local and exotic types was developed and a large number of new strains possessing desirable character combination were synthesized and are now available for field testing.

2.4. Heterosis studies

Successful efforts have recently been made to commercially produce hybrid seed in culture. Heterosis for characters like height of main stem, number of bolls, size of bolls, seed cotton yield, G.O.T. percentage, staple length and even for strength have also been evolved in recent studies in the University. As a result, we believe that this phenomenon can be exploited through a well organized programme. Hybrid cotton can usher in a new era in cotton production. Efforts are under way to find out best hybrid combinations after thorough studies on the combining ability of prospective parents.

3. Generation advancing

The cotton germplasm comprising about 300 lines both exotic and local genotypes, is being maintained in the department regularly. This diverse material is used by the researchers in developing crossing programme each year. For this purpose about 40 lines are planted in greenhouse during winter season under controlled environmental conditions. When the parents start to flower, different sets of parents, based upon differences in important economic characters, are crossed following diallel crossing system, triple test cross method and other appropriate crossing method. Fully developed healthy F_1 seed are picked and planted in the field during normal sowing season i.e. May and June. Some important hybrid material is also planted in greenhouse as F_1 generation for to obtain seed for growing F_2 in the field. This technique has appreciably cut short the time for developing plant material to be screened out for higher yield of seed cotton better lint percentage and other fiber characteristics. The availability of the facility of the greenhouse is being utilized advantageously by the postgraduate students and the researchers for screening the breeding material.

Heterosis studies

Successful efforts have recently been made to commercially produce hybrid seed Heterosis for characters like height of main stem, number of bolls, size of bolls, seed cotton yield, lint, percentage, staple length and fiber strength had been observed. This information on the occurrence of hybridization suggests that this phenomenon can be exploited through a well organized pogramme. Development of hybrid varieties of cotton and their adoption in the cotton belt can usher in a new era in cotton production in the country. Breeding efforts are under way to find out best hybrid combinations after making thorough studies on the combining ability of parents available in the germplasm.

III. MAIZE

Maize, being a relatively short-duration cereal crop, is potentially capable of producing largest quantities of food grain per unit area. As such its cultivation can significatly contribute to the overall food production in the country. With a possibility of raising two grain crops a year from the same field, maize has attained an added significance in our accelerated food grain production programme. Besides, being an important food grain for human consumption, maize is also becoming a valuable industrial raw material and a major component of livestock and poultry feeds.

1. GENETIC STUDIES

1.1. Correlation and path coefficient analysis

Grain yield is a very complex character. It is partitioned into various yield components and the exact contribution of each component can be figured out by considering the interdependence of various components. Path, coefficient analysis has been found useful in estimating the relative effects of various components of yield. Correlations (phenotypic and genotypic) were worked out for four major yield components, viz. number of ears per plant, number of kernel rows per ear, number of kernels per row and 100-grain weight. All the components showed highly significant positive correlation with grain yield. It may, therefore, be concluded that selection for any of the characters would very likely boost the yield potential. Investigations regarding path analysis revealed that 100-grain weight had maximum direct effect on grain yield per plant.

1.2. Diallel analysis of some agronomic characters

A first pro-requisite in understanding and changing the genetic architecture of a crop is a knowledge of its genetic make up and the nature of gene action. Diallel cross analysis technique was used to study the gene action for various characters of economic impartance in sizeable inbred material of maize.

Vr/Wr graphs for various characters indicated that number of days token to silking, plant height, 100-kernel weight and grain yield per plant were controlled by overdominance type of gone action. Number of kernel rows per ear and number of kernels per row were under the additive genetic control.

1.3. Breeding of varieties

Two high yielding synthetic varieties of maize viz UM2 and DM6 have been developed. UM2, a medium tall variety with low ear placement and a strong root anchor, matures in about 100 days and produces bold, yellow, semi-dent grain. In experimental plots the variety has yielded 2.6 tons of dried grains per acre.

UM6 is a variety of meduim stature with medium- to low-placed long ears and bright yellow, semi-flint to flint grains. It matures in 95-100 days and gives high shelling percentage producing 2.5 tons of grains per acre. The variety has been further improved for adaptation to spring planting through selection for fast emergence and vigorous seedling growth at low temperature and for tolerance to high temperature at flowering and maturity. Both the varieties are under field testing.

Due to obvious technical difficulties in the development of maize hybrids, the emphasis has now shifted to the evaluation of synthetic varieties and in some cases the best intervarietal crosses surpass the adapted hybrids and crosses among genetically diverse populations show an acceptable level of performance. UM81, a synthetic variety was also developed by crossing Akbar composite with Sarhad yellow, a widely adapted commercial variety of N.W.F.P. This variety is putting up good performance in preliminary trials and has the promise to develop into commercial variety. Four other populations of maize were also {selected which are suitable for grain yield and fodder purposes. Those populations have shown accelerated growth, increased number of broader leaves and tall stature of the plant. They are also better

grain yielders.

Maize

In Pakistan maize is the third important cereal after wheat and rice and is cultivated on an estimated area of 0.9 million hectares with an annual production of 1.3 million tones. It is an important food grain for human consumption as well as a valuable industrial raw material and a major component of livestock and poultry feeds. The average yield in Pakistan is low as compared to many maize growing countries of the world. In view of its increasing importance there is need to develop maize hybrids and synthetics with improved yield potential and wider adaptability. The research activities being pursued in the department are focussed on the following objectives:

Development of promising inbred lines and maintenance of germplasm with genetic diversity for population improvement.

Genetic studies for morpho-physiological drought related traits for the development of improved types identification and evaluation of germplasm with quality attributes for the development of hybrids of industrial importance Development of new high yielding hybrids with wider adaptability.

1. GENETIC STUDIES

Correlation and path coefficient analysis

Grain yield being a very complex character is partitioned into yield components and the exact contribution of each component can be figured out by considering the interdependence of various components. Path coefficient analysis has been found useful in estimating the relative effects of various components of yield. Correlations (phenotypic and genotypic) were worked out for four major yield components, viz. number of ears per plant, number of kernel rows per ear, number of kernels per row and 100-grain weight. All the components showed highly significant positive correlation with grain yield. Therefore, selection for any of the characters would likely boost yield potential. Investigations regarding path analysis revealed that 100-grain weight had maximum direct effect on grain yield per plant.

Combining ability studies in maize inbred lines

Eight inbred lines (NC9, F131, OH54, WA3748, WF-9, OH41, AES 204, A-638) were crossed in all possible combinations and evaluated for yield and its components. Both general and specific combining ability effects contributed significantly to grain yield and the components like plant height, ear number, kernel rows, number of kernels per row and grain weight. The variances due to specific combining ability were greater in magnitude and more important for all the characters showing the dominance of non-additive gene action. In general, increased grain yield in the crosses appeared to have come through increased number of kernel rows per ear and number of kernels per row.

Genetic analysis of grain yield and its components in maize diallel cross

A set of diallel crosses involving six inbred lines (M14, A50-2, A545, A638, OH41, USSR40) was made to determine the type of gene action. Plant height, number of ears per plant, grain yield and 100-grain weight were controlled by over dominance type of gene action. Ear diameter was controlled by complete dominance.

Diallel analysis of some agronomic characters in maize inbred lines

A first pre-requisite in understanding and changing the genetic architecture of a crop is knowledge of its

genetic make up and the nature of gene action. Diallel cross analysis technique was used to study the gene action for various characters of economic importance in sizeable inbred material of maize. Vr/Wr graphs for various characters indicated that number of days taken to silking, plant height, 100-kernel weight and grain yield per plant were controlled by overdominance type of gone action. Number of kernel rows per ear and number of kernels per row were under additive genetic control.

Genetic and phenotypic association for economic characters in maize

Correlation within parents or crosses are of value to indicate the degree to which various characters of a plant are associated with economic productivity. Correlation between grain yield and its components were studied. Plant height, ear number, kernels per row, ear length, ear diameter and grain weight showed positive and significant correlation with yield at the phenotypic and genotypic levels. It is inferred that selection for any of these components or a combination of these characters would be expected to enhance grain yield in maize.

Genetics of dry matter accumulation in maize

The study was made to determine pattern of dry matter accumulation on eight exotic and indigenous inbred lines viz, OH33-1, W64SP, WF9, B34, Q97, PB7, JY and $52B_4$ which were crossed in a complete diallel fashion. The cross combinations were sown along with the parental lines in a triplicate randomized complete block design. Analysis of gene action was made for dry matter accumulation at different stages of growth and different parts of the plant at maturity alongwith various yield components. The results demonstrated the preponderance of dominant genes for all the traits. Broad-sense heritability was high for all the traits studied. Significant and positive correlation between grain yield per plant and all other traits except dry matter of leaves per plant at maturity was recorded.

Varietal Improvement

Due to obvious technical difficulties in the development of maize hybrids, the emphasis has now shifted to the evolution of synthetic varieties and in some cases the best intervarietal crosses surpass the adapted hybrids and crosses among genetically diverse populations show an acceptable level of performance. UM81, a synthetic variety was also developed by crossing Akbar composite with Sarhad yellow, a widely adapted commercial variety of N.W.F.P. This variety is putting up good performance in preliminary trials and has the promise to develop into commercial variety. Four other populations of maize were also selected which are suitable for grain yield and fodder purpose. These populations have shown accelerated growth, increased number of broader leaves and tall stature of the plant. They are also better grain yielders. Two high yielding synthetic varieties of maize viz UM2 and UM6 have been developed. UM2, a medium tall variety with low ear placement and a strong root anchor, matures in about 100 days and produces bold, yellow, semi-dent grain. In experimental plots the variety has yielded 2.6 tons of dried grains per acre. UM6 is a variety of medium stature with medium- to low-placed long ears and bright yellow, semi-flint to flint grains. It matures in 95-100 days and gives high shelling percentage producing 2.5 tons of grains per acre. The variety has been further improved for adaptation to spring planting through selection for fast emergence and vigorous seedling growth at low temperature and for tolerance to high temperature at flowering and maturity. Both the varieties are under field testing.

IV. PULSES

Mung and Mash.

Tedious ad low crossability and consequent meagre genetic variability are the major factors for miserably low grain yields in edible legumes like mung and mash. Viral diseases also play a havoc in the absence of any reliable genetic resistance against these natural hazards. Concerted efforts are, therefore, required

not only to create fresh heritable variation but also to exploit the existing resources to the maximum benefit. Screening of a large number of mung and mash purelines and hybrid material against prevalent complex of diseases and production hazards was undertaken. Three pure lines of mung viz. Mg-1, 562-1 and AUM233 have shown promise to become commercial strains and are in advanced stages of field trails.

The newly developed mung line Mg-1 has shown excellent performance in the National Uniform Mungbean Yield Trials during the year 1983 producing 525.21 Kg of grain per hectare.

Similarly Mash 133 has shown a great promise in trials at Bahawalpur, Multan, Vehari, Shiekhupura, Toba Tek Singh and Faisalabad. It is early maturing high yielding variety with attractive canopy for easy harvest. This has also been included in the National Uniform Yield Trials for the last three years and has shown an excellent performance.

Knowledge about the exact correlation of morphological characters with yield is of special significance in crops ridden with depleted genetic variability. Studies on this important aspect were conducted both in Mung and Mash and the character correlation was established to devise an effective selection strategy. Pulses being crops of marginal lands face acute environmental stresses particularly of low moisture and high temperature. A large number of lines were screened against these hazards and the characters responsible for possible resistance were documented. Mung and mash being generally intermediate in habit exhibit large amount of flower abscission resulting in low fruit setting and reduced yield. Phytoharomones can possibly provide an answer to important problems in grain legumes. Efforts were, therefore, initiated to determine a suitable hormone and an effective dose to chock unnecessary abscission.

2. GRAM

Gram is the major agricultural crop in the barani/marginal lands of the country but is faced with extremely low productivity due to pathological hazards like wilt and blight. Efforts were therefore, focused at developing reliable screening techniques for will and blight. Consequently a new gram variety AUG480 was developed which has very high genetic resistance against blight. After thorough field trials, the seed was distributed to the commercial growers and presently the varity is grown over ten thousand acres in the barani tracts of the country.

Gram wilt and gram blight nurseries have also been established with a new technique of identification, isolation and multiplication of inoculum of the fungi. The University labortries are now in a position to not only supply the requisite inoculum to interested institutions and breedrs but can also extend help in screening their nurseries on request. We are currently recieving material for this purpose from almost all the national and international orgnizations engaged in gram breeding.

Several hybrids and advanced generations of crosses are also under study to determine the genetic basis for various components of yield and in case of disease to determine host-pathogen relationship.

Among the thousands of lines screened, twenty six varieties have shown varying degree of resistance to important viral and fungal diseases.

The varieties with high productivity and resistance to stored grain pests and pod borer have also been documented for future use in the hybridization programme.

Studies with regard to mode of inheritance of some qualitative and quantitative characters in six crosses of gram revealed that inheritance of flower colour and stem colour was controlled by a single pair of genes with purple as dominant over white flower and coloured stem dominant over green stem. Such

simply inherited characters are easily transferable and are clearly recognised in the segregating generations. Seed shape was also Mondelian in inheritance whereas seed colour was governed by poly genes while characters like days to flowering, plant height, number of primary and secondary branches, 100-grain weight and grain yield showed quantitative inheritance.

Correlation and path coefficient studies conducted for a large number of genetic characters of gram indicated that characters like 100- grain weight, length and thickness of pod had highly significant positive effect on yield, where as path analysis indicated the direct effect of height and indirect effects via secondary branches and seed number per plant. Direct effect of number of primary branches and pods per plant was negative and these characters contributd mainly through plant height, secondary branches, seed number per plant and grains per 10 pods which had the direct bearing. It can therefore be concluded that selection made on the basis of plant height and more' number of seeds per plant can successfully lead to the development of high yielding varieties of gram.

Yield stability studies were carried out using linear regression interaction. Considerable fluctuations in avarage yield performance observed in gram populations over the years were primarily due to the lack of suitable genotype. Efforts are therefore focuesed on the development of a variety capable of turning in consistently better yields under usual envivonmental fluctuations.

PULSES (New Material)

Pulses, the dry edible seeds of leguminous plants, constitute an important source of balanced human diet throughout the world. They are especially crucial in a country like Pakistan where animal protein is scarce and economic conditions of the people preclude consumption of meat. Chickpea, the principal “rabi” pulse legume in Pakistan, is planted on an area of 860.0 thousand hectares with 611.5 metric tones production and the average yield being 711kg/ha. Mungbean, the second important pulse legume in Pakistan, is a short duration crop having low input requirements and suitable for cultivation both under rainfed and irrigated conditions. The average yield of pulses in Pakistan is low as compared to other countries of the world. This is primarily due to poor genetic make-up of the cultivars available, excessive vegetative growth, low tolerance to various diseases and non-availability of seeds of improved varieties. The research program for the genetic improvement of pulses is pursued in the department of Plant Breeding and Genetics with the following objectives.

Objectives

- Screening of chickpea germplasm for source of disease resistance and adaptability
- Evaluation of mungbean lines for early and uniform maturity, improved physiological efficiency and resistant to mungbean yellow mosaic virus.
- DNA marker assisted selection for wilt resistance in chickpea
- Testing of promising strains and advanced lines of chickpea and mungbean under a range of agro-climatic conditions

Chickpea

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extend help in screening their nurseries on request. We are currently receiving material for this purpose from almost all the national and international organizations engaged in gram breeding.

Several hybrids and advanced generations of crosses are also under study to determine the genetic basis for various components of yield and in case of disease to determine host-pathogen relationship. Among the thousands of lines screened, twenty six varieties have shown varying degree of resistance to important viral and fungal diseases. The varieties with high productivity and resistance to stored grain pests and pod borer have also been documented for future use in the hybridization programme.

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Gene Pool

The existing germplasm collection was enhanced by the addition of mutants and recombinants derived from local and exotic genotypes. The germplasm of various legumes was propagated in the breeding area for manual crossing between diverse types of gram, lentil and mung. New entries were received from PARC, AARI, NIAB, BARI, ICARDA, ICRISAT, AVRDC and other regional and provincial research institutes dealing with pulses breeding.

Breeding Studies

The success of any breeding program depends upon the extent of variability in the crop material. Genetic variability was created through irradiation and by attempting several fresh crosses among diverse genotypes of various pulses.

Handling of Breeding Material

The F_1 seeds were sown in the field and inheritance of various parameters was studied. The F_2 and advanced generation material of chickpea supplied by ICARDA was screened against various biotic and abiotic stresses. Superior segregates were kept for generation advancing. Selections were also made from germplasm introduced from various National and International agencies and from the advanced breeding material developed locally.

GENETIC STUDIES

Interrelationships and path coefficient analysis in chickpea

Correlation and path coefficient analysis was made for various traits in chickpea. It was concluded from direct and indirect effects that total weight of the plant, 100-grain weight, number of pods per plant and numbers of seeds per pod were more important attributes of selection for high yielding genotypes.

Heritability estimates of some quantitative characters in F_3 population of chickpea

Heritability estimates were made for plant height, weight of plant, number of primary and secondary branches, number of pods per plant, number of seeds per pod, 100-grain weight and seed yield per plant. Cross combination AUG-104 x Punjab 2000 was found to be superior than the other crosses showing higher estimates of plant height, number of pods, seed weight and seed yield per plant.

Path analysis of yield attributes in mungbean (*Vigna radiata L. Wilczek*) genotypes.

The experimental material comprised fifteen mungbean genotypes which were grown during two seasons. Path coefficient analysis performed on the pooled data revealed that number of pods per plant had maximum direct positive effect on seed yield per plant followed by plant height. Relatively small but positive direct effects were recorded for pod diameter, number of columns per pod and pod length.

Field screening of chickpea germplasm/line against wilt resistance

The use of molecular markers has speeded up the resistance breeding for a variety of objectives. The establishment of molecular markers technology and the generation of a genetic map would also be desirable for marker assisted selection and the positional cloning of resistant genes in chickpea. Among the fungal diseases, chickpea wilt caused by *Fusarium oxysporum* f. sp. ciceris is a serious problem and more common in relatively dry areas (Thal) of Pakistan. The economical and ideal way of controlling disease is the use of host resistance which can be determined by screening germplasm in the sick field. For this purpose a sick plot was prepared in the field. The inoculum of various fungus races especially the more virulent strains obtained from NIAB and AARI was properly developed and spread in the field. During the month of August, 2004 a susceptible line AUG-424 was sown in the infected field and when the seedlings started wilting, they were ploughed in the soil, thus increasing the intensity of inoculum. Chickpea germplasm received from various sources was screened against Fusarium wilt. These germplasm lines / cultivars were sown in artificially developed wilt sick plot in the experimental area of the Department of Plant Breeding and Genetics. A wilt nursery comprising 61 lines received from ICARDA through the courtesy of NARC, 139 lines from Plant Pathology Department, U. A., Faisalabad and advanced lines developed in the Department, were screened against wilt.

Large scale chickpea yield trial

Ten elite lines of chickpea were sown in this trial. The data were recorded for disease and yield parameters. The highest yield of 2081 kg/ha was produced by Punjab-2000 while the University line AUG-27 yielded 2064 kg/ha.

Preliminary yield trial of chickpea (twenty varieties)

Twenty elite lines selected on the basis of wilt and blight resistance were sown in a randomized complete block design with three replication. The plot size and line to line distances were kept 400x120 sq. cm and 30 cm. Blight, wilt and yield data were recorded. Line 104 gave maximum yield of 1860 kg/ha followed by 112 (1815 kg/ha) and 110 (1780 kg/ha). The lowest yield of 785 kg/ha was given by line 120. Wanhar

2000 produced 1530 kg/ha grain yield.

Comparative yield trial of 15- varieties of chickpea

Fifteen selections were made from the advanced material on the basis of previous year's performance which was planted in a randomized complete block design with three replications. The variety AUG-786 was found to be the highest yielder. The check variety Bakhar-2000 occupied the second position. Gram blight was not observed in any case and all except 4005 were wilt susceptible.

Comparative yield trial of lentil

Ten elite lines of lentil were sown in a randomized complete block design with three replications and evaluated for yield, disease incidence, and germination percentage. Line AUL-9850 yielding 1458 kg/ ha performed better than rest of the entries closely followed by Masoor 93 (check variety) which yielded 1381 kg/ha.

Comparative yield trial of mungbean

A trial of 15 mungbean lines was planted for yield performance. Line AUM-38 exceeded rest of the varieties by yielding 1206 kg/ha. However, all entries faced incidence of yellow mosaic virus but the stand of the crop was good. Two other lines AUM-28 and NM (check variety) performed equally good by giving 1173 kg/ha and 1111 kg /ha seed yield.

V. SUGARCANE

1. FLOWER INDUCTION

Absolute lack of sexual reproduction is perhaps the most obstinate problem in sugrcane improvement in Pakistan. Researches in this vital crop were, therefore, primarily devoted to the induction of flowering for genetic improvement. A genetically diverse collection of some three hundred clonal lines was used for flower induction at Murree Hills Sub-station Charrapani (altitude 4000 ft.). Most of the lines showed erratic flowering with meagre pollen viability. The prominent factors inhibiting flowering were diurnal temperature fluctuations, lack of proper photoperiod and soil moisture regimes. Most flowering lines were ridden with environmental male sterility. Sustained efforts have however, resulted in the establishment of more than 200 clonal lines which have been developed through polycross using 12 elite lines having synchronized flowering.

2. GENETIC VARIABILITY

The range and type of genetic variability available for major economic characters in sugarcane were also investigatd in a large number of local and exotic clones with diverse origin and attributes. Almost all economic characters exhibitd fairly broad spectrum of genetic variability and the maximum was recorded for number of tillers, sucrose contents and leaf size. These characters, therefore, indicate fairly high chances of improvemet through appropriate selection techniques. Least amount of variability was recorded in plant height and internode length. It, thus seems imperative to induce heritable variation in these characters to make further progress.

3. CHARACTER CORRELATIONS

Foliar arrangement and morphology significantly contribute not only to growth and development of the plant but also determine the rate and quantum of carbohydrate accumulation in sugracane. Prominent canopy characters like leaf arrangement, leaf shoot ratio, leaf angle, specific leaf weight, leaf area,

ciliation, venation and stomatal frequency were studied to establish relationship of these important leaf characters with sucrose contents. Foliar angle and area, venation and stomatal frequency had positive correlation with brix while leaf shoot ratio and specific leaf weight were negatively correlated. Correlation coefficients of all these characters with photo intensity were also calculated. Stomatal march and sucrose percentage had high positive correlation with light intensity, while number of stomata (both lower and upper surface) leaf width, cane 'yield per plant and leaf venation had low positive correlation. Photointensity was observed to influence cane productivity primarily by providing longer periods of stomatal activity rather than altering their frequency and size. It may therefore, be concluded that there exists a possibility of selecting genotypes with specific morpho-anatomical features for more productive utilization of available natural photoregimes.

4. EFFECT OF PHYTOHARMONES

The effects of several phytohormones including gibberellic acid, tri-iodobenzoic acid, indole acetic acid and cycocel on the morpho-anatomical characters like plant height, tillering, stem thickness, leaf area, leaf thickness, venation, ciliation, cell size, stomata number, cane yield, and the sucrose contents were studied. All the hormones had significant effect on height internode length, cane thickness, leaf and cell size while in most cases effect on tillering was non-significant. Cane thickness was significanlty increased by cycocel while the reverse was true for gibberellic acid which increased height but decreased thickness. Both cycocel and gibberellic acid encouraged lateral bud sprouting, however, the effect of cycocel was more pronounced. The sucrose percentage was significantly increased by both cycocel and gibberellic acid while tri-iodobenzoic acid and indole acetic acid did not influence it appreciably. Tri-iodobenzoic acid was found particularly effective in intitiating floral primodia in Juvenile canes.

5. MUTATION BREEDING

Sugarcane is hard to hybridize due to almost total absence of sexual reproduction. Consequently the crop seriously lacks genetic diversity needed for further improvement. Non-conventional breeding techniques like induction of somatic mutations through ionizing irradiation, therefore, provide an alternate avenue for improvement. Efforts were made to find out a proper irradiation dose capable of triggering usable somatic mutations and also to identify mutant canes of commercial value. It was observed that gamma irradiation significantly reduced bud germination. Increase in dosage resulted in progressive decrease in bud sprouting. Tillering was not appreciably altered by irradiation although varietal differences were significant. Cane length and thickness was adversely affected. Cane height was reduced mainly through reduction in internode lenght. Cane yield and sucrose percentage was generaly reduced although several mutant clones showed increased sucrose contents. Some mutants having decreased cell size increased venation and stomatal frequency were found particularly suitable for planting under stress conditions characterized by low soil moisture and high ambient temperatue.

VI. OIL SEEDS

1. SUNFLOWER

1.1. Gentics and Breeding

A sizeable sunflower germplasm has been studied for genetic variability ranges of various important economic characters and the material has been documented for use in future breeding programmes.

Genotypic and phenotypic correlations were also worked out for characters like plant height, number of leaves per plant, stem diameter, seed yield and oil contents. All the characters showed positive correlation with seed yield except internodal length which had negative effects.

Sunflower has recently been introduced as a commercial oil seed ad shows good prospects for improvements through the exploitation of hybrid vigour. Local sunflower production so far has been dependant upon the imported hybrids and synthetics. Efforts were therefore, initiated to develop and evaluate inbred lines to introduce local hybrids. A number of inbred lines have been developed. Their hybrids are in various stages of field evaluation. Yield and growth analysis studies conducted on exotic hybrids and open pollinated varieties have indicated that some open pollinated varieties were equally productive under local environments. They were however less attractive due to lack of uniformity in height and maturity.

2. RAPESEEDS

2.1. Germplasm collection

A larger collection of genetically diverse germplasm was built and is being exploited for setting up new plant populations with specific imporvement objectives.

2.2. Estimation of genetic variability

Several local and exotic varieties of *Brassica compestris.* Toria Swedish, a local variety Toria A, T.L.15 , Toria and NST were used for the estimation of range of variability present for different genetic parameters.

An appreciable amount of genetic variability was observed for almost all the characters. Presence of a fairly good amount of heritable variation for important economic characters like number of pods, grains per pod, grain weight and oil contents indicates the scope of possible genetic improvement.

Similar studies were initiated on "sarson" varieties both local and exotic. Several cultivars including the varieties Carinata, Bangladesh, Span, Tower and Balba showed large amount, of genetic variability for most of the characters like flower initiation, number of pods per plant, pod length and yield per plant.

2.3. Oil and protein contents

Analysis of oil and protein contents in large number of Toria ad Sarson varieties showed considerable range in oil contents while there were only insignificant differences for protein contents. This clearly points to the possibility of sustained genetic improvement for oil contents, whereas infusion of fresh genetic variability is necessary to improve protein contents in various types of oil seeds.

An extensive survey of varieties, strains, ecotypes and species of different rapes and mustrads has been completed to build-up a germplasm pool. Promising isolates were evaluated and used for further breeding. In this context several genetic parameters have been evaluated and further work is in progress. Most remarkable discoveries made in the field related to the evolution of a ploycross toria variety and the development of an innovative technique to make successful crosses in groundnut for the first time in our ecology.

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Germplasm has been evaluated for drought and salinity tolerance. A number of lines have been selected as drought and salinity tolerant for hybridization programs. Sizable work was been completed for seedling growth rate evaluations for early seedling establishment, and number of lines have been developed for quicker growth and early seedling establishment. These lines have been used in hybridization programe and number of elite lines have been produced which are at various phases of evaluation.

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The germplasm in all the oilbearing brassicas was evaluated for drought tolerance. A number of lines were selected from local and exotic germplasm, used in hbridization programme and developed number of elite lines in both B. juncea and B. napus. These lines are being evaluated for the evolution of high yielding drought tolerant of brassica varieties. The visual evaluation of number of lines were made for erucic acid contents in B. napus, for selection of material with low erucic acid contents for edible purpose and extremely high erucic acid for their potential use as biodesial. The attempts are underway to develop canola quality in *B. juncea* which is more drought and shattering tolerant and earlier than *B. napus*. The material so developed is in evaluation for agronomic characters.

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CENTRE OF AGRICULTURAL BIOCHEMISTRY AND BIOTECHNOLOGY (CABB)

The science of biotechnology and genetic engineering has provided scientists with modern tools to bring about a biological revolution. Plant biotechnologists use novel techniques to develop crop varieties with higher yields, preferred nutritional value, storability and having resistance to environmental stresses, insect pest and diseases. The genes can be made to express in bacteria and yeast to produce enzymes, medicines and other important products, which are otherwise very difficult to obtain in large amounts. Transgenic plants, possessing genes from wider sources, are being grown now, which have been synthesized making use of the tools provided by the modern science of biotechnology and genetic engineering.

Biotechnology has started facilitating many areas of science but the University of Agriculture, Faisalabad being the most prestigious institution of agricultural education and research in the country established CABB to focus on the agricultural biotechnology.

The developmental phase of the project CABB has been completed and it was formally inaugurated by the chairman Higher Education Commission during September 2003. The completion report PC IV has been submitted but the centre is yet to be facilitated with staff and other non-developmental budget. With the help of some research projects funded by various agencies and some temporary grants the salient research work carried out since its formal establishment is reported.

Training Courses

Three national hands-on training courses were organized on the Integration of Modern Biotechnological tools with Conventional system of Crop Genetic Improvement for the teachers and researchers of various universities and research and development organizations from all over the Pakistan including AJK attended the course. Additionally several courses were organized for the teachers and postgraduate students of the university at various times.

Establishment of Growth Chambers

Growth chambers are the necessary component in biotechnology and genetic engineering. However, this necessity was missing in the centre. Two dismantled growth chambers were erected with help of Pakistan Council of Scientific and Industrial Research under the repair and maintenance of scientific equipment programme.

National and International Linkages

Bilateral working relations have been developed between CABB and different national and international research organisations. For example, a collaborative programme with National Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad is in progress. The international linkage program between the CABB and School of Biological Sciences, The University of Liverpool, UK has been established.

Strengthening of Library Facilities

Efforts have also been made to develop a library in the centre. Some books on Biotechnology and Genetic Engineering have been purchased for the library.

A project for the strengthening of library facilities were submitted for funding to the Higher Education Commission (HEC) entitled as "Upgradation of the Centre for Agricultural Biochemistry and Biotechnology (CABB)" and list of the required books were also submitted to the Pakistan Council of Science and Technology (PCST).

Development of modified DNA extraction Protocol

A modified DNA extraction protocol has been established and the manuscript has been accepted in the "Plant Molecular Biology Reporter Canada". This modified method yields 700-800 µg of good quality DNA from 300 mg leaf tissue of cotton and wheat samples. The quality of the DNA is quite suitable for PCR-based marker studies.

Molecular Characterization of Cotton

The cotton cultivars were screened for a new strain of CLCuV, Burewala virus, and were characterized through RAPD and the characterization of coloured cotton cultivars through RAPD has also been carried out. The use of Simple Sequence Repeats (SSR) has been started in cotton to obtain more reliable and reproducible results.

A study on the transformation of truncated replicase gene of CLCuV DNA – A into Cocker –312 was carried out in collaboration with NIBGE. A truncated AC1 gene isolated at NIBGE was amplified with the primers CAG AAG CTT ATG GCC TAC ATC GAC AAG GA (forward) and CAG GGA TCC TCA AGA TCT ACT CTC CTC CT (reverse). The amplified DNA fragment of the right size was eluted and cloned in a plant expression vector (pJIT 60). The pJIT 60 tAC1 in E. coli DH5-alpha by electroporation. The cotton seedlings of Cocker –312 were used for transformation. The explant was incubated with *Agrobacterium Tumefaciens* strain LBA 4404 containing truncated Rep gene.

Genetic diversity among cotton genotypes was estimated through RPAD markers. The plant material including four varieties and their six F1 hybrids were used in the study. After optimisation of protocols, DNA of the 10 genotypes of cotton was amplified with 15 different random primers, out of which 10 were found polymorphic. A total of 776 DNA fragments were generated by the 15 primers with an average of about 7.7 bands per primer. Of the 776, 27 fragments showed polymorphism among the ten cotton genotypes which is an approximately 3.5 % polymorphism. The genetic similarity matrix (99 to 83 %) of RAPD data for the ten cotton genotypes was constructed, which did not indicated substantial differences among the 10 genotypes. The cotton genotype BH-118 and BH-118 × HR-129 had the greatest similarity 99.0%. Most of the genotypes fell in the range of 91-98 % similarity. Thus, there appeared a high degree of over all similarity between the tested genotypes. The genotype HR-129 was found genetically more dissimilar to the cross combination FH-1000 × BH-118, showing 83 % similarity. The UPGMA cluster of the 4 cotton varieties and their 6 F1 hybrids further revealed associations based on RAPDs. Based on RAPD markers the cotton genotypes FH-1000, BH-118, CIM-506, and HR-129, appeared as elite cultivars.

Molecular Characterization of Vegetable Crops

Gene pool for genetic diversity studies in tomato was collected from various institutes like PGRI, Islamabad, AARI Faisalabad and AVRDC Taiwan. The DNA marker studies of Tomato for different agronomic characters like heat and disease resistance are also in progress using RAPD techniques.

Heat Tolerance studies in tomato

In tomato high temperature of 42 ^{o}C for 4h cause blossom drop in tomato and prevent production of tomato during summer in the country and depress yield to a maximum. Heat tolerance in tomato (L. esculentum) genotypes was assessed using membrane thermostability (MTS) technique, and other floral characteristics. The data were collected for membrane thermostability values, number of flowers per plant, stigma elongation, antheridial cone splitting, number of flowers shed/ plant, number of fruits/plant, number of days for fruit setting and yield per plant.

The variation between the accessions was greater in traits like antheridial cone splitting, followed by number of fruits per plant and membrane thermostability.

The associations of fruit yields per plant were positive with number of flowers per plant, number of fruits per plant, membrane thermostability and number of days for fruit setting. The association of fruit yield per plant with number of flowers shed, stigma tube elongation and antheridial cone splitting was significant and negatively correlated with yield of tomato.
Among the genotypes studied for the effect of heat on the floral characters, “Cchaus” was the best genotype having tolerance to heat stress. The genotype “Cchaus” having high membrane thermostability and lowest number of flowers shed produced highest fruit yield during hot period. It was followed by genotype “2413L” having highest membrane thermostability value but shedding of flowers was more than Cchaus. The study showed that “Roma” having lowest membrane thermostability was the most sensitive genotype to heat. It was concluded that variation for tolerance to heat stress exist in tomato. The genotypes “Cchaus” and “2413L” showed the highest degree of tolerance to the stress among the tested genotypes. Thus, potential seems to exist for breeding tomato genotypes with increased tolerance to heat stress to sustain tomato production in the hot summer months.

It has been proved through research that among the heat stress transcription factors family HsfA1 and HsfB1 are the main transcription factors that impart resistance to tomato against high temperature. Efforts are being made with German researchers to develop constructs and to optimize conditions for agro-bacterium mediated transformation to develop heat stress tomato cultivars.

Characterization of bacterial strains through RAPD analysis

Molecular typing methods provide an opportunity for estimating relatedness within and among different isolates based on DNA polymorphism and they seem to be the method of choice in predicting phylogenetic relationships. DNA extraction was done using alkaline lyses and normal saline method. The alkaline lysis method yielded higher amount of genomic DNA than the normal saline but the purity as well as the quality of DNA when run on 1 % agarose gel was found comparable. Due to the technical simplicity and speed of RAPD methodology, RAPD markers have been successfully used for the generation of genetic variation and phylogenetic analysis. Characterization and evaluation of genetic differences among these different isolates was necessary for the effective control measures and antimicrobial selection.

Total genomic DNAs from six isolates were extracted for random amplified polymorphic DNA (RAPD) analysis by using 15 random decamer primers. 85 bands were observed from all of fifteen primers with an average of 5.6 bands per primer. A primer A-04 produced maximum number of fragments while minimum number of fragments was produced by C-01. Of these amplified fragments almost all showed polymorphism among different isolates of *Pasteurella multocida.* There was a single primer C-05 with primer sequence (5´- GATGACCGCC-3´) that can identify more than one RAPD profile without the aid of other primers indicating that RAPD markers can be used for the identification of *P. multocida* isolates. The genetic relatedness among six *Pasteurella multocida* isolates was ranging from 58.6 % to 77.3 % that showed the level of DNA variation was high among these isolates. The phylogenetic tree constructed from the RAPD data showed a single lineage which indicated that all isolates are descendents of a single

species of *Pasteurella multocida.* It is recommended that the birds be vaccinated against Fowl Cholera using the local isolates.

Molecular characterisation and hybrid identification in wheat

Seven lines of wheat, i.e., WL-43, 27HTN/1-54, WL-23, CHENAB-70, 3WLRG/1-8, 12WLRG/1-12 and 7HTN/1-54, screened for salinity tolerance in the Department of Plant Breeding and Genetics, were used for fingerprinting. Considerable variation has been observed with only 15 random primers used for PCR. The work would substantiate the future breeding programme of the Wheat Group in the department.

Doubled haploid production and hybrid identification in wheat

Three maize (*Zea mays* L.) genotypes were tested for threir influence on induction and regeneration of haploid wheat (*Triticum aestivum* L.) embryo to further improve the efficiency of wheat × maize system for the doubled haploid production. Maize genotypes were crossed to the six wheat F1 crosses. Two efficient parameters, caryopses formation frequency (CFF--number of caryopses/100 pollinated florets) and embryo formation frequency (EFF--number of embryos carrying caryopses/ 100 pollinated florets) along with two other parameters *i.e.* haploid embryo regeneration (HER—number of haploid embryos regenerated/ 100 pollinated florets) and doubling of chromosome number (DCN--number of haploid plants showing doubling of their chromosomes/ 100 pollinated florets). The CFF of individual maize genotype ranged from 74.89 to 84.44%, EFF of individual maize genotypes ranged from 50.22 to 65.05%, HER of individual maize genotypes ranged from 13.00 to 29.44% and DCN of individual maize genotypes ranged from 6.278 to 25.00%.

For embryo formation Auqab2000 × Ufaq2002 crossed with mixed maize pollen showed excellent performance with a mean value of 76.67% EFF. The values of mean ranged from 76.67%-45.00%. Auqab2000 × Ufaq2002 and Auqab2000 × Lu-26 both when crossed with pop corn pollen showed the poorest performance with a mean value of 45.00%.

For DCN, doubling of chromosome number showed a range of mean values form 30.33-5.00. Inqlab-91 × Auqab2000 crossed with mixed pollen showed the best performance with mean value 30.33% followed by Inqlab-91 × Ufaq 2002 crossed with mixed pollen (29.67%). Ufaq2002 ×Lu-26 crossed with pop corn showed the weakest performance (5.00%).

For maize genotypes producing the highest EFFs, the regeneration frequency was not necessarily higher. Hence, we suggest a new index, haploid formation efficiency (HFE—number of haploid plants formed /100 pollinated florets), be used for identification of efficient pollinators. The HFE ranged from 31.62.0 to 43.41%. In this study, mixed pollen of maize was identified as the best pollinator with an average EFF of 36.57% across six wheat genotypes. The mixed pollen sources showed the best performance for the production of doubled haploid following wheat × maize system. The mixed pollen was obtained from a local open pollinated source. Therefore, the best performance of the mixed pollen source for the doubled haploid production would seem to be due to its high adaptability to local environmental conditions.

Eight RAPD Primers were used in this study. Five of them were polymorphic and three were monomorphic. The results of RAPD markers are satisfactory as it helped to identify all the hybrids. Two primer only GDL20 and GDL16 helped to identify all six F_1 hybrids. GLD-20 acted as highly polymorphic primer. It exhibited polymorphism among the parents. Four hybrids were identified (Inqlab-91 × Auqab2000, Inqlab-91 × Lu-26, Auqab2000 ×Lu-26, Ufaq2000 × Lu-26) with GLD-20.) Other two Auqab2000 ×Ufaq2002, Inqlab-91 × Ufaq2002 were identified with GLD16. Conventionally the genetic purity is determined by field test Grow Out Test. (GOT) is conducted. The GOT is an expensive and time consuming procedure delaying planting and leading to the loss of seed viability. Molecular markers technique is an alternative that offers efficient, quick and reliable assessment of genetic purity and hybrid

identity.

Hybrid identification in Oats

Results of randomly amplified polymorphic DNA confirmed the hybrids tested. Out of 10 primers used C-8 and A-8 gave the best results in detecting polymorphism in the breeding material indicating that these are helpful in identifying hybrids. It may be suggested that the genetic base of the parents must be broadened so that they can be efficiently used in the hybridization programme aiming at the improvement of oat for higher green fodder yield and better nutritional quality.

Research Project in Progress

Molecular Characterization of available germplasm of all the crops in Pakistan

A research associate was provided by the PCST upto December 2004 to make up the deficiency of staff in the CABB. A research programme on molecular characterization of wheat and cotton, screening of cotton germplasm were started with his help. The cotton germplasm was screened for CLCuV (Burewala strain) and studies were also initiated on transformation, gene cloning and gene silencing for their potential uses in the conventional system of crop breeding.

Molecular Characterization of available Germplasm of Wheat in Pakistan funded by PARC Islamabad through agriculture linkage programme

In the project of Molecular Characterization of available germplasm of wheat in Pakistan funded by the ALP, the 72 varieties of wheat have been characterized through RAPD. Results of 20 wheat cultivars from period of 1933- 20002 have been accepted in international journal “Genetic Resources and Crop Evolution (GRACE)”. The result obtained from RAPD analysis of wheat indicated a narrow genetic base among the varieties, which, seems to be the major constraint in the genetic improvement of these crops for yield and adaptability. Knowledge of diversity patterns allows the plant breeders, to better understand the evolutionary relationships among accessions, to sample germplasm in a more systemic fashion, and to develop strategies to incorporate useful diversity in their breeding programmes. The results will be helpful to draw the strategies for future breeding programmes in the country and indicate the need to evolve varieties having diverse genetic background. The other 20 wheat varieties have been further characterized through RAPD and their results are in preparation to submit them into an international journal. Moreover, the characterization of 100 wheat varieties is in progress. Meanwhile, work on microsatellite has been started on wheat. Initially the protocols for SSR have been optimized and work is under progress with more 50 SSR primers.

Initiation of M.Sc (Hons) degree in Agricultural Biotechnology

To make use of biotechnology in crop improvement, there is a great need to develop human capital and trained manpower in this field. Realizing the importance of biotechnology the Higher Education Commission (HEC) has started various degree-oriented programmes in various fields. In view of the potential of this modern science for improving crop agriculture in Pakistan, curriculum for the degree of M.Sc. (Hons) Agricultural biotechnology was developed, the degree programme was started and first batch of students was admitted from September 2005.

SOIL SCIENCE

1. RECLAMATION OF SALT AFFECTED SOILS

1.1 Use of chemical amendments

An experiment was conducted on the interaction of gypsum and water depth in the reclamation of saline-sodic soils locally known as "Thur bara" soils. Ground gypsum at the rates 50, 75 and 125% gypsum requirement (GR) of soil was mixed thoroughly with the upper 15 cm layer of the dry soil columns. Water equivalent to 60, 90 and 120 cm was applied for leaching. Results of only one representative "Thur bara" soil are presented. The soil was sandy clay with pH of saturated soil paste (pHs) of 9.0, electrical conductivity of saturation extract (ECe) of 40.5 ds/m, exchangeable sodium percentage (ESP) of 71 and hydraulic conductivity (HC) of 0.008 cm/hour. The data for soil treated with gypsum at the rate of 75 and 100% of GR indicates that pHs, ECe and ESP decreased while HC increased with increasing amount of gypsum applied (Table 1). Gypsum application at rates equal to or greater than 75% of GR increased the HC to more than 0.1 cm/hour which is considered as the safe level for leaching and irrigation purposes. The HC of upper 15 cm layer was slightly higher than that of the lower 15 cm layer indicating better replacement of exchangeable sodium by clacium from the upper 15 cm layer. This is shown by the lower ESP values of the upper compared to the lower layers.

Leaching with water alone reduced the ESP from 71.0 to 38.2 and 42.3 in the upper and lower 15 cm layers, respectively but the HC was so low that third foot of water did not pass through the soil even after one year since the begining of the experiment. In addition to other factors, a part of the reduction in ESP during leaching with water alone may be due to the calcium and magnesium supplied by the leaching water and 'valence dilution* effect (i.e. for exchange between cations of unequal valence, dilution of equilibrium solution favours the retention of more highly charged cations).

Table 1. Analytical data of the "Thur bara" soil treated with gypsum at the rate of 75 and 100 per cent of gypsum requirement and leached with three levels of water.

Gypsum added	**Leaching Water (cm)**	**Soil Depth (cm)**	**pHs**	**ECe (dS/m)**	**SAR**	**ESP**	**HC (cm/hour)**
Nil	60	0-15	8.50	3.70	39.1	38.2	0.056
		15-30	8.53	3.90	44.0	42.3	0.042
75% of GR	60	0-15	8.06	3.39	19.9	22.8	0.165
		15-30	8.19	3.45	22.5	25.0	0.161
	90	0-15	7.91	2.55	15.8	18.2	0.155
		15-30	7.99	2.68	18.2	20.2	0.152
	120	0-15	7.87	2.01	12.5	13.8	0.151
		15-30	7.92	2.13	13.3	14.2	0.148
100% of GR	60	0-15	7.89	3.83	12.9	16.5	0.223
		15-30	7.98	3.88	15.2	18.1	0.221
	90	0-15	7.82	3.16	10.1	12.1	0.219
		15-30	7.82	3.21	11.1	14.0	0.217
	120	0-15	7.73	2.55	7.7	9.3	0.204
		15-30	7.78	2.60	8.6	11.0	0.203

pHs = pH of saturated soil paste
ECe = Electrical conductivity of saturation extract.
SAR = Sodium adsorption ratio.
ESP = Exchangeable sodium percentage.

Application of gypsum at the rate of 75% of GR followed by leaching with 120 cm of water reduced the ESP to less than 15. This combination was approximately as effective in reducing the ESP as gypsum applied at the rate of 100% of GR and leached with 90 cm of water. This indicates that the amount of gypsum or depth of water required for reclamation of sodic soils may be reduced depending upon which

item is more expensive. Chemical amendments including, gypsum(G), sulphur(S), pressmud (PM), farm yard manure (PYM) and combinations of FYM with the first three were compared for their effectiveness in soil leclamation. Canal water equivalent to 120 acre-cm was used for intermittant leaching. All treatments reduced the soluble salts to safe limit. Maximum reduction in ESP was noted with the application of S+FYM when leached with 120 acre-cm of water. Sulphur, gypsum, sulphur + FYM reduced ESP to less than 10. Maximum reduction in pHs was noted with S.Maximum increase in hydraulic conductivity occurred with gypsum+FYM and thus took minimum time for reclamation. The above mentioned facts indicatied an overall reclamation efficiency in the descending order S+PYM>G+J-YM>S>G>PM+PYM>PM> simple leaching.

Leaching of soils treated with H_2SO_4, HCl, HNO_3 and gypsum in amounts equal to 75 and 100% GR removed soluble salts and exchangeable sodium from the calcareous saline-sodic soils. However, EPS was reduced to lower levels with HNO_3 and HCI than that with H_2SO_4 and gypsum. All the acids decreased the soil pHs to lower values than with gypsum. The rate of passage of water through soil was faster with H_2SO_4 and gypsum than with HNO_3 and HCl as indicated by HC of the reclaimed soil. However, simple leaching with water decreased the HC. With H_2SO_4, 120 cm of water passed through the soil column in 94 days compared to 109, 131 and 146 days with HCI, gypsum and HNO_3, respectively. Application of H_2SO_4, HCl and HNO_3 equivalent to 75% of GR was better than gypsum applied equal to 100% GR. All treatments gave significantly higher yield of dhancha *(Sesbania aculeata)* than control (simple leadhig), but themselves differed nonsignificantly.

In another field study, the application of gypsum 8100%GR proved to be the best treatment for reclamation of a saline-sodic soil as it caused the maximum reduction in soil ECe and ESP. The ameliorative effects of gypsum, H_2SO_4, HCl and $CaCl_2$ @ 75%GR were statistically similar in respect of lowering the soil ECe. In general, gypsum produced better yield of wheat while HzS04 that of rice compared to other amendments. However, the treatment differences decreased with time and soil depth. Somewhat contradictory results of these two experiments could not be explained at this stage and thus deserve further research to resolve this issue.

1.2. Use of high electorlyte waters

High-salt waters, in addition to chemically reclaiming the soil, maintain or increase the soil HC. Two "Thur bara" soils from Sahiwal district and two from Faisalabad district were used for reclamation with high-salt waters. Experiment was conductd in concrete pipes of 15 cm inside diameter. The soil columns were about 30 cm high. Synthetic saline water with initial salt concentration of 644.5 me/I and sodium adsorption ratio (SAR) of 34.4 was used for leaching. Successive dilutions of this water were used for reclamation. Six combinations (A-F) of high-salt water and its dilutions were tried. The data on soil characteristics before and after leaching with the most efficient combination are given in Table 2. In all soils the salinity decreased to less than 2.5 dS/ro. Similarly the pHs decreased during reclamation. The ESP was reduced from the initial values of 51.8 or greater to a final value of 9.6 in all the soils. There was 18 to 25 fold increase in HC of "Thur bara" soils which were impermeable originally. Marked differences were observed in the depth of water required for reclamation with various combinations. For example 198 to 258 cm of water were required for reclamation of various soils with the most efficient combination of water.

1.3. Biological methods of reclamation

In order to test biological methods for reclaiming saline-sodic soils an experiment was conducted under controlled conditions in cement pipes. All efforts to get good germination and growth of dhancha *(Sesbania aculeata)* failed. After leaching for a period of 235 days, kallar grass *(Leptochloa fusca)* did not bring down the ESP close to safe limit. Biological treatment (growing of kallar grass) was slightly better than simple leachig, yet it was a very slow method of reclaiming Baline-sodic soils. As compared to

biological method, the superiority of gypsum for increasing the hydraulic conductivity and thus shorten the period of reclaiming saline-sodic soils was established.

An experiment was undertaken to use *Leptochloa fusca* to reclaim soils where growth of other common plant species was negligible. Two soils were artificially salinized to various concentrations and saline-sodic and sodic conditions were allowed to prevail. Kallar grass was sown in these salt treated soils. Three cuttings were obtained in about three months. It was noticed that kallar grass could not survive in pots receiving the highest concentration of salts, i.e. 22.5 me/100 g soil.

1.4. Physical methods of reclamation

Field studies were undertaken to reclaim salt-affected soils through physical and chemical methods using saline-sodic groundwater (EC = 1.7 dS/m, SAR = 10.0, RSC = 6-7 me/l) on two soil series. The data for 5 wheat crops from a saline-sodic sandy clay loam soil {Khurrianwala series) indicated that gypsum at the rate of 100% gypsum requirement gave 90% higher yield than the control. For the first two rice crops out of four, sub-soiling (50±5cm deep, 150 cm apart crosswise furrows) gave 45% higher yield over the control, after which the effects of sub-soiling subsided and gypsum proved superior for the remainging crops. Gypsum treatment lowered the soil ESP from 45 to l6 at the end of 2nd wheat crop in the case of rice & wheat crops while the cost of gypsum was recovered fully from the first crop of wheat. Rice prnvftd *ii* better crop for reclamation due to its drainable surplus water. Soils of "Coarse loamy, mixed calacareoue hyper thermic, Typic Halorlhida" family tike the Khurrianwata flerieB con be made productive by gypsum treatment within 2-3 cropping neaBons with modi-rate soil, water and crop numagement,

Table 2. Comparison of soil characteristics before and after leaching with the most efficient treatment.

Soil	EC dS m^{-1}	pHs	ESP	SAR	HC (cm/hr.)
"Thur bara"1 Original soil	51.6	8.9	63.5	136.0	0.025
Cobmination B	2.5	7.9	9.6	8.2	0.453
"Thur Bara" 2 Original soil	48.4	9.0	64.2	178.4	0.020
Combination B	2.5	8.0	9.5	7.9	0.497
Faisalabad I Original soil	185.4	8.3	59.9	231.9	0.682
Combination C	2.5	8.0	9.6	0.2	0.606
Faisalabad 2 Original soil	208.1	7.6	51.8	97.2	0.745
Combination C	2.5	7.9	9.5	7.7	0.625

The above mentioned experiment was repearted on an adjacent field of the Gandhra aeriea where data were recorded fop R crops (4 wheat and 4 rice). The soil wan a memebor of the "Fine loamy mixed calcareous, hyperthermic Halic Camborthids" family. Susboiling alone was not effective in this case and gypsum (100%GR) in the caae of wheat and sub-soiling + gypsum in the case of rice gave maximum yield. The ESP of soil was reduced frum 68.9 to 13.9 by subsoiling + gypsum at the end of 5th crop (2 wheat + 3 rice). The coat of gypsum was recovered after 4 crops (2 wheat + 2 rice). Gypsum application with or without pub soiling with rice-wheat rotation using saline-sodic water could make similar soils fit for growing a variety of crops within 4-6 cropping seasons. However, subsoiling alone and use of brackish water cannot improve such soils within a practical length of time.

2. USE OF POOR QUALITY WATER

2.1. Uee of high SAR/RSC waters

An experiment was conducted on Neelam cultivar of maize in cement pipe lysimeters of 60 cm length and 22.5 cm inside diameter, containing 26 kg of nonsaline loam soil. Four synthetic waters with EC of 1,2,3

and 4 dS/m, each with SAR values of 5, 10 and 15 were used for irrigating the maize crop. Duplicate leaching fractions(LF) of 0.06, 0.11 and 0.20 were achieved for each water. Leachates collected in plastic containers were measured and analysed occassionally. Maize dry matter yield did not any ehuw nnu significant effect of different water salinities except for an increase in dry matter with 2 dS/m EP water-Yield was directly related to LF indicating the advantage of higher LF for maintaining the soil salinity/sodicity at low levels. Maize dry matter increased with increasing SAR of irrigation water, since soil and water had riot achieved steady-state by the time of harvesting maize. Later on, steady-state was achieved and the calculated SAR and EC values of drainage waters were very close to the observed ones.

In order to evaluate the adverse effects of sodic waters on soils and crops, experiments were conducted with saline-sodic waters of different sodium adsorption ratios, with and without residual sodium carbonate. The adverse effects of water salinity on the growth of maize, berseem and sorghum were generally more prominent with waters containing no residual sodium carbonate (RSC) than those containing RSC because of lower soil salinity produced with RSC waters as there is generally more precipitation of salts from RSC waters than from no RSC waters. However, the adverse effecs of water sodicity were apparent on soils and not on crops because soil structure are not that important in pipe lysimeter. The adverse effects of bicarbonate waters will be more prominent on crops under field conditions. The accumulation of soluble salts and exchangeable sodium was reduced significantly by increasing the leaching fraction, indurating it to be an important water management practice for effective use of saline-sodic irrigation waters. In conclusion, the waters with RSC are more hazardous than no RSC waters of equal SAR.

2.2. Amendment of high bicarbonate waters

An economic method of amending saline-sodic groundwater was tried by passing it through a watercourse lined with gypsum stones. The results indicated that the groundwater with TDS of 1056 ppm, SAR of 9.3 (m mole/l)l/2 and RSC of 6.55 me/l when passed through a 183 m long watercourse lined with gypsum stones (10-25 kg) took a period of 8 crops (4 rice + 4 wheat) to lower the ESP of soil from 71.4 to 15.8 with progressive increase in yields. The reclamation was accelerated and the yield of crops improved when additional quantities of powder gypsum along with the amended water were added to soil. The gypsum stone method, a relatively slow procees for reclaiming a highly saline-sodic soil like the Gandhra series, yet seems feasible to get a reasonable yield during the reclamation of low sodium hazard soils and waters.

The effect of saline-sodic irrigation waters on the dynamics of $CaCO_3$ in different soils was studied in a laboratory experiment conducted in glass columns, $CaCO_3$ dissolution occurred when leaching was done with canal as well as with high RSC waters in the presence of organic matter. However, water having RSC of 2 solublized more $CaCO_3$ than canal and RSC of 4 water. Precipitation of $CaCO_3$ was more with RSC of 4 water than RSC of 2 when leaching was done in the absencc of organic matter. Exchangeable sodium of both the soils decreased by leaching with all the three waters, the maximum reduction being when organic matter was also added. In the presence of organic matter, the canal water was more effective for reducing exchangeable sodium than high RSC waters while in its absence canal water was the least effective.

2.3. Fertilizer practices for salt-affected soils

The suitability of different N and P fertilizers was determined for crop production (rice and wheat) in saline-sodic soils irrigated with saline-sodic water. On the basis of yield data for 9 crops (5 wheat + 4 rice), it is concluded that ca-containing commercial fertilizer of N and P, that is $Ca(NO_3)_2$ and SSP were better to counteract the ill effects of poor quality water compared to Cafree fertilizers (nitrophos, urea, TSP). Over long periods the use of Ca-containing fertilizers was expected to be superior on moderately saline-sodic soils.

The reclamation process through the use of amendments and leaching of salt-affected soils will alter the availability of the nutrient elements and thus affect the crop yields, during reclamation studies, using (laline-sodic water, it was found that gypsum treatment conserved P against leaching because its concentration was lower than with H_2SO_4 or HCl, but still higher (15 ppm) than the control as well as the critical levels (8-10 ppm) for agricultural crops. This indicated application of P at lower rates i.e. about 50% of the recommend dose, during the first 2-3 years of reclamation was effective live for crop production. The availability of K remained inconsistent, though higher than critical level. This seems to be the consequence of the dominance of the hydrous mica in the clay fraction of the native soils. The availability of micronutrients (Cu, Kn, Ve, Mn) was a little affected by the reclamation treatments (sub soiling, gypsum and; their combination) during the first two crops (rice and wheat) on the Khurrianwala and Gandha series. However, Na induced K or Zn deficiency, particularly for rice, during the reclamation phase may be possible. To avoid the yield loss, K and Zn application may be needed.

3. SALT TOLERANCE OF CROPS

Salt-affected soils need to be categorized according to their potential for successful saline agriculture and, accordingly 5 categories of the salt-affected soils have been visualized;

1. Moderately salt-affectcd cultivated areas.
2. Highly saline-sodic soils with irrigation supplies.
3. Highly salt-affected soils with associated problem of water logging
4. Highly saline-sodic dense soils without irrigation supplies.
5. The light textured soils of the coastal sandy belt with highly saline water available for irrigation.

The first category mainly comprises cultivated land with saline patches where farmers apply all inputs but returns are inadequate. The best strategy to tackle the problem in these areas is to develop and select tolerant varieties of crops such as wheat, barley, rice, cotton and oilseeds etc. For the other four categories of land there seems to be little possiblity of growing conventional cultivated crops. Natural halophytes or salt tolerant species of grasses, bushes and trees will have to be tried.

3.1. Developrnent of the screening procedure

To cater for screening requirement for a large number of genotypes and take care of the heterogeneity of the growth medum, solution culture technique was developed which involved the use of a single salt (NaCl) for creating salinity and transplanting wheat seedlings at 2 to 3 leaf stage in aero tod Hoasland's iinrdiLiln in the hoics made in thermopal sheets floating on the solution. Salinity is subsequently raised in a step wise mariner in different containers to 200 and 400 mol m-3 concentration. After about 3 weeks of growth relative decrease at a particular salinity level compared with their respective controls is taken as the criterion of salt tolerance. This screening technique has shown good correlation with the soil culture technique where salinized soil was used as the growth medium and grain yield was taken as the criterion of salt tolerance as well as with the field studies.

3.2. Studies on wheat

3.2.1. Screening

Using this technique about 600 wheat varieties/strains have been screened. The variteites LU-26S and Blue Silver have been found to be the most tolerant ones. Four varierties including LU-26S, Blue silver, WL711 and Lyp-73 have been tested in the field with ECe 12.8 - 18.5 and 8.5 - 14.4 dS/m (Site-1 and Site- II) and SAR 20-27 and 35-65 (Site-1 and Site-11). The data show that good yields (1818-1931 kg/acre) were obtained at Site-1 with nonsignificant differences within the varieties while poor yields with

statistically significant differences were obtained at Site-11. LU-26S gave better yield than all the other varieties in these experiments.

3.2.2. Sowing methods for salt-affected soils

To improve the germination of wheat under saline conditions, a number of cultivation methods were tried under field conditions. Results indicate that dry sowing technique was superior to "Wattar" sowing in soils having good infiltration rates. Also the addition of Ca-containing amendments like gypsum and calcium ammonium nitrate in small amounts (200 kg/ha) were quite beneficial in this respect.

3.2.3. Selection of salt tolerant single plants

Through selection pressure procedure a number of individuals have been selected from LU-26S and Blue Silver which have shown much higher tolerance to salinity than the parent population under solution culture conditions.

3.2.4. Effect of type of salinity on wheat growth

The effect of type of salinity i.e. NaCl alone, NaCl: $CaCl_2$ (l:l) and NaCl + Na_2SO_4 + $CaCl_2$ + $MgCl_2$ (10:5:4:1) was studied and it was found that addition of Ca in the saline medium decreased the harmful effects on plant growth than NaCl alone.

Role of Ca in increasing salt tolerance of wheat was also studied under controlled conditions and it was found that Ca definitely enhanced salt tolerance of wheat.

3.2.5. Effect of salinity-moisture interaction on wheat

The effect of four moisture levels on four wheat varieties was studied using a saline-sodic soil. Tremendous interactive salinity and moisture effects on wheat germination indicate the critical role of this factor. Obviously, failure of germination leads to a patchy crop stand and drastic decrease in yield. The data further indicate that, at moderate salinity, the moisture levels had little effect on wheat growth subsequent to the seedling establishment. Therefore, further experiments are now underway to improve seedling establishment under poorly drained saline conditions.

3.3. Barley

Sixty four barley varieties/strains were compared for their salt tolerance in four sets and out of them Antares, Pak C93, Pak N74B, Pak C96, Pak C75A, Pak E76A, Lyp-63-1249, Jau-83, Emur Nord Gard, Pak-30132, Pak-15869 were found tolerant at 200 and 400 mM NaCl.

3.4. Sorghum

Out of the 24 varieties of sorghum available, the variety Milo was the most tolerant.

3.5. Cotton

Out of 66 cotton varieties NIAB-78, AU-59, AUH-37 and AU-14 were found better tolerant of salinity.

3.6. Rice

Thirty six rice varieties were screened against various salinity levels on the basis of their seedling growth performance up to 15 days. Seedlings of each variety were transplanted into tubs containing Yoshida's

nutrient solution and exposed to incremental salt stress up to 20 dS/m NaCl. Reduction in shoot fresh weight increased with the increasing salinity levels. The varieties BG-402-4 among the coarse ones and Basmati-198 among the fine ones were found to be most salt tolerant. Whereas C622 and 45283 showed the lowest resistance to salts among the fine and coarse varieites, respectively. The salt tolerance in rice appears to be associated with the exclusion of Na from the plant tissues.

3.7. Tree species

Studies on 22 species of salt toerant trees undetaken at the salt-affected areas of Uchkera Farm, University of Agriculture, Faisalabad showed that the species *Eucalyptus camaldulensis* Arjan, Ipil Ipil, Sukhchain, Kikar, Parkinsonia, Casurina, Tamarix, Neem and Falsa were quite successful in this area. Two spp. of Eucalyptus were also compared for their establishment and survival under saline-sodic conditions and the species. *& camaldulensis* was found superior to JS. *triticornis* under advese conditions.

3.8. Grasses and shrubs

Salt tolerance studies on a grass *(Elytrigia spicota* x *E.repens)* and *Atriplex amnicola* were conducted to determine their relavtive salt tolerance. Results indicate that Atriplex had much higher salt tolerance then the cross (grass) with miximum yield at 100 mM NaCl concentration while there was no decrease in yield compared to the control at 300 mM NaCl concentration. In the case of grass almost 61% reduction in yield took place at 100 mM NaCl concentration.

3.9. Sunflower

Experiments were conducted on the salt-tolerance of sunflower. A nonsaline sandy clay loam soil with ECe of 2.5 dS/m was collected from the University farm. The experiment was conducted in glazed pots containing 11.4 kg of soil. After germination of sunflower seeds, the ECe of the soil in pots was increased step-wise to 4.0, 6.0, 8.0 and 12.0 dS/m. The yield data show that increasing salinity levels decreased the grain yield significantly. The grain yield decreased by 7, 20 and 24% at ECe of 4.0, 8.0 and 12.0 dS/m. This reduction in yield was due to reduction in the size of flower and grain, early maturity and lack of fertilization in the central part of thallus. All the above effects may be due to increase in solute suction of the soil solution.

The data on oil percentage show that increasing salinity levels decreased the oil contents of sunflower seed, but the results were non-sifnificant between the successive salinity levels. This reduction was due to decreased kernal percentage of seed, retarded development of seed and early maturity on high salinity pots. Phosphorus, potassium and calcium plus magnesium uptake by seed decreased with increasing salinity. Sodium and chloride content of seed and leaf + stem increased with increasing salinity. In the case of variety VNIIMK 8931, which gave relatively higher grain yield, the chloride content of grain and leaf plus stem was the lowest of all the varieties evaluated in this study. This indicates that this variety had some mechanism for the exclusion of chloride ion. Protein percentage in seed increased with increasing salinity, but the total N uptake decreasd because of reduction in grain yield. From this pot-culture study it is indicated that sunflower may be more salt tolerant than safflower, wheat and sorghum and less salt tolerant than barley and cotton.

3.10. Soybean

Salt tolrance of 5 varieties of soybean was evaluated in a lab. experiment. Soil salinity varied from 2.5 to 9.3 dS/m. Increase in salinity decreased per cent germination and grain yield and increased the plant mortality. Although protein percentage increased with increase in salinity, yet the total N uptake decreased with increasing salinity. Relatively salt-tolerant variety Bragg had some mechanism for the

exclusion of chloride and sodium while the other four salt-sensitive varieties lacked such a mechanism and absorbed large amounts of sodium and chloride with increasing salinity of the substrate. There was 50 per cent reduction in grain yield of variety Bragg at a salinity level of about 7 dS/m, while other varieties failed to mature at this salinity.

3.11. Lentil

Laboratory and pot culture experiments were conducted to assess the influence of soil salinity on germination, growth and chemical compostition of three varieties of lentil. Increase in salinity delayed germination and reduced the germination percentage. Compared to the control, relative decrease was 40 per cent at ECc of 9.6 dS/m. Grain and straw yield also decreased with increasing salinity. The results indicated lentil to be more salt tolerant at germination than the grain formation stage since 40% reduction in grain yield occurred at ECe of 9.6 dS/m. The concentration of N, P, Ca+Mg, Na,Cl and SO_4 in grain and straw generally increased with increasing salinity while that of K decreased. However, the total uptake of N and P by lentil decreased with increasing salinity because the relative decrease in yield was more than the relative increase in conc. of N and P at higher salinity. Only a slight increase in Na and Cl concentration of grain and straw at higher salinity indicated lentil to be a "sodium and chloride-excluder".

3.12. Mung bean

Seed germination of three varieties of mung *(Phaseolus aureus)* decreased with increasing salinity and 50% reduction in germination occurred at ECe of 9 dS/m. Grain yield and the weight of leaf+stem decreased with increasing salinity. About 50% reduction in grain yield and weight of leaf+stem occurred at ECe of 8.5 and 10.0 dS/m, respectively, indicating mung to be equally tolerant at germination and latter growth stages. The conc. of N, P, Ca+Mg, Na, Cl and S0« increased in grain and leaf+stem with increased salinity while that of K decreased. However, the total uptake of N and P decreased with increasing salinity.

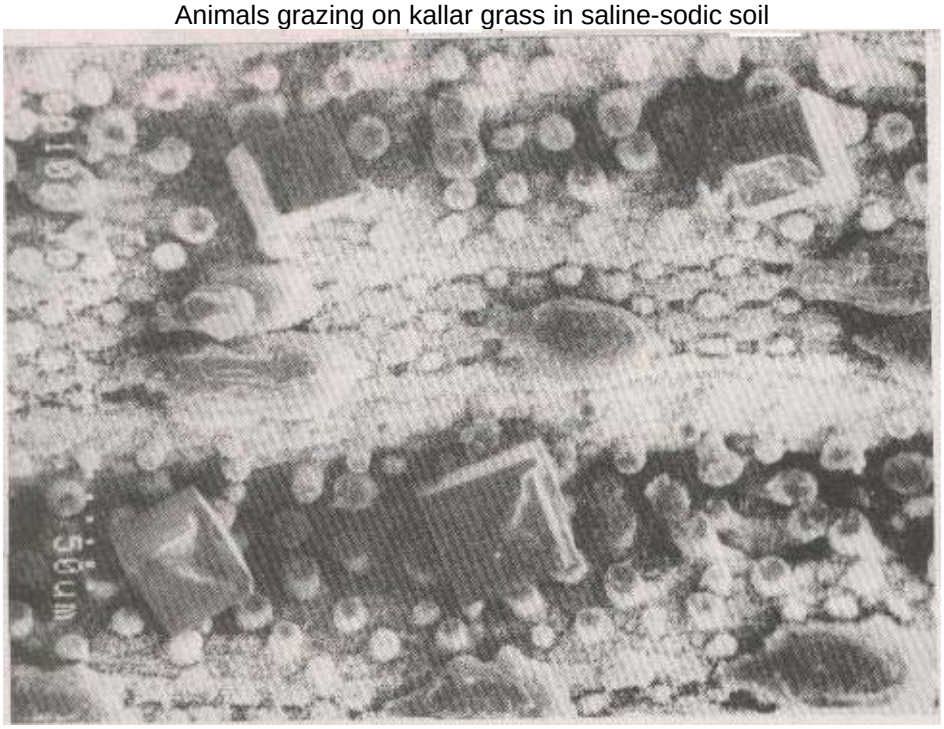
3.13. Sarson

Laboratory and pot culture experiments were conducted to evaluate the effects of various soil salinity levels on germination, growth and chemical compostion of sarson *(Brassier* napus). Increasing salinity decreased the germination percentage, seedling growth and the fresh as well as dry fodder yield of sarson. Twenty-six and fifty per cent reduction in fresh and dry fodder yield occurred at ECe of 13.0 dS/m indicating succulent growth of sarson with increasing salinity. Sarson was the most sensitive to salts at seedling stage and the least sensitive at the germination stage. Concentration of nitrogen, phosphorus and sodium in dry fodder of sarson increased with increasing soil salinity while that of potassium decreased.

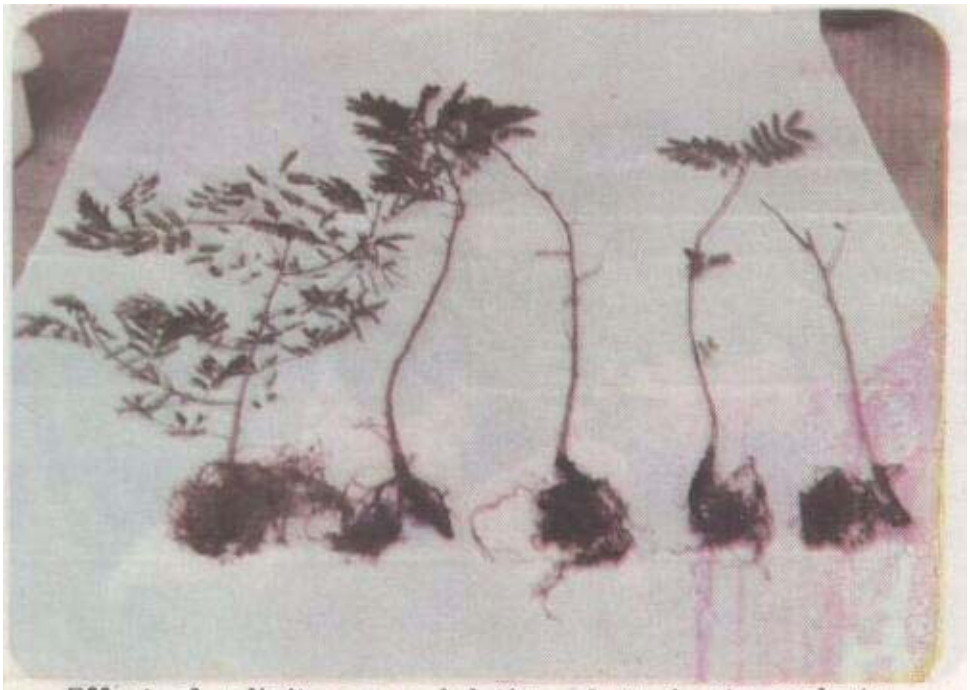
4. STUDIES ON KALLAR GRASS *(Leptocbloa fusca)*

Kalar grass is one of the few halophytes that has direct agronomic use as fodder crop. The first study on Kallar grass was initiated in 1967 in this Department. The grass was grown in two artificially salinized (saline-sodic and sodic) soils and it was observed that the grass failed to survive in pots receiving salt level of 22.5 me/l00g of soil. In another experiment, conducted in cement pipes under control conditions during 1970-71, Kallar grass proved to be superior to simple leachig in reclaiming a saline-Bodic soil.

Animals grazing on kallar grass in saline-sodic soil



Salt glands on kallar grass leaves



Effect of salinity on nodulation of *Sesbania aculeata*

A set up for *screening* of wheat genotypes for salt tolerance

Recently detailed studies oh the response of *Leptochloa fusca* to various type of environmental stresses have been completed. The salient findings of these studies are summarized below:

4.1. Response of *L. fusca* to various types of substrate salinity

Response of kallar grass to various isosmotic substrate concentrations i.e., 0.50, 0.75 and 1.0 MPa of NaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ (0.25 and 0.50 MPa) was studied in gravel culture. NaCl caused minimum inhibition in growth followed by Na_2SO_4, $CaCl_2$ and Mg salts. Na was the most compatible cation while Cl was less toxic than SO_4 as the anion. *L.fusca* exhibited a typical crypno-eu-halophytic character and had high uptake of salts (monvalent>divalent) as the osmoregulatory mechanism. Efficient excretion of salts through salt glands and increased succulence were employed as the mechanisms for a favourable ionic balance. Selective absorption and retention of K in the tissues were evident from the high Na:K ratio of the unwashed samples compared with the washed samples. Heavy wax coating on the leaf surface helped in imporved water balance.

4.2. Growth response of *L.fusca* under flooded and upland saline soil conditions

The effects of continuous flooding (submerged conditions) as against normal irrigation (upland conditions) on growth of *L.fusca* were studied in a pot experiment. The soil was artificially salinized by using, a salt mixture to achieve ECe levels of 10, 20, 30 and 40 dS/m. The shoot fresh and dry matter yields were significantly higher under flooding than under normal irrigation at low soil salinity levels (ECe 3.5-10.0 dS/m), at par at medium salinity (ECe 20 dS/m), and significantly lower at the highest salinity level (ECe 40 dS/m). High tolerance of the species to waterlogging was mainly related to the presence of well developed internal air channels and specialized adventitious roots. Overall picture of the data on shoot chemical composition indicated significantly higher accumulation of Na, P, Zn and Mn under flooded conditions than the upland conditions. In contrast, K absorption by L. *fusca* was significantly greater under aerobic than under anaerobic saline soil environments. In general, the concentration of trace elements (Zn, Cu, Fe, Mn) was sufficient to meet the dietary requirements of the animals under both flooded and upland saline soil conditions.

4.3. Growth response under a wide pH range in the root zone

L. fusca plants were grown in silica gravel and soil culture with pH regimes from 3.0-11.0. The species had shown a great tolerance at various pH levels; the test treatment was of pH 11.0 which produced maximum biomass, followed by pH 10.0, 3.0 and 4.5 while the lowest yields were at pH 9.0 and 8.0. The shoot accumulated higher contents of Na with increase in pH while more contents of K, Ca, Mg and P in shoot at pH 3.0 to 4.5 than those at pH 10.0 to 11.0. Maximum amounts of Ca, Mn, Mo and high amounts of Zn were found at pH 9.0. In soil culture studies, in contrast to gravel culture experiment, the species gave maximum and significantly higher dry matter yield at pH 8.0 than all the other pH levels while the lowest yields with non-significant differences among themselves were obtained at pH extremes i.e. 11.0, 3.0 and .4.5. A low Na:k ratio (<1.0) with non-significant differences from pH 3.0 to 8.0 showed an excellent capacity of the species to take up K under strong Na competition.

4.4. Interaction effects of salinity and phosphorus on the growth and chemical composition of *L. fusca*

The interaction effects of soil salinity and P fertilization on the fresh and dry matter yields and chemical composition (Na, K, Ca, Mg, P, Zn, Cu, Fe, Mn) of L. *fusca* were studied under wire house conditions using 4 Phosphorus (control, 25, 50 and 75 kg P ha-1) and 4 salinity (ECe control, 10, 20 and 30 dS/m) levels. L./usca responded favourably to P application at all salinity levels studied from 3.5 to 30.0 dS/m. P application 8 50 kg/ha gave the highest fresh and dry matter yields at ECc 10 dS/m. The fresh and dry matter production was affected seriously at EC<> 30 dS/m where no external P was applied.

The species maintained a favourable water balance at high salinities and in fact tissue water at the highest salinity level was very close to that at the control. Phosphorus application' had a significant effect on P concentration and a non-significant effect on Na, K. Ca and Mg contents of L.-fusca shoots. On the other hand, salinity had a significant effect on N, K, Ca, and P concentrations while the effects on Mg were non-significant. On an average except for K, the contents of Na, Ca, Mg and P increased with increasing salinity levels. However, the divalent cations (Ca, Mg) were presnet in plant tissues in much lower concentrations than the monovalent cations (NaK). In general, both P fertilization and salinity levels promoted the accumulation of Zn, Pe and Mn in the shoot but Cu showed the revearse trend.

5. SOIL FERTILITY AND FERTILIZER USE

5.1. Nitrogen Fertilization

5.1.1. Relative efficiency of different sources

The relative effectiveness of carriers of nitrogen commonly used on Pakistan soils has been tested in a number of experiments. Ammonium sulphate, urea and calcium ammonium nitrate have given similar response on wheat crop. A laboratory study to assess the effects on soil pH and available phosphorus was carried out. N @ 50, 100, 200 and 400 ppm of N each as calcium ammonium nitrate, urea and ammonium sulphate, was applied to texturally three different soils. The soils were incubated for 2 months after bringing the moisture content to 2/3rd of the field capacity. The data revealed that all the three fertilizers and their increasing levels caused a significant decrease in soil pH and a significant increase in available P. The magnitude of decrease in pH and increase in available P by the fertilizers in the case of three soils was of the order: ammonium suphate>urea> calcium ammonium nitrate. It appears from the data that nitrogen fertilizers tested, are chemically well suited for application to alkaline calcareous soils of Pakistan as they promote favourable soil environment for plant growth. For rice, urea was found to be slightly superior to ammonium sulphate. In another study point placement at a depth of 8-15 cm of both these N-carriers, behaved to be equally efficient in paddy production.

5.1.2. Methods of application

Band placement of fertilizers, 10-15 cm away and at same depth below the seed gave increased yield of wheat attributable to more efficient utilization of the nutrient from greater positional availability. Method of fertilizer application as related to higher fertilizer use efficiency has immense application for economic use of fertilizers and therefore, further research is in progress in this regard. Thorough mixing or band placement of ammonium containg or ammonium releasing fertilizers such as urea is further necessitated in order to alleviate the harmful effects of ammonia toxicity. It was observed in a field experiment on wheat that ammonia toxicity from urea can be eliminated by mixing urea with an acidic phosphate fertilizer such as single superphosphate (SSP) before application. The comparison of urea application methods indicated that 67 kg N/ha as point placement was slightly superior to mudballs and banding but significantly better than the same rate of soluble urea broadcast for various growth - characteristics and paddy yield of rice (Table 3).

Table 3. Effect of nitrogen rate, source and placement method on grains/panicle, paddy and straw yield of 1R-6 rice.

Treatment		No. of grains per pin-icle	Paddy yield (kg/ha)	Straw yield (kg/ha)
T_1	Control	100.0 d	2411 d	8629
T_2	33 kg/ha N as urea	107.0 bcd	3517 c	11948 c
T_3	67 kg/ha N as urea	113.2 b	3948 bc	13884 abc

T_4	100 kg/ha N as urea	115.2 b	5085 a	15046 a
T_5	67 kg/ha N as urea (Mudballs)	113.0 b	4454 ab	15378 a
T_6	67 kg/ha N as urea (Point placement)	126.5 a	4724 a	14264 ab
T_7	67 kg/ha N as urea (Banding)	121.0 ab	4462 ab	12944 bc
T_8	67 kg/ha N as SCU	121.0 ab	4925 a	13501 abc

Figures in columns followed by the same letter(s) are not statistically different at 5X level of significance.

When 67 kg N/ha as sulphur-coated urea (SCU) were compared with the same rate of soluble urea applied by cnventional split application, a positive effect in increasing the number of grains/panicle and consequently a significant increase in paddy yield was observed. However, sub-surface placement of 67 kg N as soluble urea by various methods produced the same paddy yield as SCU, implying thereby the role of proper placement of urea for rice culture under submerged conditions.

In the light of these findings further experimentation with uroa super-granules (USG) has revealed that N fertilizer efficiency in rice production can be increased upto about 10-30% by inserting USG through the wet soil of rice field to a depth of approximately 10-15 cm within the root zone of growing rice seedlings. In this way USG is protected from biochemical processes taking place near the soil surface and its N is effectively available to the growing rice plants resulting in increased yield (Table 4).

5.1.3. Time of application

Table 4. Effect of N source and application methods on paddy yield of IR-6 rice.

Treatment	Paddy yield (t/ha)	
	1979	**1980**
46 Kg N/ha		
1. No fertilizer nitrogen	3.010 g	3.098 h
2. UP split application	4.238 e	4.069 f
3. USG placement 7 days after transplanting	4.305 de	4.179 ef
4. UP all dry application before puddling	3.838 f	4.210 ef
5. CAN 2 split applications	3.834 f	3.680 g
6. A/sulphate 2 split applications	4.310 de	
92 kg N/ha		
7. UP 2 split applications	5.059 be	4.252 ef
8. USG placement 7 days after transplanting	5.498 ab	5.766 a
9. UP all dry application before puddling	4.710 cd	4.638 c
10. CAN 2 split applications	4.630 de	4.339 de
11. A/sulphate 2 split applications	5.303 ab	4.495 cd
138 kg N/ha		
12. UP 2 split applications	5.695 a	4.938 b

In a column, means followed by a common letter are not significantly different from each other at 5% level.

In a field experiment on wheat Maxi Pak-65 application of 150 lbs. N/a at sowing or at first irrigation and in equal splits at sowing and first irrigation or at sowing and second irrigation, gave significantly higher number of tillers, mature heads and heavier grains eventually resulting in higher yield of grain and straw compared to 150 lbs. N applied in a single or split doses at or after the second irrigation. Analysis of wheat grain indicated higher protein contents with application of N at or after the second irrigation compared to N application before second irrigation. In a study on maize, N fertilization significantly increased N and P contents of maize plants at tasseling stage and at maturity, wheareas, K concentration

was significantly decreased with an increase in N levels at all stages of growth.

5.1.4. Fertilizer use efficiency and green manuring

Fertilizer use efficiency for rice can be enhanced through green manuring with Sesbania which was well marked at lower level of fertilization. In the case of rice, the crop can be transplanted immediately after hurrying Sesbania, contrary to common belief that sufficient time should be allowed for decomposition of green manure. Agroeconomic analyses of the yield date indicated that green manuring was economically sound and practically feasible in the nutrient depleting rotation of rice-wheat, which is so popular in the rice growing areas.

5.1.5. Use of ammonium chloride

Nitrogen and potassium fertilizers carrying chloride radical are considered undersirable for application to Pakistan soils for fear of chloride accumulation. Soils of Indus, plains are inherently impregnated with chloride ions. Therefore, ammonium chloride which can be synthesized as a byproduct in the production of caustic soda, cannot be used as a fertilizer for crops such as tabacco and potatoes whose quality is impaired by an excess of chloride. In a preliminary study in rice-wheat rotation no deleterious effect on plant growth attributable to chloride ions were observed. However, the experiment is being continued on permanent layout in order to assess long term effects of ammonium chloride application.

5.1.6. Fertilizer movement in soil

Since movement of fertilizers affects their positional availability to plant roots and use efficiency by plant, a number of studios were carried out to determine the behaviour of fertilizer movement in soil. Results of a field experiment showed that NOa-N from $(NH_4)_2SO_4$, calcium ammonium nitrate and urea moved up to 30-inch depth with a 3-inch irrigation and the amount decreased with increasing soil depth. It was further recorded that with increased quantities of irrigation water up to 8 irrigations of 3-inch each, the movement of NO_3-N was observed up to 42-inch depth only. It was concluded that NO_3-N was the most mobile form of nitrogen, wheareas NH_4-N had very little mobility. Urea-N resembled NOa-N in its mobility till it was converted to NH_4 form when it was held up by the soil colloids. Greater mobility was recorded in sandy soils compared to fine textured soils. It was further noted that intensity of irrigation accelerated N movement through the soil columns. This was especially true for NOa-N and urea-N. NH_4-N, however, was less affected by the level of irrigation.

5.1.7. N losses from the soil

In addition to leaching, other processes by which added N is lost, are denitrification and volatilization. Experiments were undertaken to determine whether measureable losses of nitrogen occured during incubation in green house of a number of representative Alberta soils, following application of fertilizer nitrogen. It was found that losses varied widely, the maximum being 84 per cent for dark brown soils. Generally, losses were, however, less than one third of added nitrogen. In case of the Grey Wooded soils decreease in total nitrogen occured for all treatments, losses being equivalent to 7 to 20 per cent of the nitrogen added. It was also found that under some conditions volatile nitrogen losses from the soil carrying an arable crop were likely to be less than could be expected on the basis of experimental results involving soil alone. Another experiment was conducted to study denitrification losses of nitrogen from soils. For cultivated surface mineral soils, it was observed that 75% to 94% of the added NO_3 appeared as N_2 and the rate of evolution was 2.3 to 3.4 micro 1/g/ha, while the values for the peat were somewhat lower. Thus it was concluded that under suitable conditions of anaerobiosis and energy supply, large losses of nitrogen could occur in the field where heavy applications of nitrogen fertilizers had been used. Both the total N_2 evolved and the rate of evolution were found higher for the surface layers of the virgin soils than in the cultivated analogues. For all the soils there was a general trend of decreasing toati N_2

evolution and decreasing rate of evolution with depth. Furthermore, there was no correlation between pH and de nitrification parameters and hence pH would not be expected to be a limiting factor.

5.2. Phosphate fertilization

5.2.1. Methods of application

Though phosphate fertilizers are applied by the traditional time honoured method of broadcast and mixing at planting, yet in some investigations, band placement of phosphate fertilizers had shown to be more efficient for increasing the yield of wheat and P uptake by maize.In a pot study, three initial soil phosphorus levels of 7.5, 15.0 and 25.0 ppm P and three phosphorus application rates of 0,100 and 150 Ibs P/a as TSP were tested with two placement methods of broadcast versus banding 2 inches below the seed on corn variety J-I. The increase in soil and fertilizer phosphorus caused an increase in dry matter (DM) yield and P percentage. Banding gave significantly higher DM yield and P percentage of seedlings at 15 days' sampling. The methods, however, were non-significant at subsequent samplings of 30 and 45 days. It was further observed that P application redi-iced significantly plant K while N concentration was affected non-significantly by P fertilization.

5.2.2. P nutrition of maize

In a factorial experiment on spring maize with three paint populations of 16000, 24000 and 32000 plants per acre and four P rates of 0, 20, 40, & 60 lbs/a, it was observed that 24000 plants/a were the optimum number for grain and TDM yield. Grain yield showed poor response to applied P on this soil containing 14.0 ppm of 0.5 M $NaHCO_3$ extractable P while total DM increased significantly only at 60 lbs rate compared to the control. Added P increased P percentage and uptake by the crop while different plant stands showed a non-significant effect on these plant characters. Analyses of plant samples at various growth stages of maize revealed that per cent P contents were maximum at one foot height stage of the crop sugtesting beneficial effects of P application during early growth stage for maximum crop response. It was further observed that P fertilization tended to increase per cent N and ash contents of maize plant at all stages of growth, whereas, increasing plant density tended to decrease these plant constituents. DM yield per plant increased with P fertilization and decreased with increasing population density.

The P, initially present, was effective in increasing the yield of maize crop, especially with N application. Applied P significantly increased the fodder yield and N and P percentage of maize stalk. As soil P levels increased, the effects of applied P decreased. With increase in the levels of soil and applied P, the Zn contents of maize stalk were reduced significantly, suggesting Zn deficiency induction by P fertilization. Nitrogen application increased the Zn, P and N contents of maize stalk significantly.

5.2.3. Time of application

In a recent field study on wheat, it was observed that 20 kg P/ha, premixed with farm yard manure (FYM) applied at soaking irrigation and the same rate applied as topdress at first irrigation proved to be superior with respect to grain yield, N and P uptake compared to the rest of P application rates of 20, 40 and 60 kg/ha applied at sowing. In one year, 20 kg P/ha applied at soaking irrigation without premixing with FYM was similar to the premixed treatment. In the light of data presented, it is suggested that P application recommendation may be modified by shifting its application from sowing time to soaking irrigation or topdress at first irrigation after seeding. Application of P as SSP had positive effect in increasing the fodder yield of berseem as well as its P contents. Application of 30 kg/ha starter N alongwith 100 kg P_2O_5/ha was found to be superior to 100 kg P_2O_5/ha alone for the fodder yield of berseem. Application of 100 and 150 kg P_2O_5/ha at sowing produced similar fodder yield as the same amount applied by two equal splits alongwith starter N.

5.2.4. P movement in soil

Study on the influence of irrigation, source of P and texture of soil on the movement of fertilizer P showed that the depth of penetration of applied P increased with increasing number of irigations. Ammonium phosphate was found to be more mobile form of P whereas calcium phosphate did not move to any great extent from its site of applicationl. The movement of applied P was observed to be different in texturally different soils. It was maximum in the case of sandy soil and minimum in clay soil. The movement in loam and clay loam was found to be intermediate. It was observed that greater the lime content of the soil, the less was the movement of applied P.

5.2.5. Relative efficiency of P sources

In reference to the various P sources used in Pakistan soils, it was observed that single superphosphate (SSP), diammonium phosphate (DAP) and nitrophos when used on equivalent P basis were equally effective for the grain and total dry matter yield of maize, though in some cases SSP proved slightly superior attributable, in part at least, to ameliorative physical effects caused by the gypsum it contains.

5.2.6. Use of H_2SO_4

Application of fertilizer phosphorus, elemental sulphur or concentrated sulphuric acid to a calcareous sandy clay loam soil with initial pll of 8.1, significantly increased dry matter yield of maize plants. A significant increase in the plant phosphorus and calcium contents was recorded by the application of increasing rates of suplhur and sulphuric acid. However, at the highest rate, decline in plant phosphorus occurred. As the rate of application of these materials increased, a significant decrease in soil pH and $CaCO_3$ contents and an increase in available soil phosphorus was observed.

6. SOIL MICROBIOLOGY

6.1. Studies on Azotobacter

Aztobacter, a bacterium having faculty to fix nitrogen non-symbiotically and produce biologically active substances, was isolated from different locations of the province. Maize seeds inoculated with them were sown in the field in the presence of various nitrogen rates (0, 25, 50 and 100 kg/ha as urea) and a basal dose of 50 kg/ha each of P_2O_5 and K_20 as triple superphosphate and potassium sulphate, respectively. All the strains, except Khanpur A2, increased the grain and stalk yield compared with the controLThe highest increase i.e. 15.0% in grain and 5.0% in stalk over the control was obtained by the inoculation with Lyallpur strains A7 & A8, respectively. A tendency to produce taller plants by seed inculatiion was observed. All strains except Khanpur A5 increased mineral contents (N, P, K, Ca+Mg, Na) of grains and stalks and the highest concentration was found mainly by tho inoculation with Lyallpur strain A8, followed by Lyallpur strain A2. Inoculation of maize seeds with eleven Azotobacter strains and the control, sown in the fields receiving fertilizers (N and P at the rate of 125 and 40 kg/ha, respectively) increased the grain yield by 19.6 and 15.9%, respectively over the corresponding control. The effectiveness of inoculation was more in un-fcrtilized than fertilized soil. The increase in yield due to fertilizers without inoculation was 21.2%. Inoculation increased it further by 15.9%. The correlations between total yield and N,P and K uptake were highly significant and comparable among themselves, which showed that increase in yield due to inoculation was not due to N fixation but due to some other factors.

6.2. Studies on Rhizobium

Rhizobium, a symbiotic nitrogen fixer, is also under investigation. Strains of *Rhizobium japonicum,* a bacterium forming nodules on soybean roots,, were imported from different countries and isolated locally. Soybean, a crop which usually failed under local conditions due to the several constraints and disorders

of agronomic and physiological origin, also failed in establishing a viable symbiotic relationship by the bacterium Rhizobium through plant root nodulation. Seeds of this crop were inoculated, sown in the field and very successful nodulation was observed.The results showed an outstanding success in the harvest. Maximum increase in grain yield over the control was 73.8% for Bragg and 64.3% in case of Lee by strains imported from Czechoslovakia and isolated from Rawalpindi, respectively, in the presence of 25 and 40 kg/ha nitrogen and phosphorus, respectively. The effectiveness of the strains was different at different fertilizer rates. Some strains were more effective at lower rates while the others proved highly effective even in the presence of 100 kg N/ha. Winged bean cultivar K-ll sown at Faisalabad showed that seed inoculation increased plant population, vegetative growth, number of pods and nodulation in majority of fertilizer treatments.

6.3. Studies on blue green algae

Blue green algae (a non-symbiotic nitrogen fixer) is probably of great importance in swamp rice or paddy soils, in which they are almost universally present. Microscopic examination revealed that sixteen strains isolated had bacteria associated with them. Three fast growing unialgal cultures were shown to fix substantial quantity of atmospheric nitrogen and the presence of almost no bacteria did not have marked influence on the amount of nitrogen so fixed. Ultra-violet resistant bacteria from three algal cultures were also tested for their nitrogen fixing capacity and it was found that the bacteria from Pak-II only could fix a meagre amount of 11 micro g N/ml, whereas the others did not.

Blue green algae isolated from soils of Gujrat, Sheikhupura and Faisalabad were added to pots given P and K at the rate of 24 and 45 kg/ha. Rice variety IR-6 was grown by transplanting the seedlings. The results showed that algal application increased thn grain, straw and root weights, which were significant in majority of the cases. Maximum grain yield, 35.6% higher than PK and 40.3% higher than no fertilizer, was obtained where Sheikhupra No.2 alga was applied. Algal applications also increased the ear bearing tillers which were maximum due to alga Sheikhupura No.2. Nitrogen fixation studies showed that maximum nitrogen fixed i.e 352.8 kg/ha was due to alga Gujrat No.2 and minimum i.e. 60.0 kg/ha by the alga Sheikhupura No.l. The other algae fixed nitrogen in between these two values.

6.4. Nitrification studies

Nitrification, a biological process which converts ammonium to nitrite and then to nitrate, being a major nitrogen source assimilated by higher plants, is affected by many physical and chemical factors. In a laboratory study the effect of varying doses of dhancha *(Sesbania aculeata}* applied in combination with 200 kg N/ha either as ammonium sulphate or as urea, on the nitrifying activity of the soil and dry matter yield of wheat was observed. It was noted that nitrogen uptake and dry matter yield increased significantly as the amount of green manure increased compared to ammonium sulphate or urea applied singly.

PLANT PATHOLOGY

1. DISEASES OF FIELD CROPS

1.1. Wheat

1.1.1. Prevalence of leaf rust races in the Punjab

A survey of the prevalence of leaf rust races in the Punjab revealed the occurrence of seven races. These races with their frequency of occurrence (in parentheses) were. Race 77 (72.0X), 144 (11.9%), 149 (5.2%), 12 (13.7%), 57 (2.5%), 122 (2.5%) and 177 (1.2%). Races 117 and 122 were new records in the Punjab. Evaluation of commercial wheat cultivars for the presence of resistance against all the prevalent races revealed that cultivar Pavon was highly resistant while cultivars Arz and V-1287 possessed moderate resistance. The incidence of disease was found, to be increased with age even though the plants were moderately resistant or moderately susceptible in the seedling stage.

1.1.2. Control of leaf rust

Amongst different wheat cultivars LU 26, LU 60, Indus 79, Bahawalpur 79 were recorded as resistant whereas SA 42, SA 75, Chenab 70, LU 61, Mexipak (White) and Lyallpur 73 were susceptible to leaf rust. Cultivars 587 and Sandal were found to be susceptible to yellow rust.

Out of the fungicide eivaluated for the control of yellow and brown rusts of wheat, Bayleton proved to be the most effective at recommended rate with three sprayings. Foliar application with 0.1 percent Sicarol increased grain yield.

1.1.3. Foot-rot of wheat

Foot-rot affected plants of wheat yielded species of *Helminthosporium,Fusarium* and *Alternaria.* Three fungi together were more pathogenic than any one of them alone and their effect was more pronounced in sowings done in October than November.

1.1.4. Wheat resistance to ear cockle

Different varieties were tested for resistance against *Anguina tritici* causing ear cockle of wheat. Cultivar C-273, WL-711, Sa-42 were found to be the most susceptible, whereas AU-47 was found to be resistant.

1.2. Gram

1.2.1. Genetic and chemical control of gram blight

As blight is the most devastating disease of gram, studies were directed to find its suitable control by the host plant resistance or by the application of fungicides. Thus screening of the chickpea germplasm of desi ad kabuli types against gram blight disease revealed that CM-72, C-44, CM-83/79, C-235, V-1071, RC-32, V-1349-2, S-20, MT-1, ILC-200, CM-78/79, C-141, ILC-75-13, ILC-75-14, CM-68, C-159, CM-82/79, CM-1, CM-2, CM-84/79, ILC-3279, CM-113/79, CM-88/79 and E-l00y lines were moderately to partially resistant. None was found to be immune. As it has not been possible to control gram blight through host plant resistance, various fungicides have also been tested to find the effective control of this disease. Thus seed treatment with Thiabendazole, Calizix-M and Derosal eliminated the seedborne inoculum of *Ascochyta rabiei* whereas Daconil, Captan. Thiabendazole and Tilt significantly protected the

crop from the disease.

1.2.2. Effect of application of phosphorus on gram wilt and yield of grain

The effect of application of phosphorus P_2O_5 at the rate of 25, 50, 75 and 100 lbs P_2O_5 per acre to gram crop, receiving zero, one or two irrigations after sowing on the incidence of wilt and gram yield was studied in a field experiment laid out in split plot design. Gram variety C 727 responded to the application of 25 and 50 lbs P_2O_5 per acre, particularly when the crop received one irrigation after sowing. The application of superphosphate at these rates of application enhanced the yield, but the economical rate of application proved to be 25 lbs P_2O_5 per acre with one irrigation. The incidence of wilt in gram was reduced when the crop received one or two irrigations after sowing. The incidence of wilt in the crop receiving one or two application did not differ significantly.

1.3. Cotton

1.3.1. Root rot

Root rot is the most important disease of cotton. Amongst the isolates from diseased roots *Rhizoctoma solani, Sclerotium bataticola* and *Fusarium* spp. predominated. Other fungi such as species of *Aspergillus Helminthosporium, Curvularia, Alternari,* Armillaria, *Verticillium, Cephalosporium* and *Trichoderma* were also isolated. About 3 per cent diseased roots yielded nematodes, mostly belonging to the genus *Tyienchorhynchus* and 0.5 percent roots yielded bacteria. About 48 percent rots yielded no micro-organism what so ever. Both *R. solani* and -R. *bataticola* were pathogenic on cotton seedlings only. They could not infect the cotton plant in adult stage. However, *Armillaria* sp. was pathogenic on cotton plants at all stages of their developement but especially during the flowering stage. Interaction between different fungi revealed that *Trichoderma* sp. was most antagonistic against different fungi as compared to *Aspergillus* sp. and *Fusarium* sp.

1.3.2. Bacterial blight

Incidence of Bacterial blight of cotton caused by *Xanthomonas campestris* pv *malvacearum* varied between 20.19 to 36.92 per cent on the cultivars AC-134, B-557, Rachna and LH-62 in Faisalabad district. Under experimental conditions, desi cultivars D-9 and R-231 were found to be resistant to the pathogen. Incidence of seed-borne infection played an important role in the initiation of this disease as the seeds of cultivars AU-14, AC-134, AU-59, B-557, Rachna and LH-62 carried 2, 3, 6, 3, 4 and 3% infection. The seeds of desi cultivars D-9 and R-231 carried only 1% infection. Cultivars AU-59, AC-134, B-557 and Rachna were most susceptible to the pathogen.

The effect of the *X. campeatris* pv *malvacearum* on the host plant was proportionate to the leaf area inocluated and the severest effect of the pathogen was recorded when all the leaves of the plant were inoculated. The reducton in growth was recorded in terms of loss of photosynthetic area as a result of necrosis, leaf fall and reduced supply of water and nutrients to the aerial parts of the plant. Application of Agrimycin-100 inhibited in-vitro growth of the pathogen and caused significant reduction in symptom development.

1.3.3. Boll rot

Boll rot may cause upto 30 percent loss to the cotton crop in certain areas. A number of micro-organisms isolated from diseased bolls included *X. campestris* pv. *malvacearum, Fusarium* sp. *Alternaria* spp., *Rhizopus* spp., *Aspergillus niger* and *Diplodia* sp. X *campestris* pv. *malvacearum* was found to be pathogenic. The bacterium also attacks other aerial parts of the cotton plant. Since the disease is also seed-borne, treatment of seed with concentrated sulphric acid and foliar spray of Terramycin (500 ppm)

significantly reduced its incidence.

1.4. Maize

Stalk rot and leaf blight

Stalk rot of maize was found to be due to *Macrophomina phaseolina* and *F. moniliforme.* Application of nitrogenous fertilizers at high doses enhanced the disease whereas addition of K resulted in its decreased incidence. Application of Derosal and Vitavax as seed protectants proved effective in checking disease incidence.

Blight affected leaves yielded *Helminthosporium turcicum, H. tetramera* and *B. maydis.* The former two species attained best colony diameter at 30 °C and pH 6.5 whereas the later at 25 °C and pH 6. In in vitro trial Dithane M-45, Antracol, Vitavax-Captan, Vitavax-Thiram and Fertix checked the growth of all the three species even at half the concentration of their recommended doses.

1.5. Rice

1.5.1. Stem rot

Three different strains of *Sclerotium oryzae* isolated from diseased rice stems differed in their cultural characters and pathogenicity. Fine varieties were found to be resistant whereas coarse varieties susceptible to different strains. The growth and production of sclerotia of the above pathogen was maximum at 30 °C and 79% RH. Ceresan and Ziram were the most effective fungicides against this pathogen.

1.6. Barley

1.6.1. Root rot

In pot experiment, the incidence of root rot of barley increased with the decrease in the concentration of nitrogen in Hoagland's solution and vice versa. In field experiment, applicaion of Ammonium sulphate.Urea, Ammonium nitrate at the rate of 12, 24 and 36 Kg of nitrogen per acre respectively did not increase or reduce the seedling mortality. However, it enhanced the number of tillers, ears, grain, straw and the yield

1.6.2. Leaf stripe

The fungi *Helminthosporium gramineum* and *B. teres* causing leaf stripe and net blotch were found to be growing best at 30°C and pH 6. The former fungus was found to be more virulent than the later. The fungicide Arasan controlled both the fungi on the plant but the differences in the yield between the treated and non-treated seeds were non significant.

1.7. Pulses

1.7.1. Anthracnose and stem rot of legume

The fungi *Colletotrichum dematium* f. sp. truncate, *Sclerotium bataticola* and *Volutella* sp. were isolated from mung and urd bean stems affected with anthracnose. The former fungus grew and sporulated best at 30 °C and between pH 6.1-7.8. *Sclerotium bataticola* grew well between 25 and 40 °C. Both the former isolates caused seedling mortality in mung and urd bean. Out of the six seed dressing fungicides, Benlate significantly reduced the mortality of seedlings.

2. DISEASES OF HORTICULRAL CROPS

2.1. Citrus wither tip

The disease citrus wither tip was found to be wide spread throughout the Punjab. It is known to be associated with sick soil. In certain areas water-logging affected this disease whereas sodic soils predisposed the plants to the attack of *Colletotrichum gloeosporioides,* a weak parasite on citrus. This fungus grew well at 30°C, and between pH 5 and 6. Amongst fungicides Daconil, Karathane, Captan, Benlate and Vitavax, the last one proved effective for inhibiting the growth of the fungus.

2.2. Die back of guava

Phoma psidii isolatd from dead branches of guava proved pathogenic. The fungus showed best growth and sporulation at 25°C temperature and at 90% relative humidity. Arabinose and asparagin were found to be the best C and N sources for the maximum growth of the fungus.

2.3. Anthracnose of date palm

In 1983 anthracnose of date palm due to *Colletotrichum gloeosporioides* was recorded in the epidemic form around Faisalabad. The pathogen appeared to be a new record for Pakistan. It grew best at 25°C and pH 6. The fungicide Derosal proved to be the most effective for inhibiting the in vitro growth and sporulation of the fungus, though Benlate, Bavistin, Leromanzeb, and Ridomil were also effective in their action.

2.4. Potato diseases

On potato the incidence of early blight was observed to be fairly high on variety Ultimus. Of the different spray fungicides, Zerlate proved better in reducing the incidence of the disease. Brown rot of potato caused by *Pseudomonas solanacearum* varied from 3.6 - 5.8% in certain districts of the Punjab. Average loss in the districts of Lahore, Jhang, Faisalabad and Sialkot was found to be 4.3, 4.5 and 5.7% respectively. The pathogen blocked xylem vessels and significantly reduced the plant height, area and dry weight of leaves. Common scab of potato (*Streptomycea scabies)* and root kn*ot (Meloidogye* sp.) were recorded from Sialkot area. The incidence of root knot was however, comparatively less in white skinned than red skinned cultivars. Control of root knot nematode was best achieved by the application of Nemagon and was followed by Nemacur and Nemafos.

Bacterial soft rot which destroy the fleshy plant parts affect the plant in the field and even its produce during transit, storage, in the whole-sale and retail shops and at home. Under laboratory conditions the organisms *Erwinia carotovora* and *E. aroidea* were found to be pathogenic on potato, tomato, onion, carrot,' radish, cabbage, pea and turnip. Tubers sown in soil infested with the above micro-organisms reduced the germination upto 16.66%. However, when tubers were inoculated with these bacteria the reduction in germination was 83 - 100 percent.

2.5. Anthracnose of chillies

Amongst various isolates the species of *Fusarium, Alternaria, Curvularia* and *Colletotrichum cspsici* were found to be pathogenic on chilli fruit. The last mentioned fungus was found to be highly pathogenic on its fruit as well as the seed. The variety Faisalabad-B was found to be more resistant than the varieties Faisalabad A and Peshawar. Seed treatment with Benlate was found to be more effective than Brassicol and Brestan to control seed-borne infection and enhancing seed germination. Spray of Cosan, Zerlate, Perenox and Antracol at an interval of 10-12 days completely controlled the foliage phase of the disease.

2.6. Leaf spot of spinach

Leaf spot of spinach was found to be caused by *Cercospora beticola.*The fungus could sporulate on nutrient or spinach decoction agar provided with the nicotinic acid as a source of vitamin. The optimum temperature for the growth of the fungus was 27°C. Lahori spinach was found to be more resistant as compared to the local variety. Spray fungicide Dithane M-45, was found to be the best, though fungicides Antracol, Cupravit and Vitigran also proved good.

3. SEED-BORNE FUNGI AND THEIR CONTROL

3.1. Cereal crops

3.1.1. Wheat

Samples of wheat seed obtained from 40 different localities of Pakistan yielded the species of *Helminthosporium, Aspergillus, Mucor, Alternaria, Curvularia, Penicillium, Stemphylium* and *Cephalosporium.* On an average the non-sterilized seed had 39.25 percent infestation whereas the surface sterilized seed had 7.8 percent infection. The above fungi alone or in mixture reduced germination, tillering, earing and the yield of plant. Wheat grains were also found to be attacked by *Helminthosporium sativum* and *Alternaria tenuis* causing black point disease. Cultivar C-273 was found to be highly susceptible to the disease. Seed-dressing fungicides enhanced the germination, tillering, earing and yield of wheat plant.

3.1.2. Maize

Isolations made from the damaged and sound maize seed showed that there was higher infestation in damaged seed as compared to sound seed. The infestation in naturally infested damaged seed ranged between 64 to 96 percent. Whereas, there was 54 to 90 percent infestation in samples of sound seed.

The fungi isolated from maize seed were *Aspergillus niger, A. flavus, Penicillium corylophilum, Helminthosporium turcicum, Fusarium oxysporum, Nigrospora oryzae, Mucor strictus* and species of *Sclerotium, Alternaria, Trichoderma, Curvularia* and *Rhizopus.* Association of these fungi with maize seed resulted in seed discolouration and loss in oil and starch content in stored seed samples.

3.2. Cotton and oil-seeds

3.2.1. Cotton

Cotton seeds obtained from different cotton growing areas of Pakistan yielded the species of *Helminthosporium, Fusarium, Curvularia, Altenaria, Penicillium, Aapergillus, Mucor, Trichothecium, Cephalosporium* and *Sclerotium.* The fungi in the former three genera predominated the isolates. The seed-borne fungi caused seed-rot and seedling mortality. Out of six fungicides Delsan proved to be the best followed by Arasan, Granosan GN, Granosan M, Dieldrex in order of their effectiveness.

3.2.2. Toria and raya

The infestation of toria and raya seed ranged from 44 to 90 percent. Species of *Aspergillus, Penicillium, Mucor, Alternaria, Rhizoctonia, Fusarium, Helminthosporium* and *Sclerotium* were found to be associated with stored seed. *Alternaria brassicola* which was found to cause leaf spot on raya grew best on Richard's agar at 30°C and pH 6.5. Treatment of infested toria and raya seed with seed dressing fungicides, checked seed-borne infection, enhanced the germination capacity of the seed and increased their yield.

Fungicide Dithane M-45 was found to be most effective in controlling the disese on the foliage.

3.2.3. Safflower

The safflower seed was found to harbour large number of fungi including *Helminthosporium, Fusarium solani, Curvularia lunata* and *Sclerotium bataticola* which reduced its germination to 42 percent as against 65 percent in the case of uninoculted seed. Treatment of infested safflower seeds with various fungicides enhanced their germination. The fungicide Vitavax proved to be the best followed by Benlate, and Brassicol.

3.2.4. Sunflower

In the case of sunflower the external and internal infestation on nine varieties of seed was recorded as 77.22 and 38.66 percent respectively. The fungi isolated from the seed included *Alternaria tenuis. A,tenuissima, Aspergillus flavus, A. niger, Curvularia lunata,Fusarium oxysporum, F.solani, H. tetramera, Penicillium corylophilum* and *Rhizopus* sp*.* Almost all the fungi resulted in decreased germination of the seed. Vitavax was found to be best in enhancing seed germination. The other fungicides in the order of their efficacy were Brassicol, and Benlate.

3.3. Summer vegetables

The incidence of fungi on cucumber, bitter gourd, okra and tomato seed varied betweeti 53 to 71 percent. The isolates included the species of *Aspergillus, Penicillium, Rhizopus, Altornaria, Fusarium, Sclerotium, Chaetomium, Curvularia* and *Helminthosporium.*These fungi reduced the germination of the vegetable seeds and increased seedlings mortality. The seed dressing fungicides like Granosan, Arasan, AgroBan, Dieldrex and Granosan generally enhanced the germination of the summer vegetable seeds.

3.4. Winter vegetables

Average infestation in radish, spinach and turnip seeds ranged between 60 to 70 percent. Species of *Penicillium, Aspergillus, Alternaria, Mucor, Fusarium, Rhizoctonia, Helminthosporium* and *Curvularia* were found associated with the seed samples. Treatment of seeds with Arasan, Ceresan, Ceresan, Agrosan, and Dieldrex significantly enhanced the germination of the treated seed.

4. CYTOLOGY AND GENETICS OF FUNGI

Genetics of *Tolyposoprium penicillariae* revealed that the fungus is heterothallic and the segregation of factors exists in the ratio of 2:2. Cyto-morphological studies of *Sordaria humana* indicated that hyphal cells are predominantly multinucleate. Archicarps arise as a laterally coiled hyphal branch and are multinucleate.

5. SURVEY AND NEW RECORDS OF PLANT DISEASES

Survey and the identification of fungi occurring on cultivated or noncultivated plants or on organic matter is the regular feature of the department. Herbarium specimens and cultures of fungi are maintained. Systematic studies on fungi have been in progress for the last 10 years. A number of new fungi from Pakistan have been recorded. A new genus *Cleistobombardia* was created based upon the type species *Cleistobombardia Pakistani* Mirza and several new species have been described. A detailed list of fungi from Pakistan has been prepared. Studies on the physiology of several plant pathogens have been conducted including the effect of temperature, light, pH, relative humidity, nutrients, and fungicides on their germination, growth and sporulation. Some of the new records are given below.

1. Fruit rot of egg-plant caused by *Phomopsis vexans.*
2. Post harvest pod decay of pea caused by *Sclerotinia sclerotiorum.*
3. Foliage blight of lucerne caused by *Choanephora cucurbitarum.*
4. Stem rot of flax caused by *Sclerotinia sclerotiorum.*
5. Wilt of egg-plant caused by *Sclerotinia sclerotiorum.*
6. Leaf and pod blight of broad bean caused by *Alternaria brassicao* f. sp. *phaseoli,*
7. Leaf spot disease of banyan caused by *Cercospora ficina.*

Air-borne fungi

A new portable spore sampler had been designed to study the air-borne fungus flora. Thus the spores of *Cladosporium, Alternaria, Helminthosporium, Curvularia, Epicoccum* and different types of basidiospores and hyphal fragments were recorded in the air in varying number. The spores of *Cladosporium* and *Alternaria* predominated. These spores showed a distinct diurnal periodicity with their maximum in the afternoon.

6. NEMATOLOGY

Survey of nematode fauna of different types of soils was initiated in 1967. The isolated nematodes belonged to at least 20 genera. The nematodes *Xiphinema* sp. and *Aphelenchus* sp. were found to be pathogenic on gram *(Cicer arietinum)* and tomato (*Lycopersicon esculentum)* and adversely affected the growth of gram and tomato seedlings in pot-culture.

6.1. Survey of nematodes in citrus plantation

Citrus nurseries and orchards around Faisalabad were also surveyed for the presence of different types of nematodes. These studies revealed the presence of *Aphelenchus, Dorylaimus, Eucephalobus, Hoplolaimus, Mesodorylaimus, Mononchus, Pratylenchus, Tylenchulus* and *Xiphinema.*About 90 percent of the samples yielded the citrus nematode *Tylenchorhynchus semipenetrans* which is also reported to be involved in the wilt complex of cotton and is fairly common in our cotton soils. Pathogenicity trials with *Tyienchorhynchus* sp. and *Pratylenchus* sp. alone and in combination with *Fusarium oxysporum* f. sp. *vosinfectum* indicated that the nematodes alone did not cause appreciable damage to cotton seedlings.

6.2. Root-knot nematode

A survey of root knot nematode *(Meloidogyne* sp.) on various vegetable crops revealed its occurrence on bringal, okra, tomato, potato and bitter gourd. This nematode was also recorded on certain weeds such as *Cyperus rotundus, Foeniculum vulgare, Chonopodium album, Amaranthus mangostanus* and *Polygonum plebjum,* the former three weeds being the new hosts for this nematode.

6.3. Nematodes affecting field crops

Analysis of cotton soils revealed the presence of large number of nematodes in 29 genera. Inoculation of the plants with the nematode species of *Pratylenchus* and *Tyienchorynchus* did not show any effect on the growth of coton plant but when the inoculation was made alongwith *Fusarium oxysporum* sp. *vasinfectum,* the inoculated plants showed marked reduction in fresh weight, size and number of small rootlets. In the case of gram, *Fusarium* sp. and *Rhizoctonia* sp. when inoculated alone did not produce the symptoms of wilt in gram but when added in combination with nematodes, inhabiting the gram rhizosphere, the symptoms of wilting were apparent on the foliage. The fresh weight, size and number of roots of the inoculated plants were also affected.

6.4. Nematodes affecting rice

Survey of nematode fauna of rice fields revealed the presence of the species of *Acrobeloides, Aphelerichoides, Aphelenchus, Cephalobolus, Chiloplacus, Dorylaimus, Hoplolaimus, Helicotylenchus, Hirchmanniella, Longidorus, Rhabditis, Tyienchus, Tyienchorynchus* and *Xiphinema.* The nematode Hirschmaniella sp. was found to be pathogenic which affected the growth of the host plant.

7. PHYTOBACTERIOLOGY

Survey of different diseases caused by bacterial plant pathogens revealed the presence of *Agrobacterium* sp. on *Zizyphus jujuba, Peseudomonaa* sp. on mango, *Corynebacterium tritici* causing tundu disease of wheat, *Xanthomonas campeatris* pv *oryzae* on rice and *X. campestris* pv *vesicatoria* on pepper. These diseases were found to cause extensive damage to respective crops. Tundu disease was more prevalent in Southern Punjab and bacterial blight of rice was prevalent in the districts of Sheikhupura and Gujranwala. Studies conducted on different diseases caused by phytopathogenic bacteria are described in detail under respective host crops.

8. PLANT VIROLOGY

Virus diseases of plants being of great economic importance, investigations were initiated to find the effect of important plant viruses on the host and their mode of transmission which should help to find suitable methods of control. The work was initiated with the investigations on Chilli mosaic virus. The most important effect of pathogen on the host was chlorosis, retarded laminer growth, reduced number of flowers and production of distorted fruits. The virus could not be transmitted through seed but could be transmitted mechanically and through aphid.

9. POST-HARVEST LOSSES IN HORTICULTURAL CROPS

Losses to horticultural crop produce such as kinnow, apple, louqat, banana, tomato, onion, potato, muskmelon and pea in Faisalabad market were found to be 5.2%, 6.70%, 21.35%, 5.10%, 17.8%, 11.4%, 2.40%, 10.50% and 9.25% respectively. These losses were attributed due to injury during harvesting, faulty packing, insufficient aeration and exposure to the sun. Due to injury the crop produce attracted various micro-organisms. Amongst various micro-organisms isolated *Alternaria tenuis, A. tenuissima, Aspergillus flavus, A. flavipes, A. fumigatus, A. niger, Colletotrichum gloeosporioides, Curvularia lunata, Penicillium digitatum, P. expansum*, P. *italicum, R, arrhizus, Erwinia aroidea* and *E. carotovora* were found to be pathogenic.

9.1. Citrus fruits

Isolation of fungi from diseased citrus fruit in cold storage and market yielded 22 different species of fungi. Out of these, the following proved to be pathogenic. *Alternaria tenuis, A. tenuissima, Aspergillus flavus, A. flavipes, A. fumigatus, A niger, Botryodiplodia theobromae, Colletotrichum gloeosporioides, Curvularia lunata, Fusarium solani, Geotrichum candidum, Penicillium digitatum, P. expansum, P. italicum, Rhizopus arrhizus.*

These grew well between 25 and 30 °C. Benlate and Topsin M were more effective than Antracol and Tecto to control fruit rotting by the above fungi. Wax emulsion with fungicides was even more effective as compared to fungicides alone.

9.2. Rosaceous fruits

Diseased samples of different rosaceous fruits such as apple, apricot, plum yielded 21 different fungi in 10 genera. Out of these *Alternaria humicola, A. tenuis, A. tenuissima, Aspergillus flavus, A. fumigatus,*

A. *luchiensis, A. niger, Cladosporium herbarum, Fusarium* sp. *Penicillium dijitatum P expansum, Paecilomyces variotii, Rhizopus arrhizus, R. stolonifer* proved pathogenic.

10. MUSHROOM CULTURE

Studies on the cultivation of edible mushrooms were initialed in 1975. These studies were mostly confined to find suitable media for spawn preparation, utilization of agricultural and industrial wastes and the fabrication of low cost mushroom growing rooms for large scale mushroom production.

10.1. Spawn production technology

The technology of spawn preparation of white button, Oyster and Chinese mushrooms has been developed on locally available materials. Thus pearl millet and sorghum grains and paddy straw were found to be the best for preparing spawn of button, Oyster and Chinese mushrooms, respectively.

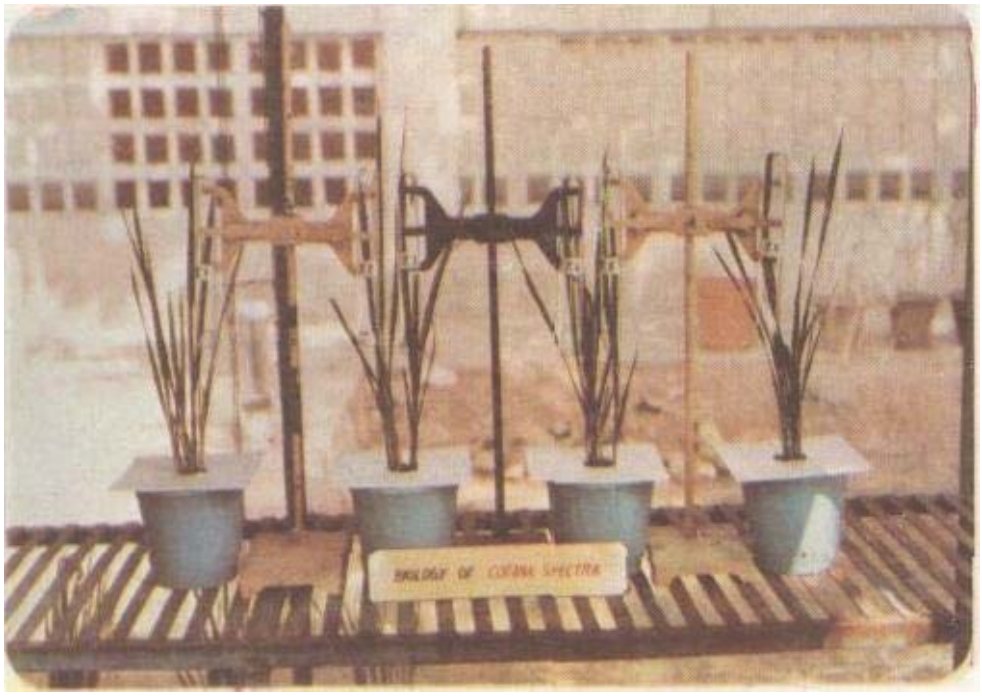
10.2. Mushroom cultivation in different ecological regions

The Chinese mushroom (*Volvariella volvacea)* and Oyster mushroom *(Pleurotus* spp.) were cultivated successfully on different agricultural and industrial wastes at Faisalabad, Quetta and Mingora (Swat). Paddy straw and cotton waste were found to be suitable substrates for their large scale cultivation. White button mushroom *(Agaricus bisporus)* was cultivated on pasteurised horse-dung manure at Faisalabad.

Hilly areas of Pakistan and Azad Kashmir were found suitable for cultivating shiitake mushroom due to suitable climatic conditions and also due to the availability of the oak logs *(Quercus* sp.), which are i.oidered to be the best for its cultivation.

Chinese mushroom on paddy straw

Spore trap in operation



RinlogifrtI Studies on rice leaf hoppar

Wheat-berseem intercropping system

Single, double and triple row planting geometery of autumn sugar cane

10.3. Construction of a thatched growing room

A thatched growing room for mushroom cultivation was constructed from locally available cheap material at Faisalabad. Spawn and know-how was provided to interested mushroom growers who have cultivated Chinese and Oyster mushrooms successfully.

10.4. In vitro culturing of wild mushrooms

Wild edible fleshy fungi of Pakistan were cultured on agar media. Four such fungi were cultivated in the laboratory and their cultures were supplied to Mushroom Germplasm Collection Centre, Maryland, U.S.A. Forty five species of edible fleshy fungi were collected from different regions of Pakistan and identified for mushroom herbarium, Faisalabad.

11. SEWAGE EFFLUENT AND ITS EFFECT ON CROPS

11.1. Microflora of sewage effluent

Studies on the microflora of sewage effluent revealed the presence of *Fusarium oxysporum, F. solani, Helminthosporium sativum, Alternaria tenuis, Aspergillus niger, A. fumigatus, A. versicolor, A. flavus, Penicillium notatum, P. chrysogenum, Mucor racemosus, Cladosporium cladosporioides, Curvularia lunata* and *Stemphylium botryosum.* Potato crop when sown in soil irrigated with the sewage effluent or that containing 93 kg potash/ha equivalent to that in sewage effluent showed higher incidence of wilt. *Fusarium oxysporum* isolated from sewage effluent was found to be pathogenic on the seed of tomato and cauliflower when sown in soil.

11.2. Effect of sewage effluent irrigation on storage rot of potato and onion

The incidence of storage rot in the produce of both potato and onion was higher in the soil irrigated with the sewage effluent or that containing 93 kg potash/ha or receiving alternate irrigation with sewage effluent and tubewell water. The vegetables such as radish, turnip, lettuce, cauliflower, long melon and cucumber grown in sewage effluent also carried large number of human pathogens and parasites.

12. BIOLOGICAL CONTROL OF PLANT DISEASES

12.1. Effect of antagonists on the survival of R. solani

Investigations carried out recently on the density of the root rot pathogen, as influenced by the antagonistic organisms, showed that the density of *R. solani* was greatly reduced in the infested soil after the additon of wheat straw contaminated with *Trichoderma harzianum or Arachniotus* sp. Ninety days after the treatment the density of the pathogen was reduced to 20 and 6% as against 100 and 93 percent in control, in the sterilized and unsterilized infested soils respectively.

12.2. Biological control of charcoal rot of sunflower

Various soil saprophytic fungi were evaluated in vitro for their antagonistic activity against *Macrophomina phaseolina,* the cause of root and stem rot of sunflower. Sunflower seed treatment with spore and mycelial suspension of *Arachniotus* sp., *Trichoderma harzianum* and *Penicillium* sp. provided 100, 87 and 40 percent control of root and stem rot disease, respectively. Seed treatment with *Arachniotus* sp. increased plant vigor and dry stem weight, whereas with *Penicillium* these were decreased. *Arachniotus* sp. increased plant vigour and head size of the sunflower. The three antagonists also significantly reduced extent of linear stem infection of the diseased plants.

12.3. Yield boosting effect of Arachniotus on various crops

In the replicated field trials conducted at different places in the province an increase in the yield of wheat ranging from 24 to 42 %, rice, 20%; sugarcane, 26.9 to 38%; cotton, 9.8 to 79.9%; maize-grain, 11.4%; Mung, 75 to 100%; fodder crop (Berseem and Maize), 32 to 35% and vegetable, 50 to 94% has been recorded through the application of *Arachniotus* sp. The residual effect of the application has been found to enhance the yield in three consecutive crops of the field crop rotations. An increase in the yield of crops following the treated crops ranged from 17 to 100 percent.

13. EFFECT OF ERGOSTIM SPRAY ON SUGARCANE

The effect of a biostimulant i.e. Ergostim, when sprayed on the 4-leaf stage of the sugarcane crop, at dosage rate of 800, 400 & 200 ml/ha revealed that cane yield was significantly increased at all dosage rates tested. However, dosage rate of 200 ml ergostim/ha proved to be the best and it increased 25.8% yield over the nontreated control.

14. FUTURE PLAN OF WORK

Investigations will be continued to find the suitable control of various diseases of important field and horticultural crops.

As the knowledge of the epidemiology of plant disease" is essential for their efficient control, studies will be continued to find the factors responsible for the development of important plant diseases.

Since mushrooms have a great potential as a source of high quality protein, efforts will be made to select various strains suitable for different regions of Pakistan. Investigations will be continued to design low

cost thatched houses for the commercial cultivation of mushrooms.

Investigations on the biological control of important plant pathogens and the boosting effect of various micro-organisms will also be continued.

INSTITUTE OF SOIL AND ENVIRONMENTAL SCIENCES

RESEARCH ACHIEVEMENTS:

A. Soil Microbiology

Development of Microbial Metabolites-based Biofertilizer for Rice "Rice Biofert":

Soil Microbiologists at our university are the pioneers who have developed the approach of utilizing substrate-dependent microbially released plant growth regulators for the betterment of agriculture industry. This novel and innovative approach has been proven to be very effective in promoting the growth and yield of various plants/crops. This approach consists of production of plant growth regulators (organic substances which coordinate and regulate plant growth when applied at concentration far below the nutrients) by the inocula from the added substrate. This approach is different from the conventional approach of biofertilizer formulations consisting of living cells of microbial bugs, which usually give very inconsistent results. These microbial metabolites can be used for seed or root treatment. After testing in the laboratory/growth room and wire house trials, an extensive work on rice was undertaken on farmer's fields to test the validity of this approach and extremely encouraging results were obtained (average up to 20% increase in yield).

ii) Development of Biotechnology for "Bioconversion of organic waste materials into biofertilizer enriched with plant growth promoting rhizobacteria and biologically active substances:

Organic waste materials are available in huge amounts in the form of farm, city (sewage sludge), and industrial (food, sugar, cotton and rice industry) wastes. The continuous accumulation of these materials is also becoming a potential source of pollution. Most of these materials can be converted into useful soil additives by microbial composting process. Through composting, the undesirable features of these materials (toxic heavy metals and organic compounds, pathogens, odor, wider C-nutrient ratios, etc.) can be changed to desirable components, and the composted materials can then be used in preparation of biofertilizers. The addition of precursors/substrates of known biologically active substances (BAS) and inoculation with PGPB could convert this composted material into a very effective biofertilizer. The PGPB can produce BAS from added substrates which would gradually be available for plant uptake. Such biofertilizers could have multifaceted effects on soil health, including: (i) increase in SOM level, (ii) improvement of soil fertility due to nutrients released from the composted materials, (iii) release of BAS capable of evoking a physiological response upon uptake by plant roots, and finally (iv) carry a high population density of PGPB. This biotechnology would certainly help in achieving optimal sustainable agriculture production. The cleaning of our environment of the pollutants present in organic waste materials (such as city sewage sludge) would be an extra benefit.

Currently, the work on this approach is going on and a project of worth Rs.2.01 million has been approved by PARC under ALP program for intensive research on these lines. The results of initial trial are very encouraging. We are confident that within a couple of years, we will be able to launch biofertilizer prepared from waste materials enriched with biologically active substances on commercial scale for improving agricultural productivity.

iii) Microbial ACC-deaminase Biotechnology for Sustainable Crop Production

Ethylene is an important growth hormone that is produced by almost all plants and mediates a wide range

of different plant responses and developmental processes. High concentration of ethylene especially at germination stage is found to inhibit root growth, thus lowering of endogenous ethylene level may result in more prolific root growth. It has been discovered that certain microorganisms contain an enzyme ACC-deaminase that hydrolyses ACC (the immediate precursor of ethylene) into ammonia and α-ketobutyrate. Inoculation with these bacteria has been shown to alter the endogenous levels of ethylene, which subsequently leads to changes in the growth and development of plants. Microorganisms containing ACC-deaminase were isolated from rhizosphere of different fields, purified and screened in different trials under axenic conditions. ACC-deaminase activity of the selected strains was determined. A positive correlation (r = 80) was found in total ACC-deaminase activity and root elongation by ACC-deaminase containing rhizobacteria. The most effective strains were selected, identified by using Biolog identification system® and used in further studies.

ACC-deaminase containing rhizobacteria screened under axenic conditions were used in pot trial to study their growth promoting activity. Results showed that these isolates were effective in increasing wheat yield. Inoculation with ACC-deaminase containing isolates increase root weight, fresh weight, 1000 grain weight and grain yield up to 51, 59 28 and 65% respectively as compared to uninoculated control.

All these selected strains were also tested under field conditions. Inoculation with ACC-deaminase containing rhizobacteria increased grain yield up to 39% as compared to uninoculated control under field conditions.

Inoculation with rhizobacteria containing ACC-deaminase also increased growth and yield of maize in pot and field trials. In a pot trial inoculation with these PGPR resulted in significant increase in plant height, root weight and total biomass (up to 17, 95 and 22%, respectively, over uninoculated control. In field trial inoculation with PGPR containing ACC-deaminase produced significant increases in total biomass (9%), cob weight (20%), cob length (15%) and grain yield (19%) over uninoculated control.

iv) Utilization of ACC-deaminase containing rhizobacteria under salinity stress:

Effect of inoculation of ACC-deaminase containing rhizobacteria was studied at 1,3,6,9, and 12 EC levels under axenic conditions. Results showed that at all salinity levels these isolates effectively increase root elongation up to 99, 45, 85,333 and 18% at EC levels 1, 3, 6, 9 and 12 respectively as compared to uninoculated control.

v) Utilization of ACC-deaminase containing rhizobacteria for improving nodulation

High level of ethylene is also found to inhibit nodulation in legumes. Therefore, a study was conducted to investigate the effect of co inoculation of ACC-deaminase containing rhizobacteria with Rhizobium. Results showed that co inoculation significantly increase number of nodules, nodule fresh and dry weight up to 11-, 12- and 9-folds respectively as compared to uninoculated control and up to 48,120 and 100% respectively as compared to inoculation with rhizobium alone.

vi) Biodegradation of Pesticides (Bioremediation of Polluted Environments)

The initial work was the isolation and identification of HCH and endosulfan-degrading microorganisms. Two bacterial isolates (LIN-1 and LIN-3) that can grow on γ-HCH as a sole source of carbon and energy were isolated from an enrichment culture. In liquid cultures of LIN-1 and LIN-3, 25.0 and 45.5% removal of γ-HCH, respectively were achieved in 2 weeks. LIN-3 was identified as *Pandoraea* sp. by 16S rRNA gene sequence analysis (99% identity).

Endosulfan-degrading microorganisms were also isolated from different environmental samples through enrichment technique. Enrichment was achieved by using the insecticide as either the sole source of

carbon or sulfur in parallel studies. Two strains each of fungi (F1 and F4) and bacteria (BF2 and B4) were selected using endosulfan as a sole carbon source. Fungal isolate, F4 was identified as *Fusarium ventricosum* by 16S rRNA gene sequence analysis. A *Pandoraea sp* (LIN-3) isolated using lindane (γ-HCH) as a carbon source was also screened for endosulfan degradation. F1 and F4 (*Fusarium ventricosum*) degraded α-endosulfan by as much as 82.2 and 91.1% and β-endosulfan by 78.5 and 89.9%, respectively, within 15 days of incubation. Bacterial strains B4 and Lin-3 degraded α-endosulfan up to 79.6 and 81.8% and β-endosulfan up to 83.9 and 86.8%, respectively in 15 days. Amongst the bacterial strains isolated by providing endosulfan as a sole sulfur source, B4s and F4t degraded α-endosulfan by as much as 70.4 and 68.5% and β-endosulfan by 70.4 and 70.8%, respectively after 15 days. Degradation of the insecticide occurred concomitant with bacterial growth reaching an OD_{600} of 0.366 and 0.322 for B4 and Lin-3, respectively. High OD_{600} was also noted with the other bacterial strains utilizing endosufan as a sulfur source. Fungal and bacterial strains significantly decreased the pH of the nutrient culture media while growing on endosulfan.

The influence of pH and temperature on the biodegradation of α- and γ-HCH was observed in liquid as well as in soil slurry cultures. The highest degradation of α- and γ-HCH (67.1 and 60.2%, respectively) was observed at an initial pH of 8.0 in liquid culture by *Pandoraea sp.* at 4 weeks of incubation. Degradation of α- and γ-HCH isomers (21.7 and 19.1%, respectively) in liquid culture was even observed at initial pH of 4.0 at 4 weeks of incubation. This strain degraded highest amount of α- and γ-HCH (58.4 and 51.7%, respectively) in soil slurry at an initial pH of 9.0. Substantial degradation of α- and γ-HCH (37.2 and 27.1%, respectively) could be observed in the soil slurry even at initial pH of 4.0. The slightly alkaline pH range favored the growth of *Pandoraea sp*. An increase in pH, from acidic to alkaline increased the bacterial growth in liquid and soil slurry.

Incubation temperature of 30°C was optimum for effective degradation of α- and γ-HCH isomers in liquid culture and slurry by *Pandoraea sp*. About 62.5 and 57.7% degradation of α- and γ-HCH isomers in liquid and 54.3 and 51.9%, respectively in soil slurry was noted in the flasks incubated at 30°C. Incubation temperature below or above 30°C resulted in decreased degradation of both the isomers in the liquid as well as in the soil slurry. The OD_{600} and viable counts of *Pandoraea sp*. at different incubation temperatures reflected that 30°C was the most favorable temperature for bacterial growth.

Increasing the soil-water ratio decreased the extent of degradation of both the α- and γ-HCH isomers. The highest degradation of of α- and γ-HCH (62.9 and 56.4%, respectively) occurred at a 10% soil slurry while the lowest (47.9 and 44.4%, respectively) was determined at a 20% soil slurry at 4 weeks of incubation.

Comparative biodegradation of α-,β-, γ- and δ-HCH isomers in liquid culture by a Pandoraea sp. revealed that the Pandoraea sp. degraded 79.4% δ-HCH and 34.3% γ-HCH in liquid culture at 4 weeks of incubation. α- and β-HCH exhibited almost the same rate (41.6 and 42.4%, respectively) of degradation. Thus, the order of degradation of HCH isomers by the Pandoraea sp. was as follow: $\delta > \beta \geq \alpha > \gamma$. The Pandoraea sp. grew well on all four HCH isomers (α, β, γ and δ). The highest OD_{600} was recorded with the α-HCH (0.186) followed by δ-HCH (0.179), β-HCH (0.173) and γ-HCH (0.153) after 2 weeks of incubation. Degradation of all four HCH isomers sharply decreased the pH of the liquid culture to below 3.50.

Pandoraea sp. substantially degraded both the γ- and α- HCH isomers at concentrations of 10 to 200 mg L^{-1} in liquid cultures. Maximal depletion of the γ- and α- HCH isomers (89.9% and 93.3%, respectively) in the liquid culture was observed at an initial concentration of 150 mg L^{-1} at 8 weeks of incubation. The kinetics of γ- and α-HCH biodegradation in liquid culture of *Pandoraea sp*. was examined at an initial concentration of 150 mg L^{-1}. The rate constant (*k*) for γ- and α-HCH were estimated to be 0.28 and 0.32, respectively. The half-life ($t_{1/2}$) for γ- and α-HCH were 2.51 and 2.19 weeks, respectively. In soil slurry

cultures of *Pandoraea* sp, simulating a soil slurry phase bioremediation treatment, substantial decreases in the levels of the HCH isomers were observed at concentrations of 50 to 200 mg L^{-1}. At 9 weeks, 59.6% and 53.3% biodegradation of γ and α- HCH isomers, respectively were achieved at 150 mg L-1. The rate constant (k) for γ- and α-HCH were estimated to be 0.29 and 0.25, respectively while half-life (t ½) were estimated to be 2.34 and 2.75 weeks, respectively.

Saline Agriculture

The University of Agriculture has introduced the concept of "living with salinity" as an alternative to the drainage strategy which is now called Saline Agriculture. Salient achievements in the field of Saline Agriculture are as under:

i) Development of Screening Techniques and Selection of Salt Tolerant Varieties

Several genotypes of different crops were screened using this technique, e.g.

Crop	No. of genotypes screened	Tolerant varieties
Wheat	2500	LU 26S, Blue Silver
Rice	1100	NIAB 6, KS 282
Barley	135	PK 30132, PK 5869
Cotton	66	NIAB 78
Oil seed	3 crops	Gobhi sarson
Sorghum	24	Milo and J 263
Sesbania	50	BA 6 CB2 CB8
Sugarcane	12	SPSG 26, SPSG 394

ii) Development of Salt Tolerant Varieties of Field Crops

Wheat lines SARC 1, SARC II, SARC III and SARC IV were developed which have shown higher salt tolerance over the existing local wheat genotypes.

iii) Physiological Studies on Salt Tolerance

Different physiological traits responsible for salinity tolerance in wheat, rice, cotton and kallar grass (salt-grass) were identified as given below.

iv) Wheat, rice and cotton

Exclusion of Na and Cl, compartmentation of toxic ions in older leaves, better K:Na (ion selectivity) and Zn:P ratios in tissues besides the faster rat of growth were found to be the major traits associated with salt tolerance in crop plants.

v) Kallar grass

Accumulation of greater amounts of Na, Mg, P, Zn and K was prominent in kallar grass (L. fusca). Profused salt excretion through leaves was the major adaptation for salt tolerance while development of aerenchyma in root was related to tolerance to waterlogging.

vi) Research on Shrubs/Salt Bushes

Studies on salt tolerant forage shrubs belonging to genera Atriplex and Maireana, on various aspects were conducted.

vii) Adaptation studies

Sixteen seleted spp. Of Atriplex and Maireana were planted in two series of trials at 3 site by SARC. Survival of all the species was significantly affected because of inundation (waterlogging) and salinity. Two spp. (A. amnicola and A. lentiformis) were found well adapted to local conditions and produced good biomass. All the Maireana spp. At the three tested sites showed little promise for revegetation of salt affected wastelands.

Establishment studies

The results of establishment studies revealed that bushes established well when planted at 10 cm above ground level on the side of raised banks during winter season. Results of irrigation experiments suggest that Atriplex species can survive without irrigation supplies after establishment, but better biomass can be obtained if irrigation is applied. Nevertheless, growth and biomass production was found relatively affected upon irrigation where ground water level was near to the surface.

ix) Productivity trials

Three productivity experiments to study the most appropriate harvesting month, harvseting frequency and planting density were conducted. The results reveal that wider spacing increases growth of individual plants, and more frequent harvesting (after 2 months interval) increases annual forage production, enhances leafiness and quality of the forage. However, mortality increases when salt-bush harvested during March to July.

Studies on Tree spp.

In long term field studies, a number of woody and some multipurpose tree spp. were compared for performance under saline/saline sodic conditions. Based on experiments of various tree spp. From the point of suitability for different salinity situations have been placed in different groups.

Agronomic Studies

Yield could be increased manifold by planting wheat & rice at an appropriate time, which was November and June for wheat and rice, respectively. Results revealed that dry sowing of whet on soil having good permeability gave much better germination, seedling establishment and yield compared with normal `watter' sowing.

Plant Nutrition of Salt-affected Soils

The requirements of plant nutrients for salt-affected soils are entirely different than the normal good lands. Our results show that crop yield can be improved significantly by supplying N a week after the transplanting of rice. Further, three splits of N over the growth period of rice gave better results as compared to normal practice of applying N. Phosphorus induces toxicity to rice under salt-affected conditions. Nevertheless, moderate application (20 kg P ha-1) under saline conditions is beneficial in improving paddy yield. Good response of rice to Ca, Zn and B has been observed under saline and saline-sodic soil conditions.

Saline Agriculture Technology Transfer Project, Satiana (Satiana Project)

A comprehensive programme of technology transfer is underway in collaboration with the local Agri. Extension Staff. So far, 1000 acres have been planted under E camaldulensis and 35 acres under Atriplex amnicola. To cultivate wheat in moderately salt-affected soils, seed of salt-tolerant whet SARC-I

has been supplied to farmers for 150 acres in the area. Besides this some important inputs such as gypsum (21390 bags) and fertilizer (1600 bags) were also provided to farmers to facilitate the redevelopment process of moderately salt-affected soils. Due to these activities, enthusiasm has developed in the disappointed poor farmers of the area to cultivate waste/salt affected lands.

Welfare association of salt land users

Welfare association of salt land users (WASLU) has been established by SARC in the Satiana area to alleviate the sufferings of the poor lot of the farmers through a participatory approach by adopting Saline Agriculture Technology, i.e. the cultivation of salt tolerant crops, trees and forage shrubs for the economic utilization of the salt-affected land.

Soil Fertility and plant Nutrition

i) An Alternative Approach to Tackle Nutrient Deficiency Problems in Pakistan Soils

Optimizing soil fertility to achieve high crop production is difficult in areas of low economic stability since inputs are costly. Sustainable production of food and forage with a focus on plant adaptation to stress environments is thus becoming a priority for developing countries like Pakistan.

For the last few years, our scientists have been working on the identification and selection of wheat, rice and cotton varieties which can give relative higher yields with low levels of nutrient applications especially P and K. From the results of preliminary experiments we have found substantial differences in P an K requirements of the varieties of these crops. Range of differences for different growth parameters and utilization indices observed. These findings are to be tested at multisites in the farmer's field for final recommendations to the end users.

ii) Nutritional and Physiological Aspects of Cotton Related to Cotton Leaf Curl Virus

Resistance and tolerance of plants to disease and insects can be increased or decreased by changes in anatomy, morphology and chemical composition of plants. Results of preliminary studies suggest that incidence and severity of CLCV symptoms is significantly enhanced in plants of all varieties receiving adequate supply of nitrogen, phosphorus and potassium compared to the plants receiving deficient levels of these nutrients confirming the general hypothesis that nutritional factors favouring host plant also favor viral multiplication. Nevertheless, it is important to note that despite higher scoring of CLCV symptoms in plants supplied with adequate nutrition, their yield (as depicted by shoot dry weights) is still substantially higher compared to the plants grown with deficient levels of these nutrients and lower incidence of CLCV. These results may imply that even though better nutrition of the plants may initially increase the incidence of the virus, however, if plants got the potential to partially recover from infection (as observed in a later experiment), they can produce higher biomass compared to those which are malnourish and have lower infection of CLCV. However, these results need to be confirmed in the field before formulation of any recommendations to the farmers.

iii) Cheaper Source of Potassium Fertilizers

Fertilizer use in a vital component of the scientific package of Agri. Technology. However, the use of fertilizer is imbalance in respect, of P and especially K (potash). SOP is conventional use as source of K . But SOP is twice as expensive as MOP. Thus a project was started to evaluate MOP as a source of potash in Pakistan and also to ascertain the ill effects of chloride, if any, on crops. After conducting different trials on different crops, it was concluded that MOP could be used safely for almost all crops without the harmful effects of chloride on soil and plant health.

Farmers can use a cheaper source of potash. MOP without any fear of its ill effects on soil and plant.

Soil and Water Chemistry

i) Gypsum: an Economical Reclaimant

Gypsum application at the rate of 100% gypsum requirement of the upper 15 cm soil layer can reclaim saline-sodic and sodic soils within 2 to 3 years simultaneously yielding good crops of rice and whet. The cost of gypsum could be recovered from the first two to three crops that are cultivated after gypsum application.

ii) Subsoiling: Effective Tool for Breaking Hard Subsoil

It is recommended that crosswise subsoiling to a depth of 50 $\pm$ 5 cm and at a distance of 120 to 150 cm followed by gypsum application at the rate of 100% gypsum requirement of soils can efficiently reclaim saline-sodic and sodic soils having hard pan in the subsoil.

iii) Biological Soil Reclamation Technology for Subsistence Farmers

Majority of the farmers of Pakistan can not start reclamation of their saline-sodic and sodic soils because of high initial investment to purchase chemical amendments. Dissolution of native $CaCO_3$ under the action of plant roots during biological reclamation plays a major role in decreasing soil sodicity. Effectiveness of biological reclamation was found comparable to the chemical (gypsum) reclamation at certain places. Among the various plant species tried for soil reclamation, kallar grass (Leptochloa fusca) was found more suitable. This approach requires more time and can only be tried under conditions where these plant species can grow well. Moderately saline-sodic soils (ECe up to 10 dS m^{-1}; SAR up to 75) can be reclaimed successfully by growing dhancha or kallar grass continuously for 2 to 3 years. The farmer will also get benefit in terms of forage harvest.

iv) Use of Brackish Water for Crop Production and Soil Reclamation

An increase in irrigated agriculture does not correspond to increase surface water supplies. Paradoxically, while a serious water deficit exists, there is an excess of drainage water. Many brackish waters, like the drainage water, can be used efficiently for irrigation and reclamation of salt-affected sols if proper management practices are applied. On the basis of the results obtained from different studies, it is recommended that brackish water (EC up to 3.5 dS m^{-1}, SAR up to 15 and RSC up to 7 mmolc L^{-1}) can be used effectively for growing rice and wheat crops and for soil reclamation if either sulphuric acid is applied along with irrigation water (like fertigation) equivalent to water RSC or farm yard manure is added to the field annually @ 25 Mg ha^{-1}.

v) Field Training Programme for the Farmers

Farmer education and training pertaining to reclamation technologies of salt-affected soils growing rice-wheat crops was accomplished through organizing them in Focus Groups of Farmers (FGF) followed by on-site excursion during field days at different sites of the Fourth Drainage Project Area, Faisalabad.

vi) Metal Ions in City Waste Effluent: Effect of Application on Soil and Vegetables

Toxic concentrations of several metals [lead, copper, zinc, manganese, nickel, chromium, iron, cadmium and cobalt] in vegetables like spinach (*Spinacia oleracea* L.), fenugreek (*Trigonella foenumgr aecum* L.) cauliflower (*Brassica oleracea* L.), pumpkin (*Cucurbita moschata* Duch. Ex Poir), brinjal (*Solanum melongena* L.), Onion (*Allium cepa* L.), bittergourd (*Momordica charantia* L.), and okra (*Abelmoschus*

esculentus L. Moench) were identified. On an average, these metals in the edible parts of vegetables were above the permissible limits for human consumption, the concentration being still higher in non-edible parts. Metal ion concentration decreased with soil depth which is indicating less movement of metals or rapid conversion into insoluble forms in soil s causing accumulation in root zone soils irrigated with raw city effluent. The concentration of most of the metals was the highest in roots followed by leaves and fruits, except tomato and cauliflower where the concentration was he highest in roots followed by fruit and leaves. In general, the edible parts of summer vegetables contained higher levels of these metals than that in winter season vegetables, and sewage irrigated vegetables accumulated higher levels of metals in plant parts than those of canal irrigated ones. It is recommended that leaves and root parts of vegetables grown using raw sewage must be avoided, and off-season vegetables be avoided since proportion of vegetables grown with sewage is high in markets in these seasons.

E. Soil Physics

1. Effect of tillage and farm manure on physical properties and growth of maize (*Zea mays* L.)

A field experiment was conducted to evaluate the effect of tillage and farm manure on soil physical properties (field saturated hydraulic conductivity, bulk density and water content) and growth of maize. Four tillage methods used were zero, minimum, conventional and deep tillage. Three farm manure levels used were control, FM @ 10 and 20 Mg ha^{-1}. Tillage methods were kept in main plots while farm manure levels in sub-plots. Maize crop was grown up to maturity. Recommended levels of N, P and K were maintained by using chemical fertilizers. The main objective of this study was to assess the performance of farm manure compared to chemical fertilizers. Dibble method was used for maize sowing keeping plant-to-plant distance of 22 cm and 70 cm row to row. Tillage significantly affected plant height, dry biomas, grain production and maximum plant height (220 cm), dry bio-mass (8.71 Mg ha^{-1}) and grain production (10.48 Mg ha^{-1}) was observed in case of conventional tillage, while lowest (163.3 cm) plant height, dry bio-mass (5.11 Mg ha^{-1}) and grain production (5.94 Mg ha^{-1}) in minimum tillage, respectively. Soil bulk density and hydraulic conductivity was significantly affected by tillage and minimum bulk density was observed in conventional and highest in minimum tillage while maximum hydraulic conductivity was observed in conventional tillage. Concentration of P in soil and N and K in shoot was significantly affected by tillage system.

*2. Residual effect of tillage and farm manure on wheat (*Triticum aestivum *L.) growth and soil physical quality parameters*

Experiment was conducted in the field at the research area, Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad to study the residual effect of tillage and farm manure on growth of wheat and soil physical properties. Four tillage methods, i.e. zero tillage (ZT), conventional tillage (CT), deep tillage (DT) and minimum tillage (MT) and three farm manure levels (control, FM @ 10 and 20 Mg ha^{-1}) were used in the previous crop. Wheat variety Inqlab-91 was sown with automatic seed drill maintaining the distance between plant to plant (22 cm) and row to row (70 cm). Recommended levels of N, P and K were used as urea (250 kg ha^{-1}), DAP (250 kg ha^{-1}) and SOP (125 kg ha^{-1}), respectively. Wheat was harvested at maturity and shoot and soil samples were collected. Oven-dried shoots and soil were ground and then analyzed for N, P and K concentration.

Tillage methods significantly affected the soil physical properties as they increased saturated hydraulic conductivity and soil porosity and decreased bulk density of soil. The effect of tillage methods on plant growth and yield parameters was non-significant except for plant height and 1000-grain weight. Farm manure significantly affected the soil physical properties and growth of wheat as it increased saturated hydraulic conductivity, soil porosity, plant height, total dry matter, number of spike lets per spike, straw yield, 1000-grain weight and grain yield of wheat while decreased bulk density of soil. Tillage methods significantly increased K concentration in wheat shoots only, while their effect on K concentration in soil

and N and P concentration both in shoots and soil was statistically non-significant. Farm manure significantly increased N concentration in wheat shoots, P concentration in soil and K concentration both in wheat shoot and soil, while its effect on P concentration in wheat shoot and N concentration in soil was statistically non-significant.

INSTITUTE OF HORTICULTURAL SCIENCES

1. FRUIT CROPS

1.1. Citrus

1.1.1. Genetic improvement

Hybrid seedlings of some interspecific crosses of 1984-85 and 1985-86 are under observation.The seedlings from crosses having Duncan grapefruit as one parent are showing vigorous growth as compared to others.

The cvs used for hybridization along with the crosses are given in the following list.

Important commercial varieties of mandarin *(C, reticulata),* sweet orange *(C. sinensis)* and grape-fruit *(C. paradisf)* were raised from the seeds of their open-pollinatd fruits. At present there are several nucellar lines of kinnow, sweet orange, grape fruit and some other mandarin varieties standing at their bearing stage. However it is not yet known whether these are virus free and have fruit comparable to their maternal sources. Studies are in progress (see next page) .

1.1.2. Propagation techniques

Grafting techniques for vegetative propagation of Kaghzi lime (C. *aurantifolia)* were developed by T-grafting or veneer-grafting. The most suitable time for grafting was found to be first fortnight of March, giving an average success of 68-80X. In summer and autumn grafting success ranged between 70-79 percent in different cases. It was also observed that grafted plants grew faster than the budded ones.

1.1.3. Rootstock selection for Kaghzi lime *(C. aurantifolia* Swingle)

Kaghzi lime was grafted on ten rootstocks to identify some commercially compatible and prospective ones. Rootstocks used were Jatti Khati *(C. jambhiri* Lush.), Jamberi Khati(CL *jambhiri* Lush.), Jullunduri Khati (C. *jambhiri* Lush.), Kharna Khata *(C. karna* Raf.), Kaghzi lime *(C. aurantifolia* Swing.), Eureka lemon (C. *limon* Burm.), Mithi (Hybrid of sweet lime and rough lemon), Gadda Dehi (C. *aurantium* Linn.), Nasnaran (C. *limonia* Osbeck) and sweet

The cv.used for hybridization along with the crosses are as under:-

SPRING 1985			
1.	Mangal Singh	X	Pineapple
2.	Pineapple	X	Mangal Singh
3.	Kinnow	X	Pineapple
4.	Pineapple	X	Kinnow
5.	Duncan	X	Kinnow
6.	Kinnow	X	Duncan
7.	Pineapple	X	Duncan
8.	Duncan	X	Pineapple

9.	Washington Naval	X	Duncan
10.	Kinnow	X	Musambi
11.	Musambi	X	Kinnow
12.	Feutrell's Early	X	Duncan
13.	Feutrell's Early	X	Kinnow
14.	Kinnow	X	Feutrell 'Early
SPRING 1986			
1.	Kinnow	X	Feutrell 'Early
2.	Feutrell's Early	X	Kinnow
3.	Kinnow	X	Pineapple
4.	Kinnow	X	Musambi
5.	Musambi	X	Kinnow
6.	Kinnow	X	Duncan
7.	Duncan	X	Kinnow
8.	Feutrell's Early	X	Duncan
9.	Duncan	X	Feutrell's Early
10.	Kinnow	X	Foster
11.	Kinnow	X	Foster
12.	Feutrell's Early	X	Foster
13.	Musambi	X	Duncan
14.	Kinnow	X	Willow Leaf
15.	Willow Leaf	X	Kinnow
16.	Feutrell's Early	X	Valencia Late
17.	Valencia Late	X	Feutrell's Early
18.	Musambi	X	Valencia Late
19.	Kinnow	X	Blood Red
20.	Pineapple	X	Blood Red

1.1.4. Reducing nursery period

Seeds of rough lemon *(C, jambhiri* Lush.) were sown in the middle of October under simple glass house. It was observed that these seedlings became transferable after 4-5 months and become budable by the month of August (10 months after seed sowing), while those started in the open took about 2 years to reach this stage. It was also observed that the seedlings-raised, in glass house had only 5% bench-roots while this disorder was 25% in the seedlings raised in the open (Table 1).

Table 1. Effect on root and shoot growth of rough lemon under different environments.

Glass house nursery (open)				
	February	***March***	***February***	***March***
Plant height	12.61	14.82	7.10	7.30
Performance of rough lemon seedlings after transplanting from the glass house to the field.				

	May	***June***	***July***	***August***
Time of observation	17.73	19.68	23.23	30.32
Diameter of stem (cm)	--	--	0.78	0.82
			Budable	

1.1.5. Manuring and fertilization

Major and minor elements have been tried in different ratios on various citrus fruits. It has been observed that the application of the different nutritive elements not only increased the size and yield of the fruit, but also enhanced the fruit quality.

1.1.5.1. Trace elements

Minor elements like Zn and Mn were sprayed in low concentrations on kinnow and sweet orange varieties. It was found that the deficiency might be corrected with one or two periodical applications of Zinc and that increase in Zn and Mn level of leaves induced better fruit-set and high yields of good quality citrus fruit.

1.1.5.2. A long term manurial trial:

A long term manurial trial on Pineapple sweet orange variety is in progress. NPK alone in different doses and incombination with FYM or Sewage manure alone is not effective but when used in combination with NPK invigorated growth and increased fruit yield. It was also noted that organic manures alongwith chemical fertilizers when applied to 10-years old sweet orange plants, the nitrogen contents in the leaves were increased upto 3%. Results about growth and fruit yield were significantly better when organic and inorganic manures were used together than applied separately.

Table_3 Effect of Aron, Alar alone and in combination with NPK regarding flowering time, sex expression, fruit set, fruit drop and yield in sweet lime (C.limettioides)

Treatment	**Flowering time (No. of days from 30.12.1981**	**Perfect flowers**	**Fruit set %age**	**Fruit drop %age**	**Yield (fruit/plant)**
Control	47	10.70	4.92	58.15	93.66
Aron	43.33	19.33	15.30	35.01	202.66
Alar	47.33	12.03	8.24	56.01	146.00
NPK	32.00	12.84	9.44	35.46	171.66
Aron x NPK	46.33	20.21	17.74	28.42	245.66
Alar x NPK	65.33	15.28	11.36	32.92	181.66

1.1.5.3. Source of nitrogen

Ammonium and nitrate sources of nitrogen were supplied to 3-year old Peutrell's Early mandarin in the month of ^February. It was noted that in both the sources the translocation of nitrogen to leaves took two weeks. Ammonium source remained available longer that the nitrate source.

1.1.5.4. Uptake efficiency of NPK

A comparative study is being done regarding NPK absorption of Kinnow and Feutrell's Early mandarin, their leaf chlorophyl contents at different growth stages and number of annual flushes. Preliminary results

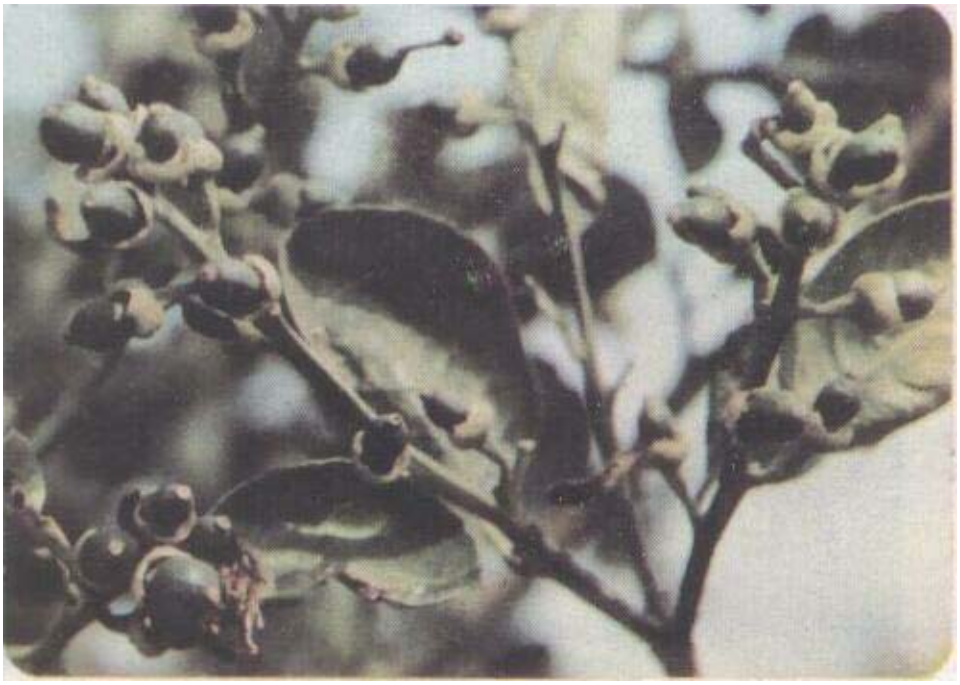
indicate that Kinnow leaves of similar age contain higher level of chlorophyl than Peutrell's Early.

1.1.6. Growth regulators and fertilizers in sweet lime

Sweet lime is generally a shy bearer citrus fruit; the cause is mainly the presence of a large numer of imperfect, mostly male flowers. In order to test a belief that better nutrition coupled with some growth regulators could improve fruiting, growth regulators like Aron and Alar were sprayed on foliage alongwith NPK (2:1:1:) soil applications in different combinations and alone. A good response on yield was observed. It was found that Aron in combination with NPK gave the maximum yield, followed by Aron alone. It was observed that the increase in yield was resulted through the increased number of perfect flowers under these treatments. Alar and NPK alone and in combination also showed significant results over control (Table 3).

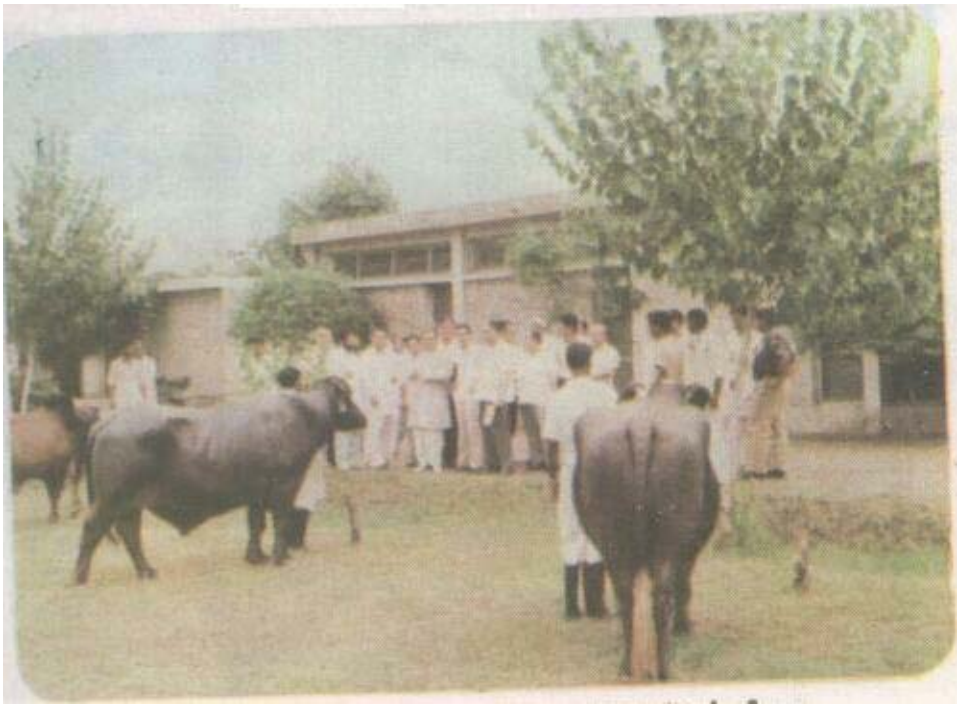
In another experiment sweet lime was treated with several combinations of NPK with NAA and Alar growth regulators in various concentrations. Alar applications alone and in combination with NPK induced early flowering, more hermaphrodite flowers, and higher fruit set. Yield was definitely improved in treated plants as compared with control.

Profuse bearing on a well balanced fertilized hinnow tree



Heavy fruit set on sweet lime as a result of treatment

University Hockey Team being introduced to the Vice Chancellor, Mr. M, Mumtaz Ali



Chinese delegation visiting livestock farm

1.1.7. Granulation

Granulation intensity by number and weight was observed in various commercially sweet orange and mandarin cultivars. It was observed that among sweet orange cultivars (C. sinensis Linn.), Valencia Late was least affected while Washington Naval, Hamlin, Pineapple, Musambi and Jaffa were affected to various degrees of granulation. Among mandarins (C. reticulata), Kinnow was least granulated ,Feutrell's Early and Mangal Singh were less affected whereas Willow Leaf produced almost completely granulated fruits.

To observe the effect of irrigation frequency on citrus granulation, Pineapple sweet orange plants were irrigated after 7, 14 and 21 days intervals. Plants irrigated after every 21 days showed more of this physiological disorder. It was suggested that granulation intensity may be controlled, to some extent, by judicious irrigation of citrus orchards.

1.1.8. Mutation breeding

Sweet lime *(Citrus limettioides)* bears about 95% staminate and only 5X perfect flowers. This behaviour leads to a very poor crop. Efforts have been made to induce more perfect flowers by means of heavy fertilization and use of growth regulators. The results obtained were not satisfactory. This project was undertaken to bring some mutational changes in the propagation material (cuttings) to induce sweet lime to bear more perfect flowers and crop. Sweet lime cuttings were irradiated at 3, 4 and 5 Kr. All 5 Kr treated cuttings died. Only one in 4 Kr and 16 in 3 Kr remained alive. The survived plants are bearing. The data on sex experssion ratio and different fruit constituents are being determined. The preliminary results did not indicate any significant difference between irradiated trees and control.

1.1.9. Salinity tolerance in rootstocks

Seeds of twenty rootstocks including citrus hybrids like citranges *(Poncirus trifoliata* x d *sinensiB)* and citrumelloes were sown in the greenhouse. Six of these namely Volkamariana *(Citrus limon* Burm. (f)). Red rough lemon *(C. jambhiri* Lush.), Jatti Khati, Jamberi Khati, Bitter sweet orange *(C. aurantium* Linn.) and Yuma citrange were tested on water culture at- different salinity levels. Yuma citrange and Bitter sweet orange were found comparatively tolerant followed by Volkamariana. Jatti Khati, Jamberi Khati and Red rough lemon were extremely sensitive to salinity.

1.1.10. Germ plasm bank

Efforts are already under way to collect the available germ plasm treasure in a compact block, seven varieties as mentioned below of sweet orange, four of grape fruit have already been raised in germplasm bank. The work shall be completed in stages starting from the collection' of plant material available at the campus and then on province and country levels. Foreign materials will also be collected in due course of time (see the following list).

1.1.11. Irrigation

Irrigation at the intervals of 7 days, 14 days and 28 days were applied to Musambi sweet onange. Fruit weight, fruit volume, fruit diameter, juice contents, T.S.S. percentage and peel thickness were increased significantly in 7-day irrigation interval, followed by 14 day interval while 28-day irrigation interval was at the tail. However, peel weight did not change with either of the treatments.

1.1.12. Benlate against fungal diseases

Benlate at the rate of 150, 200, 250 and 300 gms/100 gallons of water was sprayed on 15-year old declining Kinnow trees suffering from footrot disease. The sprays were repeated in March, April, May and June. The disease was halted by high concentrations.

Against a serious disease of sweet lime termed as Limb Withering, Benlate in the concentrations of 50, 150, 250 and 350 gms per 100 gallons was applied but the results were not encouranging in this case.

1.1.13. Root system in rough lemon (Citrus jambhiri Lush.)

Mandarins (Citrus reticulate Blanco)

1.	Honey mandarin	2.	Ponken
3.	Shamael	4.	Murcott
5.	Willow Leaf	6.	Nova
7.	Sunket	8.	Oscilla
9.	Freemount	10.	USDFS Dancy
11.	Mangal Singh	12.	Natal Naartje
13.	Wilking		

Sweet organs (Citrus sinensis Osbeck.)

1.	Washington Naval	2.	Venille
3.	Sweet Seville	4.	Lue Gim Kong
5.	Due Rai	6.	Parson Brown
7.	Dweet	8.	Salustiana
9.	Marrs Early	10.	Casa Grande
11.	Torroco (N)	12.	Hinkley

Grape fruit (Citrus Paradisi Macf.)

1.	Shamber	2.	Little River

3. O.P.Davis Seedling 4. Marsh J.B.c. 430

Table 4. Transplanting success of seedlings and grafted mango plants, and T-grafting success under various treatments.

Treatment		Transplanting Seedlings	Success Grafted plants	T-Grafting Success
1.	Half the root removed and waxed	55.20	70.00	63.63
2.	Half the root removed and not waxed	68.40	71.43	73.91
3.	Three fourth root removed and waxed	60.40	50.00	61.11
4.	Three fourth root removed and not waxed	52.80	61.54	48.15
5.	Control	67.20	46.16	48.43

The root system of three year old rough lemon seedlings was exposed. It was observed that 60% of the roots were present within the upper 20 cms. of the soil, 36% between 30-60 cms. and only 3% roots deeper than one meter. Spread of the root system was also noted and it was found that 93.4% of the roots were within a radius of 30 cms. The longest lateral root extended upto 2.25 meters from the stem.

1.1.14. Storage life

The experiments were carried out to study the effect of 2, 4-D on the storage life of lemon and Kinnow fruits. The fruits were treated with 100 to 500 ppm of 2, 4-D. It was found that 500 ppm of 2, 4-D had a marked effect in extending the storage life of fruit as compared to other treatments and control.

1.2. Mango **(Mangifera indica** *Linn.)*

1.2.1. Propagation

As a result of 'extensive studies on Vegetative propagation in mango, a new technique of propagation was developed. It involves approach grafting of about one-week old seedlings with the fresh branches of similar thickness of scion trees. The third week of September has been found to give the best results. Graft union occurs in 4-5 weeks. It has eliminated the use of pots and the scaffolds. All the graftable branches on a tree can be utilized for propagation and in this way hundreds of grafts can be obtained from a single tree. Losses due to wind storms etc. are negligible because the stock plants are so light in wight that they swing along the branches instead of breaking away. Cost of production is about 25% of the plants, procuced by conventional mango inarching method. Percentage of field sucess is yet to be worked out.

1.2.2. Transplanting techniques

To overcome Problems of higher transplanting losses in mango shocks were given to the mango seedlings through different degrees of root pruning before trasplanting. These mango plants were grafted in the nursery after one year from where these were directly sold with their earth balls in the next season.

The treatment, where half of the seedling roots were removed and transplanted without waxing proved to be the best method (Table 4). This method is economical as well as time saving.

1.2.3. Mango malformation

The endeavours made in order to reduce the intensity of malformation of mango inflorescence are as under:-

It is presumed that the malady prevails due to deficiency of major and minor nutritive elements. The different combinations of nutrient elements and their method of application were tried but the response was not encouraging. However, some varieties like Neelum and Mehdiabad showed some resistance against malformation of mango inflorescence.

Plant growth regulators have also been tried in this regard.It was concluded that gibberellins increased the number of perfect flowers and reduced the percentage of malformed bunches. Male flowers were few on inflorescence from treated trees.

The propagation programme was initiated to study transmission of causal organism of mango malformation. The observations indicated that the symptoms of the disease appeared irrespective of the source of budwood, that is, whether obtained from healthy or un-healthy material.

A number of varieties were subjected to chemical analysis to determine the amino acids and proteins in healthy and malformed inflorescences at different stages of development. Fifteen and twelve different tuypes of amino acids were found in mango leafy shoots and inflorescences respectively in both healthy and malformed specimens at different stages of growth. The number of amino acids increased with increase in the age of inflorescence both in healthy and diseased samples. Diseased materials lacked in cystenine, valine, I-leucine and histidine. Higher levels of total proteins in the healthy shoots and panicles as compared with the diseased ones were also observed.

Plant growth regulators sprays in the third week of August to first week of September and deblossoming of panicles during the month of January when these were 2.5-3 cm in length minimized the intensity of malformed inflorescences (Table 5, 6 and 7).

Table 5. Effect of time of deblossoming on emergence and malformation of mange inflorescence and fruit set.

Treatments of deblos-soming	Percentage of inflorescence	Percentage of malformation	Percentage of fruit set
Last week (30th) Jan.	50	26	50
First week (7th) Feb.	30	61	67
Second week (14th) Feb.	56	19	32
Third week (21st) Feb.	61	14	29
Control	100	35	14

Table 6. Flower sex ratio of healthy and malformed inflorescences in mango.

Plants	Healthy inflorescence			Malformed inflorescence		
	Perfect flowers (%)	Staminate flowers (%)	Pistillate flowers (%)	Perfect flowers (%)	Staminate flowers (%)	Pistillate flowers (%)
I	44.2	55.8	-	7.8	92.2	-
II	32.2	67.9	-	55.0	94.5	-
III	28.9	74.2	-	5.5	94.5	-
IV	41.0	59.0	-	6.2	93.8	-
Total	146.2	256.8	-	24.5	357.0	-
Averages	35.8	64.2	-	6.2	92.7	-

1.2.4. Mycoplasma a cause of mango malformation

It has been claimed that Mycoplasma like bodies have been indentified in branches bearing malformed

inflorescences. To verify these findings sections were cut of shoots, roots and inflorescences affected by malformation.

The sections were stained by. Dieves Stain specific for indentification of mycoplasma. Contrary to the claim the sections from normal shoots, roots and inflorescences stained deeper than malformed ones. Thus the presence of mycoplasma could not be confirmed as a cause of floral or vegetative malformation.

1.2.5. Do seeds transmit Bunchy Top ?

To elucidate the role of seeds in the transmission of vegetative malformation of mango saplings (Bunchy Top), 126 seeds/stones of the elite mango cultivars namely Langra, Anwar Ratoul, Samar Bahisht, Dusehri and Fajri were sown in a wooden cage covered with ordinary muslin cloth away from mango plantation during July, 1985.Fortnightly observations were made on germination, vegetative character and incidence of malformation.

Observations made until April, 1986 almost nine months after sowing the seeds, did not show any symptoms of vegetative malformation (Bunchy Top) in the cage though the mango seedlings raised in the open showed malformation varying from 1-5% in the same period.

Further investigations will determine whether any vector is responsible for the spread of the disease or it .has some thing to do with the intensity of temperature. But one thing is almost sure that Bunchy Top is not seed borne disease and the seedlings are infected later on. Infection may be fungal, viral or soil borne and not inherent.

1.2.6. Storage life of mango fruit

Short post-harvest life is a limiting factor in export and extended local distribution of mango. Keeping fruit in consumeable condition for a prolonged period is a serious problem for thorough investigations. Therefore, a programme was planned to study the ripening and effect of applied chemicals in response to the duration of mango storage. Chamicals like 2,4-D, 2,4,5-T, GA waxing and Maleic Hydrazide were applied to mature mangoes. It was observed that the storage life of mango fruits can be incresed by waxing and Maleic Hydrazide (1000 ppm) for 4 & 5 days respectively at room temperature (23-30°C) as compared to control.

1.2.7. Chilling sensitivity of mango fruit

Research studies were conducted to find out response of fruit of Langra and Dusehri mango cvs. to low storage -temperature i.e. 3 ± 1°C and 6 ± 1°C for 0,4,8 and 12 days. The samples after keeping in the storage for fixed time and temperature were shiftd at room temperature (26-32°C). Observations were started 5 days later. It was concluded that Langra mango was more sensitive to skin injuries as compared to Dusohri. The chemcial composition was found arbitrarily changed in both the varieties as compared to the 'control.

1.3. Guava (Psidium guajava Linn.)

These trials were mainly concentrated on varietal selection, induction of parthenocarypy and vegetative propagation.

1.3.1. Varietal trials

A few varieties of guava have been tried in the University Kx peri mental l«'ruit Gardens out of which Safeda, Hafzi and Karela were found promising varieties.

1.3.2. Induction of parthenocarpy

Experiments were conducted to study the effect of growth regulaotrs on the induction of parthenocarpy and development of guava fruit. The guava fruit produced by the application of 1000 ppm GA was found to be completely seedless, with more flesh thickness, more ascorbic acid and pectin contents as compared to control (seeded fruit).

1.3.3. Propagation

Vegetative means of propagation were tested in guava. It was observed that the regeneration of guava can be done successfully by vegetative means. By Veneer grafting, T-grafting, and cutting the success achieved was 80.80-83 and 50X respectively.

1.4. Datepalm

1.4.1. Development pattern of datepalm fruit (Phoenix dactylifera Linn.)

Datepalm keeps on pushing out spathes from early February to the end of March with a difference of about 30-45 days between emergence of the first and the last spathe. However, it is commonly observed that all date fruit ripen almost at the same time. Investigations indicated that although higher fruit set but more fruit drop combined with warm environments caused rapid fruit development in the late emerging spathes and made it possible to ripe fruit on all spathes simultaneously.

1.4.2. Comparative study on some datepalm cultivars

Five datepalm cultivars were compared including Hillawi and Khadrawi on the basis of plant morphology, physico-chemical characteristics of fruit as well as their adaptability to soil and climatic conditions of Faisalabad, aimng at to recommend some more date palm cultivars for commercial cultivation to overcome the scarcity of good dates in this region.

Hillawi and Khadrawi were the best cultivars in Khalal (doka) and rutab (dung) stage resepctively, closely followed by Mekran, Sayer and Haleeni. Mekran and Sayer may be recommended for cultivation in addition to Hillawi and Khadrawi. Yield of Haleeni was the lowest but its quality was comparable with any good date palm cultivar of this region.

1.5. Banana *(Musa eapientum* Linn.)

A large number of banana varieties were imported from India, Malaya, Ceylon and Indonesia.

Experiments showed that on te basis of morphological characters, yield and quality of the fruit, Begowal, Ceylon, Anwar Hussain, S10, S18 and Soni may prove suitable varieties for cultivation in the Punjab. Fruit quality of S14, and Basrai was found better but their high degree of susceptibility to the extremes of climate especially during winter made them unsuitable for their cultivation in this region.

1.6. Propagation of Litchi *(Litchi chinenais* Sonn.)

The main draw back in the layering method of propagation of litchi is the formation of weak root system of layerages. To overcome this problem various soil media different layerage techniques, duration of layering and plant detachment procedures were tried. It was observed that soil media (1:1 soil sand ratio), ring layerage technique and 3 month layerage time was the best for propagation of litchi. There was not much difference in various detachment procedures. Young mother plants gave better results than the

older ones.

2. VEGETABLE CROPS

Department of Horticulture is undertaking research On more than thirty summer and winter vegetables. Breeding, evaluation of foreign introductions, effect of growth regulators, fertilizer trials and agronomic practices are the major areas of research.

2.1. Potato

2.1.1. Progeny testing of hybrids

Tubers of the following crosses were sown in an observation plot for screening:

1. 9120-2	x	9003-3
2. Atlantic	x	Cardinal
3. Cardinal	x	9003-3
4. lyeti	x	Cardinal
5. Desiree	x	9120-2
6. lyeti	x	9003-3
7. Patrones	x	9003-3
8. Chandar Makhi	x	9003-3
9. Chandar Makhi	x	Sitamn

More than twenty clonal selections have been made on the basis of morphological characters of plants and tubers, and tolerance to frost and diseases.

2.1.2. Crop density vs seed size and weight of tuber

The relationship of stem density with seed size and weight showed significant differences among the cultivars and treatments. Out of the three sizes studied i.e. 25,50 and 75 gm, the 75 gm tubers showed better results in most of the characters.

2.1.3. Performance of potato seed sources

Potato seed from the following sources were collected and tested for their performance:

1. Punjab Seed Corporation	
i) Autumn Seed	Sl
ii) Spring Seed	S2
2. Market Seed	
Autumn Seed	S3
3. Jaffar Brothers	
i) Spring Seed	S4
ii) Mirpur Khas Seed	S5
iii) Gilgit Seed	
4. Kalam Integrated	
Development Project	S6
Kalam Seed	S7

S4 and S5 gave higher percentage of germination than S6 and S7 for disease incidence S2 and S4 (Spring seed) expressed least resistance where as autumn to autumn seed offered better resistance than Spring seed. As for number of tubers was conce-ned Sl was found significantly better than other

treatments. In order of merit treatments followed a sequence of 61, S5, S3, S2, S4, S7 and S6 and for weight of tuber per plant these treatments formed four groups like (i) S5, Sl, S3 and S2 (ii) Sl, S3 and S4. (iii) S2, S4 and S7 and (iv) S6.

From total yield point of view S5 and S6 differed significantly from each other occupying first and second position respectively. No significant difference could be located between S5, Sl and S3 but they had significantly ousted S3 and S6.

2.1.4. Spring vs autumn seed

Performance of spring and autumn produced potato seed of the exotic varieties Desiree, Patrones, Multa and Wilja was studied during the autumn season. The experiment was planted in split plot design with four replications placing varieties in the main plots and the seed source in sub plots. The autumn produced seed excelled in all the characters in all the varieties, suggesting that planting of autumn potato crop *from* the seed produced in the preceding autumn crop can certainly lead to an improvement in both yield and quality.

2.1.5. Control of greening and sprouting:

In an effort to increase the potato shelf-life, five potato cultivars of autumn crop namely Prime, Primura, Montana, Multa and Desiree were dipped in corn oil and stored for 90 days at room temperature under natural light. It was observed that chlorophyll formation took place in minute quantities without any sprout development with minium peeling losses in treated potatoes while in control all tubers became completely green and 50-70X developed sprouts with 67.5 - 85.4% peeling losses.

2.1.6 Adaptability potential of inter and infra specific potato hybrids under Paisalabad conditions.

Six inter and infra specific potato hybrid clones viz. *Pimpernal* x *Maritta* (33), *Ultimua* x *Solarium acaule* (10), *Kabli* x *Solanum acaule* (50) *Solarium chacoense* x *Solanum demissum* (69) Red), *Solanum* X *Solanum acaule* (70), *Solanum chacoense* (selfed) (67) were put in a trial alongwith standred variety. Cardinal and USDA clone No. 9120-2 as control in a randomized complete block design. Data were collected for plant characters like germination percentage, number of tubers per plant, weight of tubers per plant and of yield per plot (6.5 x 1.6 M). The quality characters of the tubers such as colour of the skin and flesh, shape, peeling losses, specific gravity and dry matter contents were recorded. Hybrids-70 and 10 were observed to be superior in tuber yield. Overall performance of all the six hydrid clones were significantly better than the check varieties with respect to majority of the desirable characters under Faisalabad conditions.

2.2. Tomato

2.2.1. Heterosis and combining ability in tomato

The experimental materials consisted of four tomato cultivars and their 12 reciprocal crosses. As regards the combining ability, Early-Pad is the best combiner and showed the best general combining ability. It is suggested that the variety may be used as one of the parents in tomato breeding programme.

In the case of specific combining ability (SCA), effects involving variety USSR-111 as one of the parent gave the highest values for most of the characters. It is worth mentioning that the varieties from different origins showed better performance in hybridization.

2.2.2. Growth regulators

The effect of growth regulating substances like cycocel and gibberellic acid wase observed on crops viz. tomato, peas, and okra. It was concluded that cycocel had growth retarding effects which induced resistance in the crop against heat, drought and frost, whereas gibberellic acid had growth promoting effect.

2.2.3. Fertilizer response of various tomato cultivars

Three levels of nitrogen viz. 67, 101 and 134 kg. perhectare alongwith a common dose of 67 kg of P2o5 were tested with tomato varieties namely Roma V.F., Money Maker and Lyallpur Selection 1. The different doses of fertilizers significantly enhanced the yield as compared to control. Out of these fertilizer treatments 101 Kg N + 67 kg. P2O5 per hactare showed significant effect on quality.

2.2.4. Raising of out of season vegetables

The summer vegetable i.e., cucumber, sweet pepper, egg plant and tomato were grown under plastic tunnels during winter, without artifical heating. The crops were sown during the month of October and were successfully harvested during January to March. Further studies are being made tostandardize the practices and to determine its cost for commercial cultivation.

2.3. Mushroom cultivation

Research on mushroom culture has also been initiated in this department. For this purpose two species of Pleusotus (Oyster mushroom) i.e.P. ostreatus and P. sajor caju were successfully cultivated on wheat agar. Initially two substrates i.e. paddy straw and cotton bole locules are being used for the cultural trials of oyster mushroom.

Areas around Paisalabad was also surveyed for the collection of wild mushroom during the rainy season. Various mushrooms such as *Agaricua bitooquis, Podaxix pistillaris,* Volvariella sp. and Amainta were collected for mushroom herbarium.

2.4. Garlic

2.4.1. Use of herbicides on garlic crop

Stomp and Fusilade herbicides were applied in different doses (0.75, and 1.5 litre per acre as pre-emergence and postemergence sprays against weeds in garlic crop. Both the herbicides appeared to be effective to control weeds without damaging the crops.

2.4.2. Studies on garlic raised from bulbs and aerial bulbils

The effect of underground and aerial cloves on the growth and yield behaviour of four garlic cultivars viz. Red garlic. Local garlic. White garlic and garlic were studied. It was found that all the four varieties under study behaved differently with regard to fresh Weight/bulb, weight/clove and bulb yield/plot, while plant height, fresh weight/plant and clove number/bulb were statistically similar in all cultivars. The highest bulb yield was given by Red garlic variety. The difference between bulb yield from underground cloves and aerial cloves was statistically nonsignificant.

2.4.3. Growth and yield responses of garlic (Allium sativum L.) to nitrogen fertilizer and clove size

Research studies on the effect of three clove sizes S,, 82 and 83 (mixed, small and large) and five N levels T,, *T^,* Ts, T4 And T5 (123.5, 98.8, 111.2, 135.9 and 148.2 kg/ha) on growth and yield of Garlic

(Allium sativum L.) were carried out in Experimental Vegetable Area, Department of Horticulture, .University of Agriculture, Faisalabad during 1999-2000. Results have been reported on sprouting percentage, mortality percentage, time taken to maturity, plant height, number of leaves per plant, bulb diameter, number of cloves per bulb, average bulb weight, yield per plot and yield per hectare.

1. Observations recorded on sprouting percentage indicated that clove size played important role in sprouting. Large seed clove size 83 showed maximum sprouting 96.10%, although N level and interaction of factors exhibited non significant results, table of mean values told that sprouting was increased with N level.
2. Mortality percentage was maximum in small cloves 82, followed by large 83 and mixed 8, i.e. 2.315, 1.74 and 1.605 respectively. Nitrogen level and interaction of factors did not show significant results.
3. Observations recorded on plant height indicated highly significant results for N level, seed clove size and interaction of factors. T5 (highest N level)- produced maximum height. As in interaction of factors, large seed clove size 83 in almost all combination showed maximum plant height, from this it can be concluded that N level had little effect on plant height.
4. In case of number of leaves per plant, results were non significant for seed clove size, N level as well as interaction of factors.
5. Large seed cloves 83 and controlled N level T, produced larger bulbs i.e. 4.142 and 4.818 cm in diameter.
6. In case of yield kg per plot results were same as for other parameters. Results were highly significant for seed clove size, significant for interaction of factors where as non significant for different N levels. Large seed clove size 83 in almost all combinations of N, show highest results which were statistically same. It means that seed clove size is main contributing factor in the yield of garlic. Increasing N level increased yield very slightly.
7. Results of N level, seed clove size and interaction of factors for Yield t/ha are same as for kg/plot because they were derived from per plot production.

2.5. Peas

2.5.1 Effect of different sowing times on the growth and yield of peas

Studies on the effect of different sowing times on different characteristics of some peas varieties revealed that, number of days taken to flower, weight of green pods per plant, number of green pods per plant, plant height and yield of green peas per acre were significantly affected by sowing time, while number of grains per pod, weight of green seeds per pod, pod length and number of branches per plant did not show any response.

The varietal difference was found to affect all the characters under consideration significantly except time required for germination However, number of branches and number of grains per pod were only two characters which did not show any significant difference.

2.6. CHILLI

2.6.2. Effect of plant spacings on growth and yield of chilli (Capsicum annuum) cultivars.

The present research project relates to the effect of plant spacing i.e. 20, 30, 40 and 60 cm on growth and yield of Chilli cultivars i.e. LS-465 and S-2000-33.

Data regarding the number of fruits per plant indicated highly significant results. The best position was obtained by plant spacing of 20cm which produced , 100.6 fruits/plant. It means that the number of fruits/plant are grater at the closest spacing as compared to the wider spacing. Data pertaining to fruit

weight showed non-significant results on the basis of spacing while on the basis of variety the results were significant as the fruit weights of S-2000-33 were greater than LS-465. Data regarding the fruit length indicated non-significant results Analysis of variance regarding the fruit length indicated that the results were non-significant as the length of fruit is not affected by the plant spacing but on the basis of variety the results were significant.

Data on yield kg/ha depicted highly significant results with reference to plant spacings but non-significant results for varieties. According to the table the highest yield kg/ha was obtained at 20cm followed by 30em, the second last position was attained by 40cm and 60cm stood last. It means that at closest spacing the yield kg/ha is greater than at wider spacing because at close spacing number of plants are more than at wider spacing.

2.6.2. *Response of hot pepper (Capsicum annuum L.) hybrid cultivars to irrigation systems under plastic tunnel for yield and storageability*

Between the drip and furrow irrigation systems used in plastic tunnel, drip irrigation system gave better results for growth and yield of the crop. Between the two cultivars Revival performed better comparing with Spicer under both the irrigation systems.

As for as storageability is concerned, hot pepper lost remarkable portion of weight, acidity and vitamin C content while gained dry matter during storage conditions. Use of polythene in storage checked weight loss and quality deterioration.

2. 7. ONION

2.7.*1. Growth and buld yield of onion (Allium cepa L.) as influenced by nursery raising dates, seedling age and planting geometry.*

Research project was envisaged to study the growth and bulb yield of onion *(Allium cepa L.)* as influenced by nursery raising dates, seedling age and planting geometry.

The results for total number of leaves per plant after 130 days were found highly significant. Data on the plant height 130 days after sowing (cm) turned out to be highly significant statistically. Data on diameter of the bulb per plant after 160 days (cm) depicted highly significant results.

Data on bolting percentage revealed highly significant results. Statistically maximum bolting percentages were recorded in nursery sowing date 9th September. Statistically minimum bolting percentage which is zero was obtained from sowing date 22nd October.

Data on total weight of small size onion bulbs per plot (kg) showed highly significant results. Statistically maximum weight of small size bulbs were obtained in nursery sowing date 22nd September. Minimum weight of small size bulbs were obtained in nursery sowing date 22nd October.

2.7.2. Assessment of onion cultivars under field conditions and comparison of their open pollinated and self ed progenies at the seedling stage

The present research project relates to the assessment of onion cultivars under field conditions, and comparison of their open-pollinated and selfed progenies at the seedling stage. The experiment was carried out in the Experimental Vegetable Area, Department of Horticulture, University of Agriculture, Faisalabad. Seven cultivars of onion (Desi Red, Red Imposta, PK 10321, Rubina, Phulkara, Faisal Red, Dark Red) were sown in a single field on flat beds. The salient features of the research work are summarized as under.

Length of leaves was recorded at bud formation stage at the onset of reproductive stage. Onion cultivar Dark Red appeared to have a considerably high potential for producing more length of leaves and even more number of leaves per plant as compared to other cultivars. The maximum number of buds was observed in Desi Red which showed its potential for high seed production.

At the stage of bud formation, all the above seven cultivars were selfed and crosses between them were made. Seeds produced by selfing and open pollination were used as an experimental material for studies at the seedling stage. The maximum weight of seed per umbel (g) and maximum weight of 100 seeds in self-pollinated umbels was obtained by Red Imposta while in case of open-pollinated umbels, maximum weight of seed/umbel was obtained by Faisal Red, and PK 10321 had the first position for weight of 100 seeds in open pollinated umbels. Number of seeds in one gram was highest in Rubina in selfed seeds and Desi Red in open-pollinated seeds. None of the cultivars appeared to have the best combination of characters however, the cultivar Desi Red seemed to have most of the desirable characters and hence proved to be the best cultivar.

After field work, the selfed and open-pollinated seeds were sown under lab. conditions to test its germination percentage and seed viability. The seeds were sown in plastic pots in sand culture at a temperature of 20 f 1 °C by applying nutrient solution (Johnson's solution). In case of seed germination, number of abnormal seedlings, seedling fresh weight and tetrazolium test percentage, Desi Red got the highest position in both selfed and open pollinated seeds. The tetrazolium test supported the resulted obtained from seed germination. The highest seed moisture contents in Desi Red favoured the cultivars to have more fresh weight. The maximum shoot and seedling length was observed in Red Imposta (self-pollinated seeds) and in Faisalabad Red (open-pollinated seeds), while in root length, Faisal Red performed the maximum in both selfed and open-pollinated seeds.

As far as the inbreeding depression is concerned, Faisal Red showed the maximum inbreeding depression for most of the characters like shoot length, seedling and number of abnormal seedlings.

In overall situation captured from all the experiments, it appeared that Desi Red proved itself as an excellent cultivar in both selfed and open-pollinated methods followed by Faisal Red which is also a better performing cultivar under Faisalabad conditions.

3. FLORICULTURE (ORNAMENTAL HORTICULTURE)

3.1. Induction of rooting in Bougain-villea

Hard and semi-hard wood cuttings of this ornamental vine were treated with five concentrations each of IBA, IAA during the spring and autumn seasons. It was observed that IAA at 200 ppm in the spring and NAA at 100 ppm in the autumn induced rooting in maximum number of cuttings.

3.2. Use of growth regulators on dahlia

Alar and cycocel were sprayed twice on Dahlia plants before flower emergence. It was observed that alar at 600 ppm and cycocel at 1250 ppm gave large-sized leaves and good shaped and large size flowers. Alar 600 ppm and cycocel 1500 ppm also increased the number and weight of tuberous roots. Flower initiation in these cases was 5-7 days ahead than the other treatments.

3.3. Vase life of carnation cut flowers

Carnation cut flower is a commercial enterprise. Extension in its vase life may further boost its export. Therefore it was tested in different chemical solutions. Silver nitrate at the rate of 500 ppm appeared the

most patent drug in prolonging the life of this precious flower.

In another experiment different concentrations of sucrose, glucose, sodium thiosulphate, silver nitrate and sodium benzoate were used for dipping of flowers to enhance vase life of the cut flowers. Sucrose applications appeared to be promising in increasing the life of the cut flowers upto 12 days.

3.4. Propagation of ornamental plants

A propagation trial under local conditions of F. elastica and F. nitida is under way. The softwood and semi-hard-wood single node cuttings were planted ii. au. tight polyethylene cages. Softwood-cuttings were apparently much better in sprouting than hardwood cuttings. Soft-wood and semi-hard-wood cuttings of different cultivars of Hybrid Tea rose are planted in air tight polyethylene cages for root initiation. Root formation is very significant in the cuttings of some cultivars in both types of wood.

Propagation through soft-wood and semi-hard-wood cuttings of Ponciana regia is being tried in air tight polyethylene bags. Success in semi-hard-wood cutting is apparent.

3.5. Preservation of scion wood of rose

A method was developed for the preservation of scion wood, which would allow budding to be done earlier in the year than it is possible at present. There were few significant differences in bud-take between stored and fresh buds. However, budwood stored at 6"C gave better bud take than wood stored at 4°C. Thus scion wood collected in the autumn, when it is often abundant, can be stored for a whole years (Table 7 and 8).

Table 7: Effect of packing material on survival of budwood during storage (percentage of buds sprouting)

Cultivar	Capillary polyethylene bag	Matting grease-proof paper	Newspaper polyethylene bag	Greaseproof paper	Means
Peace	100.0	3.7	100.0	100.0	98.4
Wendy cussons	80.1	87.5	87.5	87.5	85.6
Lir lancelot	100.0	100.0	100.0	100.0	100.0
Means	93.4	93.7	95.8	95.8	

Table 8: Effect of temperature on scion wood during storage (bud-take percentage)

Cultivars	Fresh bud wood	Bud wood stored at 0°C		Bud wood stored at 0°C	
		With thorns	Without thorns	With thorns	Without thorns
Peace	90.0	70.0	70.0	70.0	50.0
Wendy cussons	100.0	80.0	70.0	60.0	60.0
Lirlancelot	90.0	60.0	60.0	50.0	40.0
Means	93.0	70.0	66.7	53.3	50.0

3.6. Introduction of jojoba in Pakistan

In an effort to introduce a new plant in the country, preliminary efforts to test germination of Jojoba in different soil media is under way. Germination in sandy loam soil with 10 EC was promising than in other media. The new plant was testd .for its germination, transplanting success and performance in different types of 'soil. Seeds were also treated with NaCI in different concentrations to see the effect of salinity on seed germination. It was noted that higher concentraion of NaCI delayed germination of its seeds.

Germination was maximum in clay loam soil. A high transplanting success was observed which made the introduction of this new plant highly probable in this region.

3.7. Establishment of green spaces: Sumandari Road Faisalabad case study

Recent developments were highly appreciated by the people. There was general idea among respondents that the potential exists for appropriate development of green spaces based on community concerns and needs. They demanded facilities like lights, child play area, water tank, dust bin and security system in green spaces. All these facilities have their functional utility. There was a clear consensus among the respondents that effective and usable green spaces are valuable and scarce. They described several benefits associated with green spaces like increase beauty, control pollution and refreshment people. Despite the obvious advantages of green spaces, their establishment and maintenance has not always had smooth sailing. They have been expensive to establish and maintain. Businessman and industries felt that they had a strong case to establish the green spaces and got the benefit of their publicity. A central element of the future envisioned by respondents included the concept of sustainability. Respondent indicated that green spaces should develop by considering the impact on environment and social needs. The respondents felt that there is a need for concerted and coordinated effects to create new and enhance existing green spaces.

3.8. Effect of interior plantscaping on health and productivity of office workers

Survey results showed that on average an office worker spends eight hours a day and six days a week in the office. While studying the level of satisfaction with office environment majority of office workers had shown satisfaction with their office environment, however 72% workers reported different health problems related to office work.

From the survey results it was concluded that worker of different age, gender and organization considered plants as an important component of office environment. The workers (94.7%) agreed with this fact that plants improve the indoor environment of offices and in their opinion plants in offices also improve the concentration of office workers which leads to increase in working efficiency.

World wide studies results substantiate that indoor office environment had great impact on worker's health and productivity. From this study it can be concluded that there was unawareness among workers about their office environment however, they reported different ailments associated with working in indoor environment. As a whole they considered plants important in office environment and were very keen to improve their indoor office environment through interiorscaping, which ultimately reveals the positive attitude of workers for the better indoor office environment that lead to the better health and working capacity.

3.9. Effect of different levels of fertigation on growth and flowering of Rosa hybrida L. cvs Amalia and Anjieeq

Present research project was envisaged with a view to find out the effect of different levels of fertigation on growth and flowering *of Rosa hybrida L.* The study was carried out in the greenhouse. Rose Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, during the year 2004. Experiment was laid out according to completely randomized design with factorial arrangements having six treatments replicated thrice. Treatments were fertigated @ 250ml and 500ml at the interval of 2, 4 and 6 days to both varieties viz. Amalia and Anjieeq.

It can be concluded that fertigation @ 500ml at 2 days interval produced best results as compared to all other treatments. Whereas Anjieeq performed better as compared to Amalia.

3.10. Effect of nitrogen on growth, flower production and nitrogen contents in leaves of rose. Gruss an Teplitz (Surkha Variety)

Effect of different nitrogen doses was studied on Rose variety Gruss an Teplitz commonly known as Surkha. Urea was used as a source and nitrogen was applied at the rate ofO, 20, 30, 40 and 50g/p in two split doses. Data on the different growth parameters were recorded as number of leaves, leaf area, number of flowers/plant and flower yield and nitrogen contents in the leaves.

In the months of April, May and June maximum growth was observed and number of leaves increased significantly due to the favorable environmental conditions and application of nitrogen.

Analysis of variance on the area of leaves indicated significant increase in leaf area by the application of30g of nitrogen. Where as nitrogen at the rate ofOg/plant and 50g/plant gave the poor results and occupied the lowest position. Other treatments including 20 and 40g/plant showed the effect.

Maximum number of flowers per plant was obtained by 30g of nitrogen/plant where as control compared with other combinations gave the poor results. March and April proved to be best months in terms of number of flowers due to the suitable temperature and optimal nutritional availability.

The result of this experiment have shown that addition of nitrogen significantly increased the yield and it can be concluded that addition of 30g/plant of nitrogen per plant gave the better results. In the month of March and April yield increased significantly. 30g of nitrogen application per plant resulted in the maximum yield (52.58g).

Nitrogen taken by the plants is influenced by many factors, these include the nature of plant, its rooting system, amount and frequency of nitrogen application. The results of this experiment have shown that addition of 20g of nitrogen per plant significantly increased the nitrogen level in the leaves which showed the highest nitrogen contents in the leaves. Growth and yield is strongly influenced by nitrogen availability to the'plant. Nitrogen fertilizer can be used effectively to manage the growth of rose plant. Investigations carried out to study the impact of different nitrogen levels on the rose plant revealed that most beneficial results were obtained by the application of 30g of nitrogen per plant. Almost all the flowering characters were found to be enhanced by these levels of nutrients. At high levels of nitrogen application (40g, 50g) nitrogen contents in the leaves were less (2.083%, 2.069%). This shows the antagonistic effect of any factor, might be climatic or nutritional (availability of Potassium, "phosphorous). From the present investigation it is suggested that foliar N contents of 2.193% and 2.162% are optimum for good growth and production of quality flowers.

FACULTY OF AGRI. ECONOMICS & RURAL SOCIOLOGY

AGRICULTURAL ECONOMICS

1. AN ECONOMIC APPRAISAL OF FERTILIZER DISTRIBUTION SYSTEM IN PAKISTAN

A comparative study of the public and private sector activities in fertilizer distribution indicated that the latter was quite efficient in delivering the right quality and quantity of chemical fertilizers at the sale point nearest to the farmer. Transportation inefficiencies, problems of illegal mixing and below standard quality and quantity of bagged fertilizer disposal by the public agencies were noticed. The research recommended the strengthening of the fertilizer sale activities at the retail level and in the interior of rural sector by increasing the retail margins, and by attracting the private sector. A quality control check for fertilizer was also recommended.

2. EVALUATION OF LENDING POLICIES OF AGRICULTURAL DEVELOPMENT BANK OF PAKISTAN.

The study led to the following important conclusions:-

i) The number of leans was maximum for short term needs followed by long and medium term credit requirements while the loan volume was not in the same order i.e., largest for long term needs followed by the short and medium term credit needs.

ii) The time lag between the date of application and utilization of loans for tractor and implements was the maximum while it was the minimum for the seasonal loans. Documentation and delivery procedure caused major delays and hampered the smooth flow of credit to the farmers.

iii) Most of the sample farmers (68 percent) considered the rate of interest as 'too high.'

iv) More than 90 percent of the amount requested were sanctioned. Short term credit requirements requested, are almost being met.

v) Only borrowers for tractors and tubewells preferred to offer land as security but for bullocks and seasonal loans, personal security was preferred.

vi) Most of the loans were availed by farmers holding upto 12.5 acres of land.

vii) The repayment was maximum in case of loans for seed and fertilizer, followed by that for bullocks. Most of the outstanding loans were those for tractors and tubewells and generally from the large farmers.

viii) Agricultural Development Bank of Pakistan charged compound rate of intest plus the penalty rate of interest on the defaulted amount for the overdue period. In case of the recovery through Revenue Department, recovery charges were also added which was considered as a great burden by the farmers.

In order to improve the working of ADBP, following suggestions are made:-

A crop calendar must be prepared indicating the appropriate time to finance various agricultural operations for the major crops in the area. Crops have to be sown and harvested at a particular time. The

rhythm of nature cannot await completion of procedural formalities in an office or a Bank. Agricultural credit which is to be given, must be made available at the right time. Similarly its recovery must be made only at the appropriate time i.e. the time of harvesting.

Branches of Agri. Development Bank of Pakistan should be opened in villages instead of cities. Most of the commercial banks in the country are reluctant to advance credit particularly to the small farmers. They are simply interested in the mobilization of savings of the rich farmers.

An evaluation of the supervised agricultural credit programme of National Bank of Pakistan indicated that large farmers availed of 44 percent of the disbursed amount. Average loan was found to be of the order of Rs. 1812, Rs. 2561 and Rs. 4646 for small, medium and large farmers, whereas the per cropped acre credit availability was calculated to be Rs. 250, Rs. 119 and Rs. 139 for the above farm categories. Almost 100 percent respondents were satisfied with loaning and recovery procedures followed by the bank. The impact of this programme on farm productivity was found to be more significant on small and medium farmers than the large farms. However, the magnitude of the provision of technical know how was found to be insufficient.

3. STRATEGY FOR RURAL DEVELOPMENT IN PAKISTAN

An effort has been made to outline the flaws in the existing system of Integrated Rural Development. It is concluded that the present approach lacks soundness and realism for solving developmental problems. It is stressed that a micro-scopic approach with greater emphasis on the solution of local problems be adopted, instead of macro-scope view of the rural development programme which is more or less superficial.

The proposed strategy contains the following essential ingredients:-

i) It is proposed that decentralized regional planning may be adopted at tehsil level to solve the local problems of each area as well as to initiate local development programmes.

ii) Vocational training was recommended to improve the skills of rural labour force and to increase its productivity.

iii) The paper suggests that rural electrification is an essential pro-requisite for the initiation of rural industrialization.

iv) Since no programme of rural development can be successful without the participation of rural masses, it is recommended that the development of cooperatives may be encouraged as an engine of development.

4. INVOLVEMENT OF THE SMALL FARMERS AND LANDLESS IN DEVELOPMENT THROUGH RURAL SELF HELP ORGANIZATION

The objective of this research project was the promotion of the economic interest of the rural poor and education of their children through cooperatives. The pilot efforts at organizing the rural poor showed immense potential for replicability in other areas of Pakistan. The resource transfer in the form of Teddy Goat, generated a yearly minimum additional income of Rs. 300/-and maximum of Rs. one thousand per household. The cost benefit ratio for direct resource transfer came to around 1: 2.35. Rural poor Cooperative Society was a village level committee headed by "Kamin" (labourer and artisans) of rural Punjab to associate on equal ground with the village elite 'Chaudharis' (Landed class).

Saving and thrift programme was developing *its* roots. About twenty-five percent members of the said society inducted into petty trading and retailing to step up their meagre family incomes.

5. RURAL ELECTRIFICATION

Rural electrification is a part of the government package aimed at transferring resources to the rural poor and correction of the imbalance between urban and rural electrification. The study revealed that real economic benefits of rural electrification as a source of alternative energy to rural consumers are substantial. It has been estimated that the benefit of conversion to electricity as percentage of electricity bill varied between 164 and 807 percent in the case of small village level industrial units, between 75 and 691 percent in the case of irrigation tubewells and about 231 percent for rural households. Village electrification was found to have the greatest impact on economic activities in the rural areas. A comparative analysis of the data from the non-electrified and electrified villages clearly indicated that a crucial factors in their development was the facility of electricity and there was an urgent need for accelerating the pace of rural electrification.

6. POST HARVEST LOSSES AND STORAGE

A study of post Harvest Losses in Foodgrains, Storage and Preservation indicated that the losses in foodgrains are estimated around 12 percent in maize, 15 percent in wheat and about 17 percent in rice. As against the world average of 10 percent, the post harvest losses in Pakistan are estimated at 15 percent causing an annual loss of about 1.5, million tons. In Pakistan the alone, the loss of foodgrains can provide annual caloric requirements of about 11.6 million people. The stages of loss occurrence were identified as threshing and shelling, farm level, market level, public sector, terminal and consumer levels. Development of better storage designs was considered to be the best method for the reduction of post harvest losses. Projected storage space is thus expected to increase from 3 million tons to 7 million, tons. The estimated cost of additional storage space is Rs. 13.9 billions.

Systems analysis approach combining various components of loss occurrence may be adopted and multi-disciplinary approach may be used for evolving better solutions.

For loss reduction at critical junctures, improved storage designs may be developed and adopted both in the market and public sectors.

Small size multiple use threshers, based on local technology and local raw materials may be developed.

7. STRATEGY FOR INTEGRATED DAIRY DEVELOPMENT

The study included designing, developing, testing and dissemination of technologies of milk production, collection, procurement and manufacture of its by-products, (2) organizing the milk producers in order to create an effective receiving system for technical advisory services (3) testing the consumer tastes for different milk products in order that the developmental activities conform to the preferred milk products, and (4) developing an integrated dairy development programme so as to upgrade the income status of the rural poor.

As a result of the proposed development activities an increase in profit for dairy animals ranged from 35 to 40 percent, increase in net per farm household income for (a) landless farmers from Rs.580 to Rs.2320, (b) 5-acre farmers, from Rs.6,930 to 14,880, and (c) 12-acre farmers, from Rs.18,750 to 30,840 is envisaged over 5 years period.

8. LIVESTOCK PRODUCTION BY THE RURAL LANDLESS HOUSEHOLDS

The study was conducted on a sample of 90 livestock producers drawn randomly, from three villages, two with egalitration society structure and one with landlord dominated structure of Mona Reclamation Project

Area, Sargodha. In the sample, each situation had a share of 45 cases. The study dealt with producer profile, labour participation, enterprise mix, wet and dry status of animals, alternative measures of cost and returns, place of free fodder supply in cost of production of animals and technical coefficients of labour utilization by operations. The results of the study suggested that more emphasis should be given to breed selection, dissemination and adoption of livestock management knowledge both extensively and intensively veterinary cover and short-duration training for the producer. The study also pointed to the immediate need of credit facilities for the landless producers.

9. AN ECONOMIC STUDY OF THE FARMING BUSINESS OF THE SMALL FARMERS:

The study conducted in the Faisalabad Tehsil led to the following conclusions

(a) The land use intensity, cropping intensity and average yields per acre do not vary significantly on farms (small) with negative and positive farm income.

(b) The gross income on farms with positive- and negative net income did not vary significantly.

(c) The high cost on farms with negative income was due to higher fixed cost, attributable to greater number of family labour, under utilization of other resources like bullock power and other items of fixed cost.

(d) On farms in positive income group, the earnings from livestock sector were found to be higher when compared with negative income group.

(e) Absence of the farm employment opportunities and subsidiary industries was a hurdle in the way of utilization of surplus labour.

10. AN ECONOMIC EVALUATION OF GRADUATE GRANTEE SCHEME IN THE PUNJAB

The study showed that not only the grantees had carried out the stipulated objectives of the scheme successfully but also had created sufficient informational and adoptional impact with regard to better farming, housing sanitation and living etc. on the similar sized sampled surrounding farms. Greater impact of graduate grantees was found in the first zone while the friends and relatives had prevailed in the second zone. It may be pointed out that comparatively greater impact of the friends and relatives in the second zone was also due to the indirect impact of the graduate grantees.

11. AN ECONOMETRIC MODEL OF CROPPING PATTERNS IN THE PROVINCE OF PUNJAB

Major findings of the study are as follows:-

i. Total cropped acreage and double cropped acreages were found positively correlated with water and fertilizers.

ii. Fertilizer supply showed a positive acreage effect on food crops and negative effect on cash crops.

iii. The effect of credit supply on the acreage of food crops was negative and on the cash crops positive.

iv. Price effect on acreage was found to be statistically significant only in the case of rice crop.

v. There was a clear sign of competition among wheat and gram acreage.

12. A STUDY OF THE OVERTIME CHANGES IN THE PATTERN OF LAND HOLDINGS IN THE PUNJAB

The study examined the distribution patterns and disparities in agricultural holdings during the period

1960-72 in the Punjab. The study was based on data available from the first and the second Census of Agriculture i.e. 1960 and 1972. The magnitude of shift and consequent changes in the skewness of distribution of agricultural land overtime were determined by Lorenz Curves and Gini Coefficient.

The size distribution of farms showed some signs of change in the direction of an equitable distribution overitme. Total number of farms decreased, whereas the total farm area increased. Markovian Analysis revealed that the total number of farms would be reduced further in the future. Net reduction in the number of farms in 1984 since 1972 would be 230.18 thousands, while between 1984 and 1996 it would be of the order of 156.20 thousands. Number of small farms i.e. less than 7.50 acres would decrease, while farms over 7.5 acres would increase in future. More concentration of farms .would be in the size ranges of 7.50-12.50 acres and 12.50-25.0 acres.

13. AN ECONOMIC SURVEY AND ANALYSIS OF FACTORS AFFECTING FARM PRODUCTION AND INCOME IN SELECTED AREAS OF PUNJAB

The three type of tenure i.e. owner operators, owner-cum-tenants and tenants were studied. The findings of the study have been presented below in 2 sections. Section I:

1. As regards the overtime change in e size of holding it was 14 acres in 1965-66 as against 16.32 acres during 1971-72 due to buying more land.
2. With regard to the gross income, total expenditure and net income per cropped area, the percentage increase was found to be 16.96, 14.30 and 420.95 respectively on an average during the period 1965-66 to 1971-72.
3. Major source of income was from crops and gardens. The net income of owner operators and owner-cum-tenants from these crops increased to a great extent while it was low in case of tenants.
4. The positive shift in the trend of expenditure was recorded regarding the inputs such as labour, seed, fertilizer, artisans, land revenue water rates and other taxes. Section-11

Two major types of tenures i.e. owner operators and tenants were studied. The main conclusions of this analysis are enumerated hereunder:-

1. The land intensities were more on small holdings and tenants.
2. The gross income, total expenditure and net income per cropped area were Rs.380.48, Rs.369.54 and Rs.10.94 on the average respectively. These were more on small holdings than the big ones.
3. As regards the proportional costs, about half of the expenditure i.e. 42.47 percent was spent on livestock while least of it i.e., 0.97 percent was spent on fertilizer. The proportion of expenses on fertilizers increased with the increase of size of holding while reverse was the case with respect to labour expenses.
4. With regard to labour cost, when splitted up into 2 components i.e., family plus permanent hired labour and casual hired labour, depicted an increased share of casual hired labour with the growth of size of holding.

14. AN ECONOMETRIC STUDY FOR FORECASTING WHEAT PRODUCTION IN THE PUNJAB.

The major objective of this study was to explore the possibility of developing an econometric model to explain and predict changes in total wheat production in the Punjab Province.

Results of the analysis showed that wheat acreage under high yielding varieties and local varieties was

an important variable in determining the total wheat production.

Other variables which influenced the total wheat production during the time period of the analysis in descending order of importance included fertilizer off-take. Rainfall (July to January in inches), Rainfall (April to June in inches) and Temperature maximum (in March).

The results of this study indicated that the increased use of both the nitrogenous and the phosphatic-fertilizer was significantly influenced by the time during which its use increased due to various reasons, probably because of improvements fertilizers, farmer's experience and awareness about the profitability of the use of fertilizers etc.

The decline in the relative prices of nitrogenous fertilizers have also been important in explaining its increased use over the period of study.

Agricultural credit did not explain the increased use of fertilizers whereas acreage under major crops positively influenced the increased consumption of fertilizers.

15. BENCHMARK STUDY OF CHASHMA RIGHT BANK CANAL PROJECT

A base line socio-economic survey of Chashma Right Bank Canal Project in the Taunsa Tehsil was undertaken. The project area manifested an economic structure which entailed a plurality of socio-economic backwardness at the rural level. Agriculture which, in fact, is the mainstay of the economy was found characterized by safe routine and traditional prospective, a lack of stimulus and apathy towards development and change.

Evidently the overall net income from all farm enterprises per cultivated acre was found to be abysmally low i.e.(Rs (~) 139.10 for the project area as a whole. Non institutional credit was the main source and 94.87 percent of the credit obtained was studied to be outstanding at the end of the year. Market structures and facilities were also quite inadequate and the area depicted very limited improved technology absorption capacity.

16. DETERMINATION OF CROP RESPONSE TO FERTILIZER APPLICATION

The other important area of research covered during this period is the determination of fertilizer crop response and optimum levels of fertilization for various crops in the Punjab. This study dealt with the estimation and application of fertilizer crop response functions and was based on a large number of controlled fertilizer experiments conducted on five major crops in the irrigated areas of the Punjab.

The Major objective of this research study has been the derivation of fertilizer crop response functions and the determination of optimum levels of the input and the output relating to a range of input-output prices.

The production function analysis estimated the following balanced fertilizer optimum doses for wheat, rice, maize, cotton and sugarcane at the current prices of per maund of per maund of output and per nutrient pound of input.

	Nutrient lbs./acre		
N	P	K	
Wheat	177	117	30
Rice	184	119	40
Maize	215	50	40
Cotton	184	164	30

Sugarcane	470	219	40

More and more research in the country is suggested to be based on production function concepts and models, since economic guides or fertilizer use, at this stage are imperative for national allocation of limited resources and development of progressive and profitable agriculture.

17. ENERGY USE IN AGRICULTURE

A study on economic comparison of mechanized and traditional sugarcane farming in a selected area in the Punjab has shown that per hectare input utilization on mechanized farms was different both in quantity and constitution that resulted in significantly higher gross and net returns as against bullock farms. The presence of the tractor as a main source of power contributed positively to gross as well as net returns. The mechanization process was quite speedy in terms of tractorization but the 'adoption of improved implements like disc plough, chisel plough, sub soiler, ridger and rotavator was very slow.

In another study on Model Building for small tractor farming showed that the current available farm power was 0.3KW per hectare as against the optimum requirement of 0.8 KW per hectare. The average net revenue per hectare was found to be Rs.3478.71 on small tractor farms as compared to RB. 2937.77 and Rs. 1485.09 on large tractor and bullocks farms, respectively. An econometric analysis of the data revealed that a small tractor of 26 KW could optimally control a farm holding of 40 hectares and a small capacity tractor of 15 KW could economically command 10 hectares. The study emphasized the need for popularizing the use of small tractors alongwith introduction of models of matching farming equipment.

Energy and energy sources have attained an extremely undeniable importance since the energy crises of 1973 and 1979. In view of its equally important role in agriculture, a study on rural energy consumption in agriculture and household sectors was 'conducted in the Punjab. It was found that of the total energy consumption in agriculture, the contribution of different sources of energy, i.e., animal, manpower, chemical and commercial was 33.0, 19.2, 20.9 and 27.7 per cent, respectively. Animal energy was found to be underutilized to the extent of 69 percent. The share of animal sources of energy declined with an increase in farm size. Underutilization of animal energy was mainly due to peak and slack demand periods. The study indicated the need for research concerning the organizational and management aspects of the farm sector.

ECONOMICS OF LIVESTOCK PRODUCTION AND MANAGEMENT: A JOINT VENTURE OF AGRICULTURAL SOCIAL SCIENCES RESEARCH CENTER AND AGRI. ECONOMICS.

This book consists of six chapters. The first chapter is devoted to the role of livestock industry in the economy of Pakistan. The second chapter deals with the theoretical concepts and their application to the livestock sector. The third chapter entails the cost of production of livestock products i.e. milk and meat and their profitability. Farm business analysis is another important aspect covered herein. It includes information pertaining to farm records, net worth statement and efficiency measures with special emphasis on livestock enterprises. Another chapter deals with the farm budgeting and planning. Finally, it covers the important aspect of project appraisal.

FARM INCOME ANALYSIS OF RICE PRODUCTION IN THE RICE BASED FARMING SYSTEM: A JOINT VENTURE OF AGRICULTURAL SOCIAL SCIENCES RESEARCH CENTER AND AGRI. ECONOMICS.

The study was carried out in the rice zone of Punjab Province. Due to resource constraint, one district was taken for detailed investigation. A cluster of four villages was selected from this district. After a thorough preliminary survey a sample of 102 respondents comprising different farm size groups i.e., small, medium, large, was finally drawn. The results are summarized as follows. The intensity of cropping

was found to be high in the sampled cases.

Rice crop ranked to be high valued crop which occupied more area as compared to other crops of different seasons. Most of the respondents realized that the crucial factor affecting aroma and fineness of rice was found to be parietal characteristics as compared to sowing and harvesting time.The magnitude of recommended practices was found to be high on majority of the farms.As regards rice varieties, Kashmir a (rice variety) proved to be the best target with minimum variable cost and maximum gross margin.

21. Role of Women in Agriculture: Rural women constitute the invisible work force which keeps the family and the rural economy alive, but they and their labor often go under rewarded. Pakistani women play a major role in agriculture production, livestock rearing and cottage industries. The major objective of study was to measure the extent of participation of rural women in farm operations and determine the factors affecting the farm income and wheat Productivity. The results showed that female spent more working hours on all farm, off-farm activities and on livestock care and management.

Small, medium and large farmers got their major share of income from livestock i.e. 52.03, 78.09 and 38.85 percent respectively. Milk selling had a big contribution in income of small, medium and large farmers i.e. 54.90, 54.89 and 54.90 percent, respectively. Multiple Linear Regression Model (MLRM) was used to analyze the data. The results showed that the cropped area, income from livestock, seed quantity, fertilizer quantity, and female working hours were contributing significantly for household farm Income and wheat yield, respectively.

The study was conducted to see the impact of negative externalities of water infrastructure: waterloggging and salinity on wheat productivity in tehsi; Kot Addu, District Muzaffargarh of Punjab.

Land degradation has recently become a global and urgent issue and is now being considered with high priority, especially in the developing counties, to meet food and fiber demands of accelerated population pressure with the limited available resources. Land degradation due to water logging and subsequent salinization has been so enlarged that it is now being regarded as a global environmental problem. Water logging and salinity have very adverse social and economic effects on communities in Pakistan, causing poor living standard in affected areas, health problems for humans and animals, crumbling of mud and brick houses and difficulty in transport. study the effects of water logging and salinity on wheat productivity.

To compare the gross margins at Saline and non-saline farms. Taking all the factors of production into utilization, it was observed that the revenue obtained from Non-saline/ Non-waterlogged land was higher than that obtained from saline/ waterlogged.

Revenue obtained from saline/waterlogged land was Rs. 10440 and that obtained from non-saline/non-waterlogged was Rs. 13500/Acre

There was high contrast in the gross margins between saline/waterlogged and non-saline/non-waterlogged lands. Saline lands had an average gross margin, Rs. 3462.62 while that of non saline, it was Rs. 6522.50

22. FORECASTS OF WHEAT AREA, YIELD AND PRODUCTION

Forecasts of wheat area showed a continuous increasing trend upto 2022. For 1997-98 forecasts of wheat area was about 8264.8 thousand hectare with lower and upper limits 7809.84 and 8719.7 thousand hectares, respectively. Wheat area forecast for the year 2022 was 10431.6 thousand hectares with lower and upper limits of 8329.03 and 12534.1 thousand hectares, respectively.

Forecasts of wheat yield also showed a continuous increasing trend upto 2022. For 1997-98, forecasts of wheat yield was about 2080.78 kg/hectare with lower an supper limits of 1860.34 and 2301.22 kg/hectare, respectively. Wheat area forecast for the year 2022 was 2834.48 kg/hectare with lower and upper limits of 1516.84 and 4152.11 kg/hectare, respectively.

Forecasts of wheat production also showed a continuous increasing trend upto 2022. For 1997-98, forecasts of wheat production is 1754.8 thousand tones with lower and upper limits of 16037.8 and 1907.8 thousand tones, respectively. Wheat production forecast for the year 2022 came about 26336.3 with lower and upper limits of 18324.3 and 34348.8 thousands tones, respectively.

The future consumption of wheat was estimated upto the year 2022 using lower and upper limits i.e., 125 kg and 150 kg per head per year respectively. According to the use of 125 kg/capita/annum, the requirement of wheat in 2022 would be 24.10 million tones, while net available for consumption will be about 23.71 million tones leaving a gap of 0.39 million tones. According to the use of 150 kg/capita/annum, the requirement of wheat in 2022 would be 28.91 million tones while net available for consumption will be about 23.17 million tones leaving a gap of 5.20 million tones. The study has pointed out that strong agricultural, fiscal and monetary policy packages are urgently required to meet the situation arising in the future.

23. A STUDY AND ANALYSIS OF PRICE PATTERNS OF ONION IN PAKISTAN

The study was undertaken to explain the patterns which the onion prices ahs followed over a period of sixteen years i.e. from 1981-96 in Pakistan with Karachi, Islamabad, Lahore and Peshawar markets as focal points. The objectives of the study were the estimation of historic onion price trend, price behaviour of onion over time and investigation of cyclical and seasonal price variations. The analysis of onion price fluctuation over a period of sixteen years was split into three components. Long term price trend, seasonal price fluctuations and cyclical price fluctuations. Long term price trend for all the markets included in the study was found to be positive which means prices increased with the passage of time. Positive trend in the prices was due to increase in population, incomes and prevalence of general inflation in the economy during the period of study. Onion price displayed a cyclical behaviour with each market having (three to five) district cycles completed during sixteen years. Variations in the duration of the cycles within each market was due to irregular fluctuations i.e. other than trend seasonal or cyclical. The average duration of onion price cycle was 3.1 years. Cyclical variations were primary due to farmers response to prices.

Onion prices in all he markets showed seasonal fluctuations. The price fluctuations were caused by dwindling crop size, prevalence of general inflation in the economy during the period, lack of harmony between the export and support prices and the level of production, lack of market information, under developed infrastructure, inadequate storage facilities and increasing population. It is suggested that the import of onion seed should be restricted to the approved varieties and public sector should be encouraged to undertake onion seed production and also provide assistance to private sector for seed production. The government of Pakistan should launch a programme for the adoption of autumn crop of onion among the farmers of Baluchistan and Sindh. Introduction of cheap techniques of preservation and storage of commodity will not only reduce spoilage but would also add to price stability which will improve healthy competition in the market.

24. AN ESTIMATION OF OVERTIME CHANGES IN SIZE, DISTRIBUTION AND OWNERSHIP PATTERN OF AGRICULTURAL HOLDINGS IN THE PROVINCE OF PUNJAB

In overwhelmingly agricultural economies like Pakistan agrarian structure with special reference to size distribution and ownership pattern of land, represent crucial indicators and principal forms of wealth and

political power. A highly skewed distribution of basic resource of land does not only affect the economic well being of the rural communities but also their social and political status in the society. The present study represents an attempt at reviewing the overtime changes in size distribution and ownership of agricultural holdings in Punjab in the inter-census periods of 1960, 1972, 1980 and 1990. Measurements made in terms of Gini-coefficients and Lorenz ratio are full of policy implications for effecting improvements in the agrarian structure of Punjab economy.

25. PAST TRENDS AND FUTURE PROSPECTS OF RICE PRODUCTION IN PAKISTAN

Forecasts of rice export in 1999-2000 was about 1863 thousands tons with lower and upper limits of 1244 and 2481 thousands tons, respectively. Rice export forecasts for the year 2025 were 1934 thousands tons with lower and upper limits of zero and 4272 thousands tons, respectively. Forecasts of rice exports show fluctuations in trends.

Forecasts of rice area showed an increasing trend up to 2010 and then constant trend up 2025. For 1999-2000 forecasts of rice area was about 2402 thousand hectares with lower and upper limits of 2206 and 2598 thousands hectares, respectively. Rice area forecasts for the year 2025 was 2409 thousands hectares with lower and upper limits of 1560 and 3258 thousands hectares, respectively.

Forecasts of rice production also showed a continuous increasing trend up to 2025. For 1999-2000, forecasts of rice production were about 4999 thousand tons with lower and upper limits of 4508 and 5490 thousands tons, respectively. Rice production forecast for the year 2025 came about 12105 with lower and upper limits of 459 and 23751 thousands tons, respectively.

In order to enhance production and export of rice in the short run, the study suggested that the recommended varieties of rice should be sown, recommended seed rate, balanced use of fertilizer and herbicides be applied. In the long run private sector should encourage for installation seed processing plant to produce quality seed. Agricultural credit be provided from one window for seed, fertilizer, pesticides and herbicides. Installation of Tubewells in sweet water area should be increased. Fine varieties of rice should be produced. At processing stage mixing of different varieties should be avoided. Great emphasis should be given on quality as well as grading of rice. New buyers in the International Market be explore.

26. STUDY OF HEDGING AS A POTENTIAL ALTERNATE TO SUPPORT PRICING IN THE WHEAT MARKET OF PAKISTAN

The more specific objectives of the study are to measure the price volatility and risk management needs of the sector, assess the effectiveness of hedging as a price risk management tool and calculate optimal hedging ratio.

The government of Pakistan has successfully managed price fluctuations in the domestic market. However, the policy has not completely eradicated the risk from the market but has transferred the risk from wheat market participants to the government in the form of unstable subsidy payments. This system leaves farmers and millers with no incentive to undertake risk management on their own behalf. Overall, the government has assumed to highest price risk. International prices of wheat exhibited substantial amount of variations, U.S. dollar price of wheat at US Gulf port and rupees price at Karachi have coefficients of variation of 17.9 percent and 32.4 percent respectively. As the current system of risk management has been found inefficient for managing price risk, so a better system needs to be adopted. Hedging is considered the best available risk management tool for the sector.

All price series are converted to their first differenced forms to let them to be stationary. A high degree of correlation is found between the wheat futures contract price on the Minneapolis Grain Exchange and

U.S. dollar FOB price of Western White Wheat quoted at U.S. Gulf port (R^2 value .856 and basis risk value .144). Futures contract price of the Kansas City Board of Trade futures contract and the U.S. dollar FOB price of Hard Red Winter Wheat quoted at Pacific Worthwest port has an R^2 value of 75.6 percent and basis risk of 24.4 percent. These results indicate that the Minneapolis Grain Exchange wheat futures contract would be a more effective hedging instrument for Pakistan's wheat imports than Kansas City Board of Trade wheat futures contract. Assuming risk minimization, hedging the U.S. dollar FOB wheat price at U.S. Gulf port using the Minneapolis Grain Exchange yields a hedge ratio of 0.92.

The results from simulating hedging strategies show that all of three instruments (i.e. futures contract, call options, and swaps) can effectively reduce the price risk and variability of import costs for the sector. However, "Swaps" can be more attractive than futures contracts and call options because they are easier to implement and financial intermediaries are available to facilitate the transactions. Although, hedging involves risks and costs, but not hedging may be riskier and costlier.

27. ECONOMIC EVALUATION OF DOMESTIC SUPPORT (AGRI. RESEARCH) UNDER WTO: A CASE STUDY OF PUNJAB PROVINCE

The focus of the present study is on benefit cost ratio (BCR) of the research expenditure and forecasting of the research expenditures and benefits for the next twelve years. The result indicate that the coefficient of research expenditures is positive (.094) and statistically significant at around eight percent probability level. The partial regression coefficient the share of research expenditure in Agri. GDP was calculated that turns out to be .03 percent. The benefit cost ratio for the research is 18.172.

From the above discussions it is emphasized that the research expenditure should be increase and it should remain continue for the future.

28. ECONOMY OF ENERGY USE ON SMALL FARMS IN THE COTTON ZONE OF PUNJAB, PAKISTAN

Energy is a foundation store of the modern economy. Energy provides an essential ingredient for almost all human activities with no exception to agriculture. Modern agri. requires energy input at all stages of agri. products such as direct use of enrgy in farm machinery, water management, cultivation, harvest pest and indirect energy inputs used in agri. (fertilizers, insecticides, weedicides, etc.)

The study was conducted in the cotton zone of Punjab province accounting for 85% of the total cotton production in Pakistan. The study was aimed at the examination of production pattern, energy use rates/patterns and their impact on crop yield on small farms in the selected zone. The respondents were clustered into thr5ee groups on the basis of their energy intensiveness and productivity.

The results revealed that during the Rabi season, 37% of the cropped area was covered by wheat followed by maize and sugarcane occupying 22 and 18% of the rabi cropped area. Similarly, during the kharif season, cotton, maize and sugarcane respectively occupied 25, 22 and 19 percent of the kharif area.

Farm clusters based on energy intensiveness revealed major differences in kharif cropping pattern. Cotton occupied 42% of the kharif cropped area on the most energy intensive cluster critrary to only 10% area under cotton on the least energy intensive cluster where potato crop occupied 45% area. Among the size based categories, small farmers were found as the most energy intensive followed by very small and moderately small farms. The comparison of crop yields revealed that there were no significant yield differences attributable to energy intensiveness implying that there was possibly over application of energy inputs on the energy intensive farms.

29. ENERGY OUTPUT RELATIONSHIP: A CASE STUDY OF COTTON AND WHEAT

The study was carried out in the randomly selected four villages of Multan District. The study was aimed at the examination of energy use pattern among different farm categories and estimation of energy output relationship.

Energy consumption pattern differed widely among various sizes groups. Small farmers derived more energy from the animate sources contrary the large farmers using more of commercial energy. The share of chemical energy did not vary to great extent, as it is divisible and neutral to farm size. Keeping in view the positive response of output to energy use rates, it was suggested that efforts should be made to raise the energy use rate. In this regard, timely availability of chemical energy should be ensured and needy farmers be provided financial assistance.

30. IMPACT ASSESSMENT OF MICRO CREDIT PROGRAMME OF PRSP ON CROP PRODUCTIVITY WITH SPECIAL REFERENCE TO DISTRICT FAISALABAD.

The purpose of the study was to assess the impact of micro credit scheme of PRSP on crop productivity of wheat and sugarcane crops. The study was conducted in two selected field units Satiana and Salarwala of district Faisalabad. The summary of the main findings of the study are as under:

1. Average share of wheat and sugarcane on marginal farms before taking credit were 3.28 and 0.32 acres while on small farms the area under same crop was 6.17 and 1.21 acres respectively. After taking micro credit the average area under wheat and sugarcane on marginal farms were 3.50 and 0.25 acres while on small farms the area under same crops was 6.47 and 1.10 acres respectively.
2. In the study area before taking micro credit crop + livestock was the dominating combination with 50 percent and 68.18 percent of all the enterprise combinations on marginal and small farms respectively. After taking credit the the share of dominating combination increased to 58.69 and 79.54 percent for marginal and small farmers respectively.
3. Before taking credit from PRSP, average gross income of marginal and small farmers was Rs. 15410 and 26501 respectively while after taking credit average gross income of the same categories of the farmers increased to Rs. 19301 and 31676 respectively.
4. The average production of wheat before taking credit on marginal and small farms was 23.5 and 24.1 maunds per acre respectively. After availing micro credit average wheat production on these farms increased to 24.7 and 25.6 maunds per acre on respective farm categories.
5. Average production of sugarcane on marginal farms before taking credit was 612.7 maunds and and after availing credit it was 608.3 maunds per acre. On small farms average production of sugarcane before taking credit was 615.20 maunds and after taking credit it was 610.40 mds per acre. This decrease in yield of sugarcane in both the categories of farms was due to shortage of water.
6. It was observed that before taking credit most of the respondents belonged to very poor and poor categories. About 11 percent of the respondents were well to do, 14 percent were better off and 27 percent were poor, while 32 percent respondents were very poor and 16 percent respondents were destitute. After availing micro credit from PRSP the number of well to do and better off respondents increased by 13 and 7 percent respectively. Whereas the number of poor, very poor and destitute decreased by 3, 12 and 5 percent respectively.

32. COMPARATIVE ADVANTAGE OF COTTON PRODUCTION AND ITS POLICY IMPLICATIONS IN PAKISTAN

With the advent of free trade or trade liberalization by the year 2005, Pakistan may face the problem of competitiveness in its international trade. The study aims at to assess the comparative advantage of cotton production and its policy implications. The Domestic Resource Cost (DRC), Nominal Protection Coefficient (NPC) and Effective Protection Coefficient (EPC) were used to estimate comparative advantage of the crop for the harvesting year 1998-99 to 2002-2003. These measures were estimated tint he context of policy Analysis Matrix (PAM).

Analysis of the data showed that during the study period value of Domestic Resource Cost (DRC) ranged between 0.26 and 0.41 and the value of Effective Protection Coefficient (EPC) ranged from 0.33 to 0.59 which depicted that seed cotton produced in Punjab was taxed. For Sindh, the value of Coefficients of Domestic Resource Cost (DRC) ranged between 0.24 and 0.28 and the value of Nominal Protection Coefficient (NPC) varied from 0.45 to 0.65 and value of Effective Protection Coefficient (EPC) ranged 0.34 to 0.60.

The analysis showed that taxing of seed cotton discouraged the cultivation of the crop. It reflects that there is strong comparative advantage in the production of seed cotton.

The study concluded that the Government intervention in agricultural commodities markets against the spirit of trade liberalization and must be replaced by creating regulated private marketing system and at the same time commodity market needs to be reformed and efficiency of input delivery system be improved. Furthermore Pakistan should invest heavily in storage, packaging, grading and procurement and delivery system technologies for an effective entry to the export marketing.

33. COMPARATIVE ADVANTAGE AND COMPETITIVENESS OF MAJOR AGRICULTURAL CROPS IN INDUS BASIN.

The world economic scenario is set for change under free trade regime, increasing competition and relative competitiveness of different countries. A significant change in economic policies of Pakistan has profound implications for national economy. The study of comparative advantage is of major importance to know the extent and potential for comparative advantage and competitiveness of agricultural commodities. This is also important to identify the priorities for resource allocation among competing crops.

This study was aimed at analyzing the changing agricultural comparative advantage over time and its implications for trade development. The extent of policy distortion and agricultural protection was also determined by the study. Four major crops i.e. wheat, rice, cotton and sugarcane were analyzed by taking the data of two main provinces for three harvesting years i.e. 2000-01 to 2002-03. The data were analyzed to smooth out variations over time. Initially crop budgets were considered to analyze the crop performance, in financial terms. Later on the import and export parity estimates were obtained to evaluate comparative advantage, in economic prices. The Policy Analysis Matrix (PAM) was developed for four major crops that nearly consume 90 percent of the domestic resources and have high economic importance. The static analysis showed that Pakistan has comparative advantage at export parity prices for cotton and rice. The wheat and sugarcane have comparative advantage but at import parity prices. They have no comparative advantage at export parity prices. The DRC is fairly high for wheat and sugarcane.

The analysis was further subjected to Risk analysis. The price of commodities and price of DAP and Potash were taken as risk variables to evaluate comparative advantage and competitiveness of crops in the changing scenario. The risk analysis showed that rice and cotton in Pakistan have comparative advantage at export parity prices. Both maintained comparative edge even under price risk situation in wake of trade liberalization and export trade regimes in the next five years. The wheat and sugarcane showed a significant comparative advantage as import substitution crops but showed marginal

competitiveness in the price risk situation in the next five years, at national level.

The analysis showed that Pakistan has to maintain competitive edge in rice and cotton through quality produce and value addition. The productivity of wheat and sugarcane should be enhanced along with reduction in cost of production. The subsidy on urea (given on gas) and irrigation water should be reviewed. Sugarcane is highly water consumptives crop. Its area may be reduced and the production loss thus created can be covered through manifold increase in yield.

34. IMPACT OF SMALL SCALE IRRIGATION SCHEMES ON POVERTY ALLEVIATION IN MARGINAL AREAS OF PUNJAB, PAKISTAN.

The study was conducted to assess the impact of small scale irrigation schemes on agricultural production and poverty in marginal areas of Punjab, Pakistan. Nine tehsils of the Pathowar Plateau were selected as study area. Data were collected for the period 2002-03 and analysis was carried out with the help of various econometric techniques. Descriptive statistics with mean values for different socioeconomic characteristics were taken for various tehsils of the study area. The poverty estimates were 38 percent, 34 percent and 278 percent in the rural areas of districts of Attock, Rawalpindi and Chakwal, respectively while overall poverty in the area was 33 percent. The poverty head counts were found 26 percent, 26 and 37 percent in irrigated, irrigated plus rainfed and rainfed categories of the farmers, respectively. Socioeconomic characteristics of the poor and non-poor households were also estimated. Poor were found deprived with their access to basic necessities of life as compared to the non poor households. Agricultural income shared major portion of annual income of the poor households while income from business was found major source of annual income of the non poor households. Similarly, expenditure on food was higher for poor than non poor. Agricultural productivity and profitability was lower in the poor farm households as compared with the non poor households. In both, rainfed and irrigated agriculture, poor households had less cropped area, crop yield per hectare, and gross margin than that of the non poor. However, cost of production was found higher in poor households than non poor households. The water productivity was found 1.53 kg/M^3. , 2.47 kg/M^3 , 0.72 kg/M^3 , 1.90 kg/M^3 and 0.87 kg/M^3 for wheat, maize rabi, gram, groundnut and maize kharif, respectively. Water value was found Rs. 13.42/M^3, Rs. 18.60/M^3 , Rs. 12.24 /M^3, Rs. 10.38/M^3 , Rs. 4.77/M^3 , Rs. 19.82 /M^3, Rs. 12.71/M^3, Rs. 6.81/M^3 , Rs. 9.96 /M^3, Rs. 8.37/M^3 and Rs. 4.02/M^3 for wheat, maize rabi, gram, vegetable rabi, fodder rabi, groundnut, maize kharif, sorghum, millets, vegetable kharif and fodder kharif, respectively. The proper technical design, subsidies on pumping unit and water source development are some of the crucial factors need to be addressed for the sustainable development of irrigation schemes. Family size was positively correlated with poverty while farm size, education above matriculation and irrigation water was negatively associated with poverty. In rain fed agriculture, seed and fertilizers were found significantly affecting crop productivity where as land preparation and pesticide had positive effect on crop productively in the Pothowar Plateau, Punjab Pakistan. However in the irrigated cultivation, improved seed, fertilizers, irrigation water and the use of pesticides were found with significant affects to crop productivity. The access to irrigation through small scale irrigation schemes must be encouraged to increase crop production in order to alleviate poverty in the Pothowar Plateau. The land consolidation would improve the economies of scale for the installation of irrigation schemes and would also improve the agricultural productive potential of the Pothowar area. Interventions in population planning and education sectors were suggested to overcome the issue of poverty.

35. AGRICULTURAL GROWTH, RURAL POVERTY AND INCOME INEQUALITY IN PAKISTAN. A TIME SERIES ANALYSIS.

Rural poverty is a complex and multi-dimensional phenomenon. It has many faces changing from place to place and across time, and was illustrated in many ways; either relative or absolute poverty; transient and chronic poverty. The issues of rural poverty and income inequality are difficult to comprehend without thorough examination of several interrelated aspects of changes in the agriculture sector. The recent

analyses of large international and interregional data sets showed that the structure of the agricultural growth was a major factor in explaining the bulk of rural poverty reduction. The study in hand was undertaken to frame universally acceptable threshold of poverty, to find out trend analysis of rural poverty and income inequality by employing axiomatic approach, to assess the impact of various factors on poverty status of a household in Pakistan, to develop Poverty Equivalent Growth Rate (PEGR) for analyzing the trickle down impact of agricultural growth to the rural poor and to forecast the co-integrated trends of agricultural growth, rural poverty and income inequality. The national and international poverty lines (in absolute terms) were estimated for Pakistan by employing nontraditional techniques. The relative poverty lines based on the distribution of 100 percent, 75 percent and 50 percent of the monthly per capita income and expenditure were also estimated for the years 1990 through 2001. The estimation is quite useful to determine trends in income inequality in the country and provinces. Moreover, the population was decomposed into chronic and transient poor as against the non-poor. The clusters of population very close to the poverty lines were significantly increased from 31.53 percent to 40.88 percent. Thus such a high proportion of the population close to the poverty line calls for policy intervention because a very little effort on the part of the government institutions can check the vulnerability of the transient poor and pulling them of the poverty trap on the other hand.

In the axiomatic framework, five poverty indices were estimated incorporating both the national and international poverty lines so as to pick the most appropriate measure for further analysis and international poverty lines so as to pick the most appropriate measure for further analysis and policy implications. By developing an axiomatic framework, positive and normative inequality measures were estimated. The results revealed that income inequality is not stable showing wide variation during year 1990 through 2001. All measures of income inequality decreased in the year 1990-91 to 1992-93 and then increased continuously up to the year 2001. Most of the measures provide ambiguous result in the real change of income inequality in the country. The Atkinson-Gini Index only provides the actual trend of inequality in rural Pakistan unambiguously.

The regression model encompassing the impact of agricultural growth on rural poverty reflects that one percent increase in average household income reduces poverty (HCR) by 0.25 percent at national level. The other regression model encompassing the impact of income inequality on rural poverty showed that the coefficient of elasticity is less than one. Pakistan's rural scenario shows that one percent increase in the income inequality, poverty increase by 0.24 percent. The final regression model depicting the interrelationship among agricultural growth, rural poverty and income inequality suggests that one percent increase in income inequality and average income in rural areas of Pakistan leads to an increase and decrease poverty at the rate of about 0.31 and 0.27 percent respectively. It indicates that the impact of inequality in increasing poverty is a somewhat greater than that of growth in average income in reducing rural poverty. These results vary at the provincial level.

Pakistan's poverty an inequality statistics were studied for the first time in terms of pro-poor growth scenarios. The short term Poverty Equivalent Growth Rate (PEGR) reveals that agricultural growth is anti-poor in Pakistan and in all provinces from 1990-91 to 1992-93 and in the subsequent years (from 1992-93 to 1998-99), showed pro-poor growth in rural Pakistan. In this way, the short run PEGR analysis reveals that pro-poor growth scenario is improving in rural Pakistan. If the growth remains pro-poor in the subsequent years as reflected in the year 2000-01, there is likelihood that growth trickles down to the poor in more than the non-poor.

Logit regression provides the probability of occurrence of low and high extent of poverty in rural areas of Pakistan. The findings revealed that there was great likelihood of low incidence (below 20 percent) of rural poverty with the increase in land use intensity, cropping intensity, agricultural growth, education and number of wage earners in a family. On the other hand, with the rise in family size, inflation, rural population, income inequality and unemployment, there is high probability of occurrence of rural poverty in the country. The results of impulse response analysis, which provides a picture of future scenario,

indicate that one standard error shock to agricultural growth have negative impact on rural poverty in the subsequent 10 year period. Similarly, on standard error shock in income inequality causes rural poverty to rise up to next 10 years. Finally, the impulse response of poverty revealed that a 10 percent increase in poverty would reduce the agricultural income by 2 percent and this may continue in the next 10 years. The findings suggest that the government should focus on poverty equivalent growth rate in agriculture rather than the actual growth rates. In order to improve PEGR, the poverty alleviation policy must be in tandem with rational income distribution. There is a need to target public sector development expenditures to particular regions because of having high incidence of poverty. Thus checking vulnerability would offer wide option for the policy makers to settle the issue of the severity of poverty in the future.

36. RURAL POVERTY ALLEVIATION THROUGH THE EMPOWERMENT OF SMALL FARMERS IN PUNJAB

Pakistan's population, estimated around 149 million, is growing at the rate of 2.1 per cent per year. Nearly 67.5 per cent of country's population is living in rural areas. In Pakistan, poverty has been higher in rural areas (38.65 percent) than urban areas i.e. 22.44 percent. Poverty has many faces, such as hunger, lack of shelter etc. Technically poverty is "the inability to retain a minimal standard of living, measured in terms of basic consumption needs or some income required for satisfying them (World Bank, 2003). Most often, poverty is a situation from which people want to escape.

In Pakistan more than 45 percent people generate their income from agriculture sector and 86 percent of them are small farmers. Small farmer is operating less than 12.5 acres of irrigated land or less than 25 acres of un-irrigated 1 and (Agricultural Census, 2000). Thus, there is a dire need to raise agricultural productivity; as previously productivity is the most efficient means of alleviating poverty and protecting the environment.

The objectives of the study were to study current poverty profile, the factors responsible for small farmer's poverty to identify various indigenous knowledge based options and combination of farm enterprises to empower the small farmers. In all 300 small farmers, 100 from each district i.e. Faisalabad. Jhang and T.T. Singh were selected. In order to derive the net income of the small farmers, farm budgets for crops and livestock were estimated. The allocative efficiency of the critical inputs and comparative advantage of the major crops were estimated. The Liner Programming Technique was used to estimate optimal allocation of resources for maximizing the farm income.

The survey results revealed that the small farmers had 149 percent, 148 percent and 159 percent cropping intensities in the three districts Faisalabad, Jhang and T.T. Singh respectively. However, wheat in all the districts was occupying the major portion of the cropped area. The allocative efficiency depicted misallocation of the critical inputs. The production elasticities of seed, water and fertilizer showed the scarcity of these inputs. The Policy Analysis Matrix (PAM) for rice at the export parity prices demonstrated clear cut comparative advantage of raising this crop. Sugarcane had comparative advantage in Faisalabad division on import prices and can be grown as an import substitution crop. The PAM for cotton showed comparative advantage in Faisalabad division and can very well compete in the International market. The DRC ratio for wheat indicated that crop had comparative advantage on import parity prices in Faisalabad division.

Poverty estimation through different techniques showed that corresponding poverty gap a cross districts was 65 percent, 53 percent, and 57 percent in Faisalabad, Jhang and T.T. Singh. The low farm productivity, bigger family size, high dependency ratio, low education of the head and lack of infrastructure were the major determinants of poverty for small farmers. In order to enhance the productivity and income of the small farmers, In all 32 LP models with different scenarios were developed. The productivity enhancement was simulated through the optimal allocation of labor, irrigation water,

fertilizer (Nitrogen (N) and Phosphorus (P), concentrate in case of livestock and addition of high value crops like hybrid tomato and cut flower. All scenarios showed increase in farm income to a large extent and thus help reduce the poverty of small farmers. The optimization models indicated that the small farmers should exploit the intensive margins of N.P and water through rational use to increase small farmers income. On the basis of farmers indigenous knowledge and perceptions, it was concluded that adulteration free and timely supply of phosphoric fertilizer, enhancement of irrigational water and off farm employment were the pre-requisite for the reduction of poverty of small farmers.

37. ECONOMICS OF CROP INSURANCE

The study was designed to determine an effective premium and indemnity structure for a viable crop insurance programme for four major crops. It was based both on primary and secondary data. Primary data from 400 farmer respondent were collected regarding the critical stages of growth, crop stand, natural hazards to which crops were generally exposed and their impact on crop yield was also ascertained. A three stage stratified random sampling technique was used to select tehsil, village and farm households. Secondary data on crop yields was collected from the publications of various public sector agencies. Different measures of dispersion were employed to see the extent of overtime instability in crop yield. To determine the premium rate of loss cost. "Normal Curve Technique" was employed. Further, insurance cover and indemnity payable for a total loss and partial losses was estimated. Finally, simple averages of the information recorded regarding farmers demand for insurance were calculated. The results are summarized as below.

WHEAT

The study showed that the variation in yield may be due to any natural, physical or social hazards. The loss percentage due to natural and agronomic factors was greater than other social and management factors. The highest percentage loss was observed at the first stages of wheat crop growth cycle followed by maturity and harvesting stage of the crop.

The premium rates were determined at various insurance coverage levels. The study revealed that premium increases with the increase in insurance cover. For example, the premium increased from 1.63% to 7.66% of the insured sum at 60% and 90% of the average yield (21.19 md/acre) respectively. The, calculated premium come to be Rs.17.10 per acre at 60% coverage level and it increased to Rs. 120.47 at 90% 'coverage. It was also observed that the premium rates were higher at the small farms level as compared to medium and large farm holders.

Crop insurance gained positive response. However, payment of higher rates of premium was disliked by the farmers, especially the small framers

RICE (PADDY)

The method employed to estimate the average annual Basmati (Paddy) yield losses due to different hazards represented simple averaging of the three years data. The results showed that amongst the natural hazards, Rice blast and other epidemic diseases, drought, insect and floods contributed significantly towards crop losses making up 35.36%, 25.18%, 18.29% and 11.82% of the total loss respectively of the natural hazards. The loss contributed by the agronomic factors was found to be in the form of mortality due to late transplantation and weeds infestation which make up 49.14% and 30.35% of the total agronomic losses respectively.

The major objective of the study was to determine a viable loss cost or premium rate for the paddy. The results were computed at different coverage levels. At 75% coverage, a rate of Rs. 55.74 per acre to be the effective premium rate. It was about 4.30% of the cover. The premium rate for small farmers was

found to be higher (Rs. 60.29) as against medium and large farmers (Rs. 50.49 and Rs. 45.64). This was due to high yield variability incase of small farmers. The study revealed that 95.5% of the respondents were willing to go in for a crop" insurance programme .As many as 89% of the respondents also showed their willingness to pay premium. About 51% were ready to pay premium between 3-5% of the insured sum.

COTTON

Much of the yield variability was recorded from the mean of the time series data obtained from the relevant government offices. In the years 1978-79 and 1983-84, it showed higher negative growth trend but in the late 1980s, it showed positive growth trend. The low yield in 1983-84 was due to natural hazards like insect attack, floods and rains.

Over the last about three years, insect attack has significantly contributed to yield losses. In 1987-88 shattering of flowers due to high temperature was also observed. Rain had adversely affected some of the growers and contributed about 20 percent towards crop losses.

The third stage (flowering stage) was much affected and made up about 64 percent of the total loss. The losses at the second and first stags were 24% and 10% respectively. At the final stage, the loss was about 2% and was also reported to be insignificant by farmers.

The estimated premium rates were higher in case of small farmers as compared to medium and large farmers. For instance, at 75% coverage level, the computed premium rates for small, medium and large farmers were Rs. 110.26. 74.07 and 70.5 per acre respectively.

The indemnity payable at each stage depends upon cost coefficient (i.e. 31%. 55%, 83% and 100%) calculated from the total cost. Similarly, in case of partial losses of long term average yield, the insurance cover and indemnity were also calculated. Most of the farmers, especially large farmers, had normally sown their crop in the first fortnight of June.

SUGARCANE

The results indicated that there was a considerable degree of variability in the production of sugarcane which highlighted the fact that a considerable elements of risk and uncertainty was involved in the production of this important cash crop.

The study revealed that the main perils to which sugarcane crop was exposed included drought 27.9%, insect 21.24%, rodents 17.69%, lodging 12.8%, diseases 10.44%, weeds 4.47%, high temperature 4.05% and wind 0.97%. However, small farmers were exposed to greater losses mainly due to their limited resources. Moreover, farmers experienced 8.18%, 55.52% and 36.29% loss at germination stage, vegetative growth stage and ripening stage respectively. Greater losses at vegetative stage were due to high degree of susceptibility of crop to drought, insect and diseases at this stage.

Estimated premium rates were 1.23, 2.33, 3.13, 4.14 and 6.81% of the total value of the crop at 60, 70, 75, 80 and 90% coverage level respectively. Further, at 75% coverage level, it was 3.99% of the insured sum which seemed to be reasonable coverage and premium percentage. Moreover premium rates were higher for small farmers as compared with medium and large farmers.

Insurance cover and indemnity payable were separately computed for a total loss and partial losses. However, to reach the actual indemnity payable, 10% of the maximum indemnity payable was deducted as non identifiable amount.

Finally, it was observed that there were some basic difficulties which needed to be resolved before the commencement of a crop insurance scheme. Specifically, these included scarcity of reliable data, varied agricultural practices, moral hazards, lack of awareness and under standing of the insurance, farmers inability to pay premium, problems of trained personnel and inadequate infrastructural facilities. It is thus suggested that in order to make the scheme viable, a considerable spade work should be needed before the actual commencement of scheme.

SUGGESTIONS FOR CROP INSURANCE IN PAKISTAN

Following is the summary of some broad suggestions for the introduction of a viable crop insurance programme in Pakistan.

i. A pre-operation phase could be devoted to the collection of information and pertinent data on the actuarial aspects of the scheme. Information would be needed on farm practices, cost of production, yield and frequency of crop damage. This would facilitate compilation of actuarial tables to establish fair premium and indemnity rates.

ii. The crop insurance should at least in its initial stage, be limited to protection against the uncertainties of yield

iii. In the beginning it should apply to a few major crops and later, others might be brought in as experience is gained.

iv. The insurance programme should at first be limited to some selected areas which might later be extended, should experiences prove favorable. It would also offer a way to train personnel who would ultimately implement a more widespread scheme.

v. Agricultural insurance depends on widespread participation of a large proportion of farmers. A voluntary scheme is not likely to attract this participation. A feasible compromise between compulsory and voluntary programme might be possible, which offers basic insurance to the farmers on compulsory basis, with option of a voluntary level of insurance coverage.

vi. It should at least initially ask for a limited contribution from farmers, which means that the cost of administration and operations and even the losses need to be borne by the government and the farmers should be paid full insurance amount as indemnity.

vii. Coverage and premium rates should generally be determined by homogenous area and special emphasis should be placed on the development of the principle of maturity and experience rating within given administrative areas. It would be disadvantageous to determine premium rates and coverages on an individual farm basis.

viii. Adequate incentives should be given to farmers for keeping losses as low as possible.

ix. The benefits of agricultural insurance should be publicized to create a psychological climate conducive to implementing the programme. A strong conviction among farmers as to its value is especially important where influential sectors in a village may oppose the scheme.

13. IMPLEMENTING AGENCY

It should be administered either directly by the Government, preferably the Department of Agriculture or by some autonomous government institution working within the central government (ADBP) and in collaboration with the provincial and local government.

14. RESERVES

It is important to build up substantial reserves from the beginning as there might be the risk of a large

scale failure even at the very start.

15. SOWING TIME

Late sowing adversely affects the- crop yield, so the scheme should be implemented with a compulsory condition of sowing of crops within the recommended time period.

In keeping with these suggestions, indemnity coverage should always be expressed as a proportion of the average yield over a number of years. However, in practice, 70 or 75 percent coverage is needed to handle at least the financial costs of production and provide a minimal income to tide the farmers over to the next harvest. Any lower indemnity coverage tends to drive the farmer back to high interest lenders and thus defeats the basic objectives of crop insurance.

DEVELOPMENT ECONOMICS

1. COOPERATIVES DIIEMMA

The study was conducted in Sargodha division with the following objectives in view:

1. To investigate factors resulting in the failure of the farm credit cooperatives.
2. To explore conditions under which the farm credit cooperatives would not have failed. The criterion of sample selection was to select only those cooperatives which were demoted/promoted to form 'D' class in a specific year. A normal year of 1966-67 was selected for this purpose.

It has been concluded in this study that neither the sample farm credit cooperatives did become viable even after having existed for a period of 9 to 49 years, nor did they create any significant impact on the economy on the member-farmers. The leadership, management committees and membership did not develop and function of democratic lines. Cooperatives remained under the influence of a single person or a family while the rest of the cooperators performed mostly acclamatory and ratifying roles.

The sample farm credit cooperatives suffered badly on account of the prevalent concept among the cooperators. The cooperatives continued to be considered as a government lending institution. Self – help could not therefore, be adopted as a principle and the requisite volume of owned capital could not be expected to be built up. The deposits and share capital were not coming forward. Borrowed funds were blocked among defaulters of a primary cooperative who in 50 per cent of 'C' class cooperatives did not exceed three members. The secondary credit cooperatives had, therefore, ceased to extend any loan facilities to the primary cooperatives.

The educational aspect was totally neglected and the members did not even know that they could offer themselves for election to any office or that they could remove any office bearer through elections. Support form secondary credit cooperatives during the period of five year i.e. 1964-69.

The farm credit cooperatives are likely to succeed if the following recommendations, are carried through.

a) Minimum physical conditions for agricultural production must be given/created, the most critical being the supply of irrigation water.

b) A cooperative cannot develop in isolation. There must exist reasonable means of communication, particularly metalled roads which connect the primary farm credit cooperative with secondary credit cooperative, agricultural market in the area and the cooperative extension agencies.

c) Farm credit cooperatives should be run by properly oriented functionaries or local managers elected through general meeting.

d) The secondary credit cooperatives should function as Central Banks for the primary credit cooperatives. They should also appoint their own staff in order to ask, evaluate and recommend the loan application of the members cooperatives, supervise the loan use and affect the loan recoveries.

e) The first level extension workers should be basically graduates in agriculture with training in cooperative science.

2. CONCEPT AND MECHANICS OF SUPERVISED CREDIT (memo)

This study was conducted in order to develop as to how supervised credit should be applied to make the

small and medium farmers credit worthy and better living. For this purpose 30 small peasant proprietors with holdings ranging between 6-6 1/2 acres were randomly selected from a village in Lyallpur (Faisalabad) Tehsil.

A wide gap was found between the recommended fertilizer doses for different crops and applied by the sample farmers. Plant production measures were not at all adopted by the sample farmers. It was calculated that by using optimum doses of seed, fertilizer and insecticides, the net income per farm would increase by Rs. 6139.00 and per capita by 767.38.

Farmers' attitude towards acceptance of supervised credit was also determined. Farmers accepted most of the terms and conditions of supervised credit with a few disagreements. To a Supervised credit Programme the points of disagreement are more important than the points of agreement.

Following are given the points of disagreement.

a. 67 per cent of the sample farmers were not prepared to pay for technical extension service.

b. Penalty rate of interest was not acceptable to 50 percent of the respondents.

c. In respect of joint use of tractor and joint marketing 1/3rd of the sample farmers did not agree.

d. 30 per cent of the sample farmers were not in favour of borrowing entirely from a supervised credit agency.

For the execution of supervised credit programme, a legal contract between the farmers and the agency was recommended. The technical staff of the supervised credit agency should consist of agronomist, soil scientist, entomologist, extension and agricultural marketing experts.

3. AGRICULTURAL DEVELOPMENT AND RURAL MIGRATION IN SARGODHA REGION

A study on agricultural development and rural migration in Sargodha region led to the following conclusions;

a) It was found that a major proportion of our rural migrants left for cities in search of job opportunities and better incomes.

b) The majority of rural–urban migrants married young adults falling in the age bracket of 15 – 16 years.

c) Greater proportion of rural migrants belonged to the unskilled labour class, in as much as, proper training facilities were not available for the education of labour force in our rural areas.

d) Majority of rural migrants belonged to non-agricultural classes who migrated mainly because of economic reasons.

e) The motivating agencies assisting the migrants to seek jobs were mainly informal personal sources comprising of relatives, friends, co-villagers etc., whereas, mass media and employment exchanges in the shape of inducement agents were found to be quite ineffective, as only 2.35 per cent of the migrants claimed to have been induced by these sources.

f) The rural migrants faced serious problems of residential accommodation immediately after migration. The problems arose from un-healthy, inadequate and dirty atmosphere of the factory where they remained together in factory house. Moreover, the availability of rented accommodation was either difficult or involved very high rents.

g) Intra-rural migrants comprised of mainly landless workers who did not have residential facilities of their own and migrated primarily due to social reasons like, the displeasure of village landlords and factions in the village and also to join their relatives in the nearby villages.

h) The rural labour force was characterized by great seasonality of employment having both slack and peak seasons for agricultural and non- agricultural labour. When measured by man-hour criteria, there was found large scale disguised unemployment of labour estimated around 58.6 percent.

i) The study verified the old thesis that there existed considerable under employment in Pakistan which was estimated around 70 percent on the basis of income criteria.

j) The distribution of rural labour force was such that two thirds of the total comprised of agricultural labour and one-third non- agriculture labour force.

k) The backward areas of Sargodha region had lower yield per acre, lower cropping intensity and low land use intensity as compared to the progressive areas.

l) The basic infra-structural facilities and the state of knowledge about modern agriculture was considerably lacking in the backward areas of the region. Moreover, smaller absolute quantities of marketable surplus did not facilitate the development of large agricultural produce markets in those areas.

4. MODERN TECHNOLOGICAL PACKAGES AND CREDIT NEEDS OF THE FARMERS.

A study on modern technological package and credit needs of the farmers were conducted in IRDP MARKAZ, Rajana in Faisalabad District. A survey of adoption of improved agricultural practices was made and the farms were classified into progressive and conventional groups. Then 33 per cent of peasant proprietors i.e. 110 in all, were picked at random. The results of the study are summarized as under:-

a) The production costs on all progressive groups were much higher than those of conventional. This showed a better and higher use level of modern inputs by the progressive farmers and hence higher costs on such farms.

b) The progressive farmers were getting about two and a half times more net income from an acre as compared with the conventional category.

c) Credit requirements of progressive farmers in each size of holding were 21/4 to 3 times more as compared to conventional ones at the existing input use level.

d) The per acre credit needs for biochemical technology were arrived at Rs. 187.54 for small, 115.21 for medium and 81.53 for large progressive while these figures stood at Rs. 36.00, 35.81 and 25.55 for respective categories of conventional farmers. The cost of adoption of improved technology was worked out to be Rs.206.00, 199.00, 193.00 per acre at the respective farm sizes.

e) As regards the mechanical technology, the credit requirements at the existing level of input use were calculated at RS. 37.78, 32.68 and 26.02 for progressive farmers as compared with Rs. 17.98, 22.11 and 3.78 per acre of conventional ones. The amount needed for the adoption of improved technology was Rs. 41.00, 130.00 and in case of small, medium and large size of holdings.

f) The small progressive required an amount of Rs. 188.00 and conventional Rs. 83.00 for sustaining the existing level of inputs and for supporting technology an amount of Rs.278.00 was needed by the conventional to touch the level of progressive ones.

On medium farms, an amount of Rs. 145.00 and 48.00 was estimated as the credit needs respectively of progressive and conventional categories and the cost of adoption was estimated at Rs. 197.00 per acre. In case of large holdings the figures stood at Rs. 28.00 and 25.00 for progressive and conventional ones. The amount required for pushing the conventional farmers to the level of progressive ones was worked out at Rs. 48.00 per acre.

The progressive farmers needed much less funds to attain the recommended level of input use as compared with the conventional ones. This was due to the fact that the conventional farmers were at a very low ladder of adoption process.

5. PRICE FIXATION BY COOPERATIVE ASSOCIATIONS --AN ECONOMIC FALLACY

A study on price fixation by cooperatives was conducted with a view to analyze the monopoly control and price fixation.

The objective of this study was to analyze the monopoly and price-fixation objective of Spiro's Plan operational feasibility.

Theoretical results showed that in this type of market, the cooperative associations attempt to maintain the price above the competitive equilibrium level, in general benefits, the non-cooperating producers instead of members who have to bear the cost of holding this price umbrella. Such a plan of action would be economically beneficial to the members if the following relationship holds.

$(1+Ed)\ Mn/Md\ (1+E_n)^{\%}$

*) Ed = Price elasticity of demand for commodity N.
E_n = Price elasticity of non-members' supply.
M_n/Md = Non-members' share of the total market.

The coefficients of the price elasticity of supply as well as of demand were available in case of wheat and cotton only. By inserting the values of these coefficients into formula it was found that to successfully maintain the price of cotton and wheat above the competitive equilibrium level, 62 per cent of the total supply of cotton and 50 per cent of wheat had to be under the control of the marketing cooperative.

The Sapiro Plan had emphasized on control over production, the high price of various commodities will result in the accumulation of surpluses.

In an imperfect market high degree of buyers concentration vide differences in bargaining exist, a cooperative representing a substantial portion of the producers is in a position to exert market influence to the benefit of its producer-members; it cannot, however, fix the price. The price and other terms of trade, under such structural setting, are determined through negotiations. Spiro failed to appreciate this fact.

Price–fixation should no longer be considered as the modus operandi of cooperative undertaking. Improved pricing within the frame-work of existing commercial arrangements in consonance with the established market functionaries, instead should be the goal of producers cooperative associations.

6. COOPERATIVES DYNAMICS

A study on cooperatives dynamics suggested that the success and dynamism of a cooperative association is to be judged from its effectiveness as an organization, functioning as a society and impact on the member-farmer's economy. A form credit cooperative must have (i) adequate working capital, (ii) a minimum of internal resources in the farm of share capital and deposits, (iii) a reasonable volume of turn-over (iv) a definite percentage of repayment (v) effective link with the secondary credit cooperatives, and (vi) some reserves to off-set unexpected losses, in order to be termed as a successful organization. Such a cooperative should also exhibit certain annual growth in its resources, commensurate with the growth requirements in the member farmer's economy. Only then it shall be characterized as a dynamic organization.

The working capital should grow by at least 12 to 15 per cent, either out of the savings or outside

borrowing in order to provide the needed investment capital to the member farmers and at the same time to realize a growth rate of four to five per cent, in the members economy. The growth in the working capital of sampled cooperative was found to be 4.1 per cent retrospectively. They cannot therefore adopt, a dynamic character.

Member education has been found to be a crucial essence in ensuring the successful working of a cooperative. The emphasis should be on the meetings of the management committee and more on meetings of the general membership. Member-education should be imparted to at least 50 per cent of the membership and 100 percent to the loanees. This shall constitute a sufficient and necessary condition for the successful functioning of a cooperative association. With the passage of time it is likely to adopt a dynamic character.

It is equally important that a cooperative group should elect a person as their leader who stands more close to them in respect of socio-economic status and knowledge. The leadership should be assisted by a qualified and properly remunerated ring of extension workers.

7. INVOLVEMENT OF THE RURAL POOR IN DEVELOPMENT THROUGH RURAL PEOPLES ORGANIZATIONS IN PAKISTAN.

A project on the involvement of the rural poor in development through rural peoples organizations in Pakistan was completed with the help of F.A.O. of the united Nations in order to develop an organization of the rural poor with the following objectives.

a. To promote income generating opportunities for the rural poor.

b. To educate and motivate the members to come closer on the basis of thrift, cooperation and self help.

c. To facilitate and promote Teddy Goat production and marketing in particular and other livestock in general.

d. To advance interest free loan to needy members on easy repayment conditions.

e. To promote and encourage education and recreational activities for school going children of the members. The study brought out the following conclusions:

    i. Without a real and substantial resource transfer, the organizing of the rural poor will remain empty and meaningless. However, a resource transfer, must be a development resource transfer which leads to either direct output expansion or helps develop and expand the productive capacity of the rural poor.

    ii. In order that an organization of the rural poor should be able to participate in a development programme, it must receive a preferential treatment for business, trade, and associated credit opportunities. Otherwise the development of the rural poor through an organization will remain just a dream.

    iii. Initial organizational efforts and requirements must conform to the social norms of the village society and must receive the confidence and acceptance of the village elite. This can be done only by identifying development programmes for the provision of basic needs for the village as a whole and initiation of development efforts in regard to organizing the rural poor within the context of total development programme.

    iv. It was found that the more readily accepted entry point was through the provision of effective veterinary care and mother-child health facilities. Infrastructure for these is either absent or minimal. Due to the tenurial changes in the wake of two land reforms coupled with the technological improvements in agricultural production process, the

dependence of small farmers and rural landless on livestock has further increased.

8. STRUCTURAL PRE-REQUISITES FOR THE FUNCTIONING OF WATER USERS ASSOCIATIONS UNDER COOPERATIVE LAW

a. To identify the social attributes of the water users associations in terms of their general membership and form of leadership.

b. To differentiate between water users associations in terms of the characteristics studied under No.1 above.

c. To correlate the different attributes of each water users association with the quality of water management decisions taken at the farm level.

The study spelt out the following specific findings:

i. The perspective within which farmers perceive water users association as useful is quite limited. They acknowledge that they have been helped in improving their watercourse and thus the water losses have been mitigated to a considerable extent, has facilitated through the association.

ii. As far as the benefits of watercourse improvement are concerned, again they understand very well that water delivery to their fields has become very efficient. They, however, fail to make any assessment with regard to its impact on crop production. They have not thus for looked into the possibilities of changing their cropping intensity or crop rotation etc.

iii. Watercourses renovation implied several things like removal of trees, weeds and grass, straightening of the routes, redesigning its shape, installation of pucca nakkas. Hence these as sources of water losses have become insignificant. Nevertheless, rat holes are causing greatest loss, even much more than what it was perceived before improvement.

iv. On one of the watercourses it was found that cleaning and maintenance behaviour has not been improved. The association did not provide any level measures in this regard. Once the benefits of improvement have been clearly visualized by the farmers, maintenance and cleaning should have been of great concern.

v. Illegal options to augment water supply by farmers (both at individual and collective level) are still in vogue. Although frequency or extent of their occurrence could not be determined, yet, thefts, exchange of warabandi timings, selling and purchasing of water, damaging of check structures were admitted to have happened during the post improvement period.

vi. Water users associations have not so far shown any concern about matters relating to illegal water control options and farmers interaction with officials.

vii. Concentration of power/influence is positively related to the efficiency in watercourse decision making provided those at the top have scored very high. On two of the watercourses at least one those scoring highest had not obtained more than sixty per cent of the highest potential score. On the third watercourse these influentials have not adequately mobilized collective efforts. They had the average highest score, but were also pointed out as trouble makers, who had their vested interests.

9. MAINTENANCE OF IMPROVED WATERCOURSES THROUGH WATER USERS ASSOCIATIONS

The water users association is the best suited local institution for reconstructing, renovating and maintaining the watercourse yet it stops working after performing the single objective of watercourse improvement and the vital aspect of maintenance remains unattended. How these associations will continue to function for the maintenance as well as achieve their ultimate objective in water management is the main concern of this study conducted in the University Water management Project Area.

Findings / Suggestions

1. The re-construction/renovation of the watercourse is not the sufficient condition for organizing and successful functioning of water users associations because they will cease to exist after achieving the sole objective of watercourse improvement. The farmers will have no genuine reason to remain united in the form of a water users association. It is, therefore, imperative that water user associations should have other economic activities to do so that the members retain interest in their association.

   These activities should be of continuing nature to justify the need of an organization. In this regard it is recommended that all the water users associations should provide farm inputs on credit and initiate the activities allied to agriculture like weed control, pesticide application etc. making these associations multipurpose. They may also undertake other activities like that of mother-child health care programme and Industrial Homes at some later stage.

2. In order to achieve the objectives as suggested above it is important that water users associations should be affiliated with a department which is in a position to fulfill the financial requirements of these associations. Presently, the water users associations are supposed to be organized by and registered with the Water Management Department of the respective provinces. It has been observed in the field that the Water Users Associations so organized stopped working just after the renovation of the watercourse. The quality of the maintenance was also poor. This was because of the fact that the water users associations have nothing to do after the watercourse improvement. On the other hand, the Water Management Department has no provision for the credit facilities to be provided to these associations. The Department of Cooperative Societies does not own them as they are not registered with it. It is recommended that the water users associations should be organized by the Water Management Department and the Watercourse reconstruction should be carried out under the supervision of its staff but these may be registered with the provided to other cooperative associations. This arrangement, it is hoped, will give a perpetual succession to the water users associations. The provision of farm inputs on credit will act as an incentive for the watercourse maintenance.

3. It was concluded that where there was strong participation of members in decision-making the watercourse cleaning programme was more effective as compared to the situation where the decisions were made by a few members. Participation may be enhanced by making the water users had got the right to elect the management committee of his own choice and be elected himself.

4. Permanent watchman is essential in order to undertake routine repairs/cleaning. The payment to him may be made either by the individual members in kind/cash after every crop which is burdensome or from the collective fund generated out of the business done by the association which is desirable.

5. A programme for extension education in water management, which is presently a missing link, is urgently needed. Water Users Association provides an effective platform for disseminating knowledge and newly developed water management technologies, ensuring thereby the optimum water application efficiency at the farm. Other problems relating to agriculture can also be brought before the experts for obtaining advice and guidance, The farmers, then will get together in their individual interests. Those in the key positions can capture this opportunity to discuss and decide the collective matters. The activities of Water Users Associations thus streamlined will make it functionally more

effective.

6. The other development activities like Mother-child Health Care and industrial Homes were of course the long felt needs of the peasantry but relationship of these development activities to that of successful functioning of Water Users Association as provision of farm inputs and other activities allied to agriculture is secondary.

10. PATTERNS OF RURAL SAVINGS IN SELECTED VILLAGES OF FAISALABAD DISTRICT

The study was undertaken to know the extent of savings among different rural household categories. The effect of occupations on level of savings was found very significant and profound. In Case of farming alone, small, medium and large farmers were all negative savers. They were saving -10.0, -10.0 and -21.0 percent of the total gross savings. In case of farming plus other occupations, they were all positive savers. The rate of saving on three farm categories was calculated to be 29.6, 11.3 and 21.6 percent respectively. The non farmers were saving more as compared to other occupational categories. The rate of saving in this case was 30.1 percent. It may be concluded on the basis of above results that farming alone is the least saving category. To raise the level of saving in rural sector, opportunities must be generated to create off farm employments, in which rural people may engage themselves gainfully.

11. COOPERATIVE /CORPORATE FARMING --VISION 2015

According to Agricultural census 1990, there are 5.1 million farms in the country and 93% of these are small farms (upto 10 hectares), accounting for 60% of total cultivated area. The large farms are only 7 percent of the total farms but account for 40 percent of total cultivated area. Further, these farms have fragmented holdings.

There has been further sub-division by way of inheritance and transfer. The land reforms introduced in 1964 and 1977 have brought about still further fragmentation. Since land in agriculture production process is natural agent, therefore fragmentation of land and decreasing size of holding have detrimental effects on land ownership, investment on farms, farm productivity, farm incomes, agricultural decision making and land market. Pooling of land for modernization of agriculture is many times suggested in cooperative farming system. It is often argued that cooperative farming has been undertaken by a number of countries in the world with greater success and especially for the joint use of machinery in the agricultural sector. In an agricultural structure where numerous farm holdings are small and uneconomic, the solution lies in the pooling of fragmented small pieces in blocks under democratic management in a cooperative association.

A number of experiments have been carried out in the world. All these experiments vary in their essential character. In some countries cooperative farms have taken the forms of collectives where as in other countries, it is restricted to the joint user of farm inputs. Theoretically, there are four possibilities of cooperative / corporate farming as under: (Land Reforms commission of West Pakistan, 1959).

1. Those which take over form the members proprietary rights of land and its managements. This is a sort of collective farming and the whole of the farm can be worked as single unit. Such a kind of farming may be misunderstood as ex-propriation and raise social problems. This idea is unfamiliar to our farmers. Owing to the present individualistic attitude of the peasant, his attachment to the land and the social climate in while he lives will not accept cooperatives of this type.
2. Those which allow the proprietary rights to be retained by owners but assume the land use rights and management. For the reason already stated this form of cooperative farming has also not been recommended by the Land Commission.

3. Those which allow the owner to retain the proprietary as well as land use rights, but undertake to cater to the requirements of fertilizer, improved seeds, modern implements, arranging for marketing of the produce and lay down the cropping pattern to be followed by the individual members. This type of agricultural cooperation is most suited for the successful implementation of all the government schemes of land colonization and rehabilitation of landless labour and tenants under land reforms programme.
4. Those which only cater to the requirements of the members for fertilizers, modern implements, improved seed etc. but do not control the cropping pattern. Such a cooperative is called a better farming society and has no significant element of cooperative farming in it.

Cooperative Farming in Punjab

The Cooperative farming scheme in the Punjab province grew out to an economic necessity. It was introduced in Kharif, 1948 in order to rehabilitate landless refugees and such local sitting tenants who were cultivating the state land for the last three years. The second object was to bring the waste land under plough and increase agricultural production. The state lands in compact block of 500 acres or more in one village were earmarked in Multan, Sahiwal and Lyallpur (Faisalabad) District for cooperative farming societies to be organized under the said scheme. As much as 132 societies were organized and 1,40,000 acres of land was allocated to them. Out of it 1,20,000 acres were allocated to 10898 members at the rate of 12.5 acres per family/member. The societies being lease holders, received 40 percent share of the total Produce from the members upto 1960. In Kharif 1960, the government decided to give proprietary rights to the members of the societies. The price of land was fixed at the rate of Rs.20 per Produce Index Unit. In 1961 the Government of (West) Pakistan approved the scheme for introduction of mechanization in the Cooperative farming Chaks of Multan zone. The scheme covered an area of 1.20 lac acres belonging to 132 cooperative farming societies already operating in Multan, Sahiwal and Lyallpur (Faisalabad) districts. The main objective of the scheme was the introduction of limited mechanized operations in the field of cooperative farming. It was proposed to introduce tractor application upto the stage of seed-bed preparation.

The scheme however, could not produce the desire results because of the half hearted attempts on the part of its promoters. Although past governments have paid lip-service to the movement, this was never followed up by enough positive action to utilize our country's potential resources for a viable impact on its economy. In actual fact, to date, no serious attempt has been made to organize agriculture through Cooperative Farming as such.

In 1960, Dr. Otto Schillor of F.A.O. was invited to suggest Cooperative Farming techniques for old settled areas where progress in farming was held up due to the existence of too many small holdings and fragmentations. After a six month's study Dr. Schillor prepared a plan according to which all the owners and cultivators of a village were to surrender cultivation rights to a Cooperative society, which was then to divide the farm into subsistence units and given it on yearly rent, to selected cultivators, in terms of cash or in kind. The rent so received was to be distributed amongst all the owners of land in the village according to calculations on the basis of the leases of land pooled by them. In substances this plan was the same as that of cooperative chaks /farms, i.e. farming was to remain individual. This plan was tested for about 3 to 4 years, but it did not make headway due to the causes enumerated above and had to be abandoned.

A scheme of National Cooperation farming was initiated in 1976 and an Act to this effect was passed in order to implement the scheme. Under this scheme the corporate/cooperative farms were provided a number of facilities, which were not otherwise available to Limited Companies. A number of cooperative farms were organized in the province of the Punjab under the new Act. It has been argued that such farms were organized by the big landlords to gain benefits associated with this scheme.

Strategy to enhance Cooperative Farming

In Order to fully harness the productivity potentials that have become available with the drawing of modern agricultural era and to safeguard the future fragmentation of size of holding it is imperative that peasant economy of Punjab be given immediate attention. Cooperative farming could be a pragmatic way out. As discussed above, the experience of Cooperative Farming undertaken in Punjab in the past on State lands and newly colonized areas are not encouraging at all but some important lessons can be taken for further planning and action.

12. A STUDY INTO THE CREDIT REQUIREMENTS OF SMALL FARMERS

A sample of fifty six respondents having a farm size of less than or equal to 12.5 acres was randomly selected form eight selected villages of Tehsil and district Faisalabad of the University /FAO Project Area. On the basis of extent of use of modern technologies, the sample farmers were divided into progressive and conventional categories.

The main findings of the study were presented in the form of comparison of progressive and conventional farms. The progressive farmers were maintaining a slightly higher cropping intensity than conventional farmers, while gross household income of progressive farmers was almost double than the conventional ones. The same pattern was observed for both the categories in terms of farm expenditure and the expenditure on household consumption. Per farm disposable income of the two farm categories was Rs.45329/- and Rs. 20892/- , while on per cropped acre basis this figure stood at Rs. 3522/- and Rs. 3063/- respectively. The gap between the present and optimum level of inputs on per cropped acre basis on progressive and conventional farms was estimated at Rs. 40/- and Rs. 1146/- respectively, and was a consequence of per cropped acre savings standing at Rs. 985/- and -2419/- on the progressive and conventional farm categories. These low saving potentials have led to a gap between credit availability and requirement of the two farm categories to the tune of Rs. 4485/- and Rs. 10549/- respectively, which was based on the per acre credit requirements calculated as Rs. 1473/- and Rs. 4462/- for progressive and conventional farmers. The major constraints experienced by both the farm categories in the acquisition of credit were high cost of credit, complicated loaning procedures, inadequate loan amount for different types of requirements and the red-Tapism existing in the credit system.

In the light of above findings it is suggested that credit may be made available in adequate amounts to the farmers, in particular to the small land holders, with minimum bureaucratic formalities at low cost and with simplified lending procedures . Moreover, the credit facilities may be linked with the working of the farms and not the collateral they present. The adoption of these methods and procedures understandable to the small farmers is directly related with education of the rural people in general, the credit education of small farmers in particulars and the development of hard/soft infrastructure and devolution of power at the gross root level. Without adopting theses measures the establishment of an effective and efficient credit system will remain a distant desire to be achieved.

13. DISCREPANCIES IN PUBLISHED AGRICULTURAL DATA

Agricultural data required for streamlining agricultural production and to formulate policies both for the rural and urban sectors is normally published in the Govt. documents, namely: Economic survey, Agricultural Statistics, and Census of Agriculture. It has been noted while comparing data regarding some selected variables from the above mentioned sources, that there exist substantial discrepancies in reported data in these sources both at provincial and national levels. Therefore, it was suggested in the study that corrective measures regarding methodology of data collection, elimination of sampling and non sampling errors and procedures for data collection be given serious consideration to overcome discrepancies in reported data in different sources.

14. AGRICULTURE: STARVING AS A CONSEQUENCE OF SHRINKING FORMAL CREDIT

Agriculture is the main stay of Pakistan's economy as being the single largest sector, providing livelihood and employment to almost 70% of the population. The agriculture economy is dominated by small and medium farmers who are toiling at the lowest rung of economic ladder and hence have very small income base and saving potential to invest in farming business from equity, which makes it essential that outside finances particularly from the institutional sources be provided to make these farming communities progressive entrepreneurs of this vital sector of the economy. The gap between requirements and disbursements is widening overtime of institutional credit. This gap was around 108665 million rupees in the year 1997-98 as compared with 25598 million rupees in the years 1989-90. There is a need for manifold increase in the disbursement of institutional credit and with the given institutional structure in the country it is not possible for a single agency to achieve, therefore, a multi agency approach is recommended. Furthermore, the creation of regional rural banks can help in generating saving and in the activation of efficient loaning process.

15. RURAL DEVELOPMENT IN THE 21ST CENTURY: SOME ISSUES

As a consequence of centralized planning, limited participation of rural people in the programmes of rural people uplift and the feudal nature of the rural set up, the benefits of rural development have not trickled down to the rural masses. Illiteracy and poor infrastructure of the rural areas coupled with centralized power structure are the ingredients keeping the rural communities on the periphery and not allowing them to fully participate in the development process. To ensure their participation it is recommended that, on priority basis emphasis should be on the development of human resources, hard and soft infrastructure, and the devolution of power in the rural areas. Only then it will be possible to generate a long-lasting agricultural and rural development pattern in the nest century.

16. RURAL INSTITUTIONS AND PLANNED CHANGE IN AGRICULTURE. A COMPARATIVE PERSPECTIVE IN TWO PUNJABS

The rural institutions did not appear to have much impact in bringing about changes in the agriculture patterns and the participation of rural poor, particularly the small farmers in the total rural development process. Rural institutions were biased against small farmers. The adoption of modern agricultural practices by these small tillers of soil was possible to a great extent due to the expanding input markets in the private sector. Most of the modern technologies were neutral to scale and many farmers did have access to farm inputs if they had access to irrigation water. The green revolution did not appear to have been determental to the poor in the Indian Punjab. In fact the new technology channeled through rural institutions appeared to have slowed down long-term trends towards greater inequality in the state. In contrast, inspite of heavy interventions, in agricultural inputs supplies through rural institutions, small farmers in the Pakistan Punjab were dis-advantaged either in the access to these inputs or in the distributional process of local institutions such as credit cooperatives and Agricultural Bank. Initial inequalities in land distribution undoubtedly continued in the Two Punjabs.

The pattern of power politics in the Indian Punjab suggests that the pattern of benefits was not consistent with power politics model of institutional behavior. The rural institutions were biased towards commercial and progressive agriculture and not towards landlords and larger farmers. Nevertheless evidence suggests that cooperatives, Agricultural Development Banks and commercial Banks in Pakistan Punjab have been captured by landlords who may not use the benefits with less powerful neighbors. These differences are attributable to the market conditions and the policy content, which have clearly induced changes in the institutional behavior in the Indian Punjab, not found in the Pakistan Punjab.

17. SHORT TERM CREDIT NEEDS OF SMALL BROILER FARMERS WITH SPECIAL REFRENCE TO

FAISALABAD CITY

The study was conducted to estimate the short term credit needs of small broiler farmers at existing level of input use and to determine the preferences for different credit sources. It was revealed that the total short term credit needs of the small broiler producers were 21 percent of their total investment. Feed was the major item in total short term credit needs followed by day-old-chicks, labour and veterinary services. The respondents preferred institutional sources for the provision of credit. The problems confronting the smooth functioning of this industry as reported by the respondents were the high prices of feed and day-old-chicks, low prices of produce and other marketing problems. Lack of credit facilities, bribery and lengthy lending procedure were also reported by them.

18. ECONOMIC ANALYSIS OF INSTITUTIONAL LOANS FOR FISHERIES DEVELOPMENT IN PUNJAB.

This study aimed at conducting economic analysis of institutional loans for fisheries development in the Punjab Province. The salient results of the study are given below:

1. On an average, a fish farm in case of loanees of Faisalabad and Lahore divisions was 15.35 and 10 acres respectively whereas in case of non-loanees of Faisalabad, Lahore and Rawalpindi divisions, the average farm size was 5.5, 12.41 and 33.75 acres respectively.
2. It was observed that on an overall basis per farm total cost, in case of loanees of Faisalabad and Lahore divisions was Rs. 414607.49 and 257281.21 whereas in case of non-loanees of Faisalabad, Lahore and Rawalpindi divisions the same was calculated to be Rs.180717, 243972 and 580552 respectively.
3. The variable cost constituted 83 and 82 percent of the total cost incurred in fish farming in case of loanees of Faisalabad and Lahore divisions while in case of non-loanees of Faisalabad, Lahore and Rawalpindi divisions it was 90, 80 and 60 percent respectively.
4. On overall basis gross margin per acre of the fish farmers was Rs. 28934 and 26810 in case of loanees of Faisalabad and Lahore divisions as compared to non-loanees of Faisalabad, Lahore and Rawalpindi divisions which was Rs. 29382, 25529 and 21979 respectively.

19. DISTRIBUTIONAL ANALYSIS OF THE FARM ECONOMY OF PAKISTAN

This study provided estimates of the level of inequality in the distribution of land, irrigation, cropping pattern, fertilizer use, investments in farms, credit, and ownership and use of mechanical devices among agricultural households across farm-size groups. In doing this analysis the study made use of agricultural census reports pertaining to the years 1960, 1972 and 1980, and was substantiated by other reports of the government of Pakistan. The study identified the following reasons for inequalities at national and provincial levels.

1. The very highly skewed distribution of land across cultivating households,
2. A highly unequal distribution of government-controlled canal irrigation, and
3. the lack of small farmer's access to agricultural inputs and government controlled credit distribution. The analysis also showed high crop income inequalities across farm-size groups, and the testing of Kuznets Hypothesis based on this data revealed an 'L' type relationship. The study recommended the following:
    a. a lexicographic ordering of canal irrigation distribution to reduce inequalities across farm-size groups,
    b. introduction of high-value crops suitable to different agro-ecological regions in each province

and,

c. provision of credit on a competitive basis.

20. EVALUATION OF SUPERVISED AGRICULTURAL CREDIT PROGRAMME OF AGRICULTURAL DEVELOPMENT BANK OF PAKISTAN

The Study was conducted to explore the impact of supervised agricultural credit programme(SACP) on small farmer's productivity in four villages of Tehsil Chishtian, District Bahawal Nagar. Twenty eight loanees covered under SACP of Agricultural Development Bank of Pakistan were randomly selected for detailed study. An equal number of non loanees were also studied for comparison sake. The study brought the following results:

1. Forty three percent of the loanees stated that the lending procedure was unsatisfactory as against thirty nine percent who claimed that it was satisfactory. Only 18 percent considered it as ideal.
2. The cropping intensity of the loanees covered under SACP was calculated to be 169 percent as compared to130 percent of non loanees.
3. Per acre yield of cotton, wheat and sugarcane was 17, 29, 715 and 9, 28, 695 maunds for loanees and non loanees respectively.
4. Per farm net income of loanees and non loanees was Rs. 47572 and 33400 respectively. As for as the benefit cost ratio was concerned, it was 1.24 for loanees farmers as compared to 1.19 for non loanees.
5. Not even a single respondent had the facility of technical know how which is an important requirement of SACP.
6. About 93 percent of the farmers considered that the use of credit had a positive effect on production and hence increased in their incomes.

It was recommended that the lending procedure should be simplified, credit against hypothecation of crops should be facilitated and technical know how along with the credit should be provided.

21. LAND HOLDING INEQUALITIES IN PUNJAB

The Punjab province accounts for 58% of farm areas, 63% of cultivated area and 69% of irrigated area of the total farm economy of Pakistan. Substantial inequalities exist in the distribution of these net land area variables between different farm-size groups and are increasing over time, causing skewed distribution of income in rural areas of Punjab.

22. A CRITICAL APPRAISAL OF AGRICULTURAL CREDIT COOPERATIVES IN PUNJAB.

Both in conception and practice agricultural credit cooperatives in the Punjab have been an important component of the government's development policy. As the bulk of resources are supplied by the government, credit cooperatives are as much an agent of government administration as a voluntary organization. Even from the narrow perspective of their role as a vehicle for channeling government funds, cooperatives have been more active in distributing loans than in collecting them when due. The local elites who control societies have appropriated funds provided by the government, with no intention of repaying and making the society work.

23. RURAL DEVELOPMENT IN THE 21ST CENTURY: SOME ISSUES

As a consequence of centralized panning, limited participation of rural people in the programmes of rural

uplift and the feudal nature of the rural set up, the benefits of rural development have not trickled down to the rural masses. Illiteracy and poor infrastructure of the rural areas coupled with centralized power structure are the ingredients keeping the rural communities on the periphery and not allowing them to fully participate in the development process. To ensure their participation it is recommended that on priority basis emphasis should be on the development of human resources, hard and soft infrastructure, and the devolution of power in the rural areas. Only then it will be possible to generate a long-lasting agricultural and rural development pattern in the next century.

24. HUMAN RESOURCE DEVELOPMENT. A CASE STUDY OF RURAL FAISALABAD.

The human resource development depends on three types of factors, that is education, technical education and Health care. A study was undertaken to assess the existing status amongst the landholders and landless population of Faisalabad district. The conclusions reached are summarized as under. In the rural areas of district Faisalabad literacy rate was found to be around 70% among selected respondents. More over, 84% respondents were not content with the quality of education and the education system in vogue in the villages. Attitude of the teachers was not responsive to the needs of education and found to be the main hurdle in the way of quality education.

The situation of the formal technical education was very poor among the selected respondents. Around 6% were formally trained while informal technical education was not compatible with the requirements of modern time.

The state of health care was very poor in the selected study area. People had to travel on an average 21 kilometers for reasonable good quality medical facilities. Majority of the respondents was compelled to go to Faisalabad city center for medical treatment.

The following suggestions were extended which may be helpful in improving the ongoing situation.

Education centers should be opened in the villages by the welfare trusts and semi-government agencies. The course should be designed in such a way as the adults mauy also benefit and be able to read, write and count as a preliminary step.

After getting the preliminary training when the farmers become able to read, write and count, they may be persuaded to attend the short courses regarding new farming practices offered by the agricultural institutions from time to time.

Local governments should handle the health facilities in the respective rural areas. And Local Population is required to monitor the activities of the doctors and lower staff to ensure the attendance of the hospital employees and the quality of treatment offered to the patients.

25. DETERMINATION OF FARM GROSS INCOME FROM SUGARCANE. A CASE STUDY OF MANDI BAHA-UD-DIN DISTRICT.

The study was designed to compare and evaluate the determinants of Farm Gross Income from sugarcane, for fresh and ratoon crop on small, medium and large farm categories. Cross-sectional primary data wee collected for1994-95 crop from a sample of 90 farmers from 10 villages in District Mandi Baha-ud-Din. Four quantitative factors: fertilizer and manure expenditure, irrigation expenditure, labour working hours and operated area under sugarcane turned out to be the determinants of farm gross income from sugarcane. Tabular analysis for comparison of averages, Cobb-Douglas production function for the estimation of perameters and marginal analysis for the determination of rate of return of these factors on small, medium and large farms and for fresh and ratoon crops respectively, were used as methods of analysis.

Per acre gross income from sugarcane cultivation increases with farm size for fresh crop. But in case of ratoon crop it is more for medium farms than small and large farms. The variable "Operated area under sugarcane" shows decreasing returns to scale in case of small and medium farms, while the large farms exhibit an increasing returns to scale. The results of ratoon crop show that small and medium farms face increasing returns to scale, while large farms exhibit decreasing returns to scale. Marginal analysis shows that potential is present for the farmers to have positive return on their invests in sugarcane crop.

26. THE RISING GAP BETWEEN THE REQUIREMENTS AND SUPPLY OF INSTITUTIONAL LOANS TO THE FARM SECTOR.

Farmers need external finances in the wake of low productivity, low saving and exposure of their farm economies to floods, diseases, pest attacks and price fluctuations. Further their income pattern is seasonal but the expenditures accrue on continuous basis. And at the same time the Farming Community is subjected to the phenomenon that the resources are blocked in the form of stocks and land, and slow recovery on investments made on the farm. The combine effect of these factors results is the increasing reliance of farming business on outside funds. Realising this, the National Commission on Agriculture after a thorough analysis recommended that we should inject at least 20% of the value added by agricultural sector in the GDP in the form of agricultural Credit in the farming business. It has not happened and overtime, the gap between the requirement of outside funds and their supply to the farming sector is widening.

With the induction of Commercial Banks in the agricultural loaning process in 1972, the amount of agricultural credit provided by different institutions rose up to 13 % in 1986-87 of the GDP generated by the agricultural sector. Since then it is on the decline and was just 3.93% in 2001-02. During the whole decade of 90s it was never more than 6.40% in any of the financial year. It is important to note that different studies have established empirically that the relationship between credit and the agricultural GDP is positive and significant. This relationship compels that there is a need for manifold increase in the disbursement of institutional credit to be extended to a large proportion of the farming community, especially the small farmers. For this expansion, a multi-agency approach is recommended along with the existing institutional arrangements. This expansion of credit should also include the livestock sector along with the ongoing practice of crop production and development loans.

27. MITIGATING RISING POVERTY IN RURAL AREAS OF PAKISTAN

The most serious challenge confronting the world today is the widespread poverty and almost one-fifth of humanity or 1.2 billion people are subsisting on less than $1 a day. Overtime the gap between the rich and the poor is widening and in the case of Pakistan the incidence of poverty increased from 26 percent to 33 percent during the period from early to late 90s. Poverty in Pakistan mainly higher in rural than urban areas, and it rose more rapidly in the rural areas in the 1990s. The Gini coefficient (which indicates the distribution of total per capita income on a scale 0 to 1) of the rural areas had risen to 0.401 in 1998-99. In rural areas, agriculture is the prominent activity and the most important source of income as well, it singly accounts for 23 to 27 percent of total per capita household income, and overtime the growth in agriculture and consequently the income of the rural communities is declining. Furthermore, the declining agricultural growth has retarded the growth of non-farm activity on which depends for livelyhood a substantial proportion of the rural labor force. If we want to stop the declining income trend in the rural areas and as a consequence the reduction in overall poverty, it is required that intervention be made for the speedy growth of agriculture and the income and employment opportunities be created in the rural sector. The proposed interventions for mitigating poverty in the rural areas should address to the creation of assets for the poor, helpful in generating investment and productivity. Improvements are required in the access to credit on equal basis for generating employment opportunities particularly through micro-credit mechanism, which may further help in creating openings in the labor-intensive non-farm sector. These

can be effectively achieved in a community driven development process, through participatory, decentralized, and decision-making at the local level.

28. NGO'S MICRO-FINANCE AND POVERTY ALLEVIATION: EXPERIENCE OF THE RURAL POOR IN PAKISTAN

NGOs are civil society initiatives organized to process the need of change in human development endeavours. Although there has been an impressive growth in the number of NGOs in the recent decades their role in the provision of micro finance in Pakistan is generally questioned. The paper seeks to demonstrate that with a few notable exceptions, the record of NGOs in micro-finance is poor. When judged by two criteria of success that micro-finance world has adapted, out reach to the poor and financial stability-the results are disappointing. NGO's have thus far had trouble and suffer in achieving both outreach or sustainability. There has also been little evidence of any aggregate impact on poverty reduction as a result of NGO's micro-finance efforts regarding the rural poor in Pakistan.

29. METHODOLOGY-DEVELOPMENT OF SUPERVISED CREDIT.

This study was conducted in order to develop as to how supervised credit should be applied to the small and medium farmer's credit worthy and better living.

Supervised Credit is defined as "Lending the farmer capital and organization as a pachage deal", It is to assist the borrowers in making improvement on their farms, educate them in the wise use of credit, efficient marketing of farm produce and to raise their credit worthiness. In order to fulfill these objectives, following may be mentioned as the tools of supervised Credit.

1. Farm Planning.	2. Family Budget Planning.
3. Credit Planning.	4. Production Guidance.
5. Marketing Guidance.	6. Farm Records.

To develop the methodology of supervised Credit, detailed information was needed on farm resources, farm operations and practice, farm incomes and savings, household budgets, farmers, attitude towards adoption of supervised Credit Programme, and identification of the bottlenecks and of the critical inputs in the development of the farms. For this purpose 30 small present proprietors with holdings ranging between 6 -$12_{1/2}$ acres were randomly selected from a village in Lyallpur (Faisalabad) Tehsil.

The total areas of the sample were $292_{1/2}$ acres which did not exist in a compact block. It was found that wheat and Sugarcane were grown by 100 per cent of the sample farmers followed by maize and cotton. The area ploughed under the major crops i. e. wheat, sugarcane, cotton and maize was 49, 27, 10 percent, and 9 percent respectively. The cropping intensity was found to be 122 per cent.

The average gross income of the sample farms was calculated to be 5354.44 and production expenditure to be 1860.78. The net farm income ranged between Rs. 1564.65 to Rs. 6972.80. Taking into account the income from other sources, the average household income was calculated at a figure of Rs. 4138.00. Household consumption constituted 68 per cent of the sample farmers, household income and savings were 32 per cent.

A wide gap was found between the recommended fertilizer doses for different crops and applied by the sample farmers. Plant protection measures were not at all adopted by the sample farmers. It was calculated that by using optimum doses of seed, fertilizer and insecticides, the net* income per farm would increase by Rs. 6139.00 and per capita by 767.38.

Farmers' attitude towards acceptance of Supervised Credit was also determined. Farmers accepted most

of the terms and conditions of supervised credit with a few disagreements. To a Supervised Credit Programme the Points of disagreement are more important than the points of agreement.

Following are given the points of disagreement:

1. 67 per cent of the sample farmers were not prepared to pay for technical extension service.
2. Penalty rate of interest was not acceptable to 50 per cent of the respondents.
3. In respect of joint used of tractor and joint marketing 1/3rd of the sample farmers did not agree.
4. 30 per cent of the sample farmers were not in favour of borrowing entirely from a supervised credit agency.

For the execution of supervised credit programme, a legal contract between the farmers and the agency is recommended. The technical staff of the supervised credit agency should consist of agronomist, soil scientist, entomologist, extension experted agricultural marketing expert.

MARKETING AND AGRIBUSINESS

1. A COMPARATIVE STUDY OF TWO GHEE FIRMS IN PAKISTAN

A comparison of two ghee firms in Pakistan was undertaken to seek opinion of customers about the taste, availability and affordability of their products. The survey revealed that the consumers preferred Kashmir products due to their widespread availability, better quality and taste. The research finding suggest that there has been a cut-throat competition between the two firms which compelled them to improve quality of their products and charge a price afforded by larger segment of population from both the middle income earning group and the poorer section of the society.

2. AN APPRAISAL OF PUNJAB RURAL SUPPORT PROGRAMME IN THE SELECTED FIELD UNITS IN FAISALABAD

The study was carried out in two selected field units of Punjab Rural Support Programme (PRSP), Faisalabad with e particular focus on social mobilization and access to credit provided by PRSP since its inception. Social organizers and community organization leaders played a major role in motivating community organization members to join community organizations. Simple loaning procedure, no collateral and nearness were reported as main factors influencing the respondents to borrow from PRSP. In enterprise development sector, the average monthly income of male borrowers who initiated various enterprises with PRSP's credit was greater than those of females. Conversely, average income of male borrowers, who initiated livestock business, was more than males. Similar results were also noted in case of expansion of various enterprises and livestock business. The results showed that PRSP's micro-credit programme has significant impact on people belonging to very poor category. However, it is suggested that the (PRSP) must intensify physical infrastructure and technology development (PITD) and social sector services in the area through community organizations.

3. SUSTAINABLE AGRICULTURE IN THE PAKISTANS' PUNJAB: ISSUES AND OPTIONS

The province of Punjab in Pakistan has, in the last three decades, been one of the remarkable examples of agricultural growth. Numerous studies have attributed agricultural growth experience in the Punjab to rapid technology diffusion. It has, however been agued that economic growth in the Punjab occurred mainly due to spectacular increase in the inputs used in the production process, investments made in technology and infrastructure, especially roads and irrigation, extension systems, and institutional reforms that revitalized market incentives. The research suggests that agriculture in the Punjab now reveals disturbing trends. Productivity of major crops, have reached plateau, farm incomes stagnated and are insufficient for decent living. There has also been an alarming increase in the degradation of land, water and environment due to current pattern of agricultural development. An attempt has been made to propose some policy options for reviving agriculture in the Punjab.

4. MARKETING INSTITUTIONS AND DEVELOPMENT IN PAKISTAN: LESSONS FROM EXPERIENCE

The growing development and commercialization of agriculture sector has highlighted the inadequacies of existing agricultural marketing system in Pakistan. There has been an increasing awareness of these inadequacies and several steps have been taken to improve the marketing system and the related infrastructure. But the system is not yet geared to meet the requirements of a modern developing agricultural economy. There are various allegations that the system is exploitative, collusive, economically inefficient and operates with high profit margins. It is argued that the legal and institutional framework is outdated and is based on laws framed as far back as in the 1930s.

A successful marketing strategy in Pakistan requires more than creation of marketing institutions both in the Public and Private Sectors. A far broader based and positive role is however, required of the public sector than currently followed. Because a large part of the pricing and marketing problem arises from inadequate infrastructure, shortages of production and irregular government pricing policies, investment in roads, storage facilities, technology development and improved market intelligence systems are required. The more essential commodities such as cereals, oil seeds or milk may need much greater government involvement in pricing, distribution and market intelligence than would commodities such as fruits and vegetables. Greater government regulation of marketing practices is also necessary as evidence indicates that standardization of weights and measures, fixation of marketing charges and traders' commissions, open auctions, standard methods of payment and grading and improved market intelligence add considerably to the effectiveness of the traditional marketing systems. The relative emphasis on the various components of the market improvement package will of course vary depending on the stage of development of the country. As private trade has always been very active, the emphasis would have to be more on its regulation than on promotion. There is much greater need for infrastructural development although the benefit-cost ratio of such investments is generally more favorable in the latter.

5. A STRATEGY FOR AGRIBUSINESS DEVELOPMENT IN PAKISTAN

Agribusiness is an important sector in the economy of Pakistan. It contributes substantially to GNP and is a major source of employment for both the rural and urban population. Since most agribusiness activities are in the rural areas, their development can be an effective instrument in alleviating poverty in Pakistan. Agribusiness is a major source of foreign exchange earnings, as well as food and fiber is considered to be strategically important for national security.

Among common problems faced by agribusiness in Pakistan are: (a) international trade barriers; (b) limited access to credit, high interest rates and fluctuating exchange rates; (c) poor trade policy; (d) export and import taxes on raw materials; (e) bureaucratic practices; (f) high transportation costs; (g) raw materials of poor quality and unreliable supply; (h) lack of support facilities; and (i) lack of professional managers.

The following policies and programs might be necessary for coping with globalizing trend of the economy in the country: (a) promotion of greater cooperation for mutual benefits between local farmers and related small and medium-size business; (b) establishing of a regional framework for greater integration of production activities among countries, (c) development of supporting and related industries, (d) development of basic social infrastructure to keep up with economic development; (e) adequate supplies of basic food requirements for the increasing population; (f) development of common inspection standards for the safety of good products; and (g) conservation of resources and effective protection of environment.

In short, the major problems and challenges confronted in the development of agribusiness in Pakistan are (a) a lack of good infrastructure, i.e., roads, and telecommunications and Market information networks. (b) unreliable supplies of raw materials in terms of quality and quantity. (c) obsolete and inefficient equipment and technologies. (d) poor marketing facilities and sales networking. (e) a lack of managerial skills. (f) fluctuating foreign exchange rates and high interest rates. (g) high product looses due to inadequate post-harvesting facilities. (h) high transportation and distribution costs. (i) difficulty in accessing financing support due to bureaucratic and biases against small-scale entrepreneurs who are usually considered to be high-risk borrowers. (j) unresponsive or inappropriate government policies. (k) a lack of data and statistics on the industry

To address the above concerns, following strategies need to be pursued on the following: privatization of government-managed industries and businesses; trade liberalization involving imports and exports; the provision of soft loans and credit facilities; information/technology sharing and dissemination through

various channels of communications, e.g., extension service, tri-media, websites, forums, seminars, conventions, trade fairs and exhibits and the promotion of joint ventures of partnerships with large companies.

6. IMPACT OF WTO'S TRADE LIBERALIZATION ON PRODUCTION AND EXPORT OF KINNOW FROM PAKISTAN: PROSPECTS AND PROBLEMS

The potential of fruit export in general and Kinnow export in particular from Pakistan has never been fully reaped. In the past fruit export has hitherto been made in the traditional and non-professional manner quite haphazardly. Due to Pakistan's agro-ecological conditions and comparative advantage of an existing vast Middle East market, and due to the likely impact of WTO, there is an enormous potential to increase Kinnow exports. The present study on the bases of past trend was undertaken to build a forecast for future. The ARIMA model was applied to estimate the future production and export of Kinnow. The forecasts for the production and export of Kinnow for next 20 years are made. The forecast value of production and export of Kinnow for 2022-23 is 2617.45 thousand tonnes and 1110810 tonnes respectively. In order to estimate the impacts of WTO Trade Liberalization on the production and export of Kinnow, the concept of elasticity was used. Moreover, equations for domestic demand, domestic supply and price linkage were used for this purpose.

7. AN ANALYSIS OF FERTILIZER SUBSIDY IN THE DOMESTIC AND INTERNATIONAL FRAMEWORK: A CASE STUDY OF PAKISTAN

It is consensus among the experts that the intervention of the government in the economic model of any economy has significant impact on the equity and redistribution. But simultaneously it is observed that it creates the problem of distortions and inefficiencies in the system. After independence the size of the public sector has been increased remarkably in Pakistan. No one can deny the importance of this practice. However, the problem of efficiencies, which has been analyzed in the different studies related to indirect fiscal activities, is not in the control of the authorities. So this is the requirement of the time to analyze separately the impact of direct and indirect subsidies as well as control on the economic variables

Food grains self-sufficiency is the dominant goal for Pakistan's agricultural policy. One component of the strategy for self-sufficiency was the subsidization of fertilizer. The specific arguments for subsidizing fertilizer in Pakistan were: (a) to encourage the use of fertilizer as part of the improved production practices associated with the new rice varieties, (b) to stabilize the price of farmers by providing a ceiling price on the reties, (b) to stabilize the price of farmers by providing a ceiling price on the dominant cash input, c) to provide a relatively efficient transfer of resources from government (tax sources) to farmers to foster rural development. This last objective is one component of broader strategy in Pakistan to develop the rural sector as the principal employment growth source and d) to provide the low price wage goods to wage earners, so the cheap labor can promote the exports.

There is an important political content to the Pakistan's fertilizer subsidy policy which influences decisions regarding allocation of public resources. The Government's decision to provide fertilizer subsidies was motivated by a vision of food grains subsidies, in conjunction with the provision of a controlled floor price and maximum urban food grain price, has enabled the Government to fulfill the political imperative of providing satisfactory incentives to producers in order to extract greater surpluses of the main staple food while keeping urban prices, as well as the quantities available on the urban markets, at a level affordable to the growing, fixed-income, poor and middle-income earning population. Subsidies on inputs and output price support, together with other forms of rural investment, have been an important means of securing the loyalty of the rural elite to the overall accumulation process fostered by the state. In addition, the development of a relatively efficient system of releasing government food grain stocks in urban markets when prices rise has provided a food grain pricing system which has largely assuaged the fears of urban

populations of food grains shortages and consequently has kept the more politically volatile urban constituency relatively pleased with the Government. Keeping the rural elite motivated to produce more food grains, and more importantly, producing an adequate surplus for the urban markets, while keeping urban prices table enough to minimize the risks of deprivation and protest amongst the politically volatile urban fixed-income earners, explains the fairly widespread support for large fertilizer subsidies throughout the military and political arms of the New Order.

8. RESOURCE DEGRADATION AND ENVIRONMENTAL CONCERNS IN PAKISTAN'S' AGRICULTURE

The growth and sustainability of agriculture in Pakistan will depend on prudent use of natural resources and careful considerations for the environment. The natural resource base of the Country is under great stress, which will become even greater as the population continues to increase. It is argued that the sectoral policies, especially policies related to natural resources are outdated and lag behind the socioeconomic changes that have altered the pattern of resource use.

Resource degradation in Pakistan has arisen from distorted policies that have lead to divergence in private and social costs. In particular, several modern inputs were subsidized for much of the period, 1966-96. Electricity for tube well operations was priced at relatively lower annual rate, leading to overuse of poor quality tube well water which contributed to soil salinity. Moreover the information base on which farmers make decisions is inadequate with respect to internalizing rapid changes in soil and water quality variables by moving to more sustainable practices such as integrated nutrient and pest management and more diversified crop rotations. Public sector research has undoubtedly been biased towards development of technologies based on packages of modern inputs, and has neglected research on public goods such as integrated crop management and crops that enhance diversification and sustainability of production systems. From a policy perspective, there is a need for public and private initiative on several fronts-increased investment in resource management, research and extension, research to develop diversified and more sustainable cropping patterns and rotations, removal of price distortions on key inputs, especially water, and special incentives to invest in inputs such as gypsum that can counteract the problem of poor quality tube well water. Key factors for developing long-term sustainability of both the agricultural and the agriculture-based sectors are the removal of policy distortions and institutional constraints in the natural resource sector.

9. BARRIERS AGAINST EXPORT OF MANGO FROM PAKISTAN

Mango is one of the best fruits in the world. Its special characteristics (excellent flavour, attractive fragrance, beautiful shades of color, delicious taste) have established it as the king of all fruits. Worldwide production of mango, heavily concentrated in Asia, is estimated at about 25 million metric tons per year. The world import of mango is around 578.845 thousand tones, the value of which is estimated as 510099 thousand US dollars. Although more than 500 varieties exist, only a few of these are preferred in the international market. Pakistan stands fifth in the ranking of mango producing countries, after India, China, Thailand and Mexico, with an annual production of about 1037 thousand tones. The biggest market for mango is U.S.A. followed by Netherlands, China, U.A.E., Malaysia, United Kingdom, Australia, Japan, Saudi Arabia and Dubai. Despite rising demand in these markets, competition is formidable in the International Market because many producing countries are now growing varieties having more demand and are also able to ship them in large volumes. Consequently, producers in Pakistan may not rely simply on volume exports; instead, they have to compete on the basis of qualitative (good appearance, quality etc.) factors as well as competitive prices. The international trade scenario has changed with the implementation of multilateral trade agreements under World Trade Organization (WTO). A strong fruit culture, with emphasis on Quality factors, has dominated the International market. In recent past mango exports from Pakistan have shown a declining trend, which has placed Pakistan down to its original position. Mango exports from the Country are highly concentrated in few markets and even, in some

cases, ban has been imposed on mango exports from Pakistan. The WTO agreements will have serious implications for the exports of mango from Pakistan in the coming days. Amongst others, the Agreement on Sanitary and Phytosanitary measures, Agreement on Agriculture and Agreement on Trade related Intellectual property rights will have important bearing on the export of mango. Pakistan is not only bound to follow multilateral changes in the international trading system but also to observe bilateral obligations under various regional agreements. There are some commodity specific destination oriented specifications, which Pakistan will have to follow. Such specifications have already been conveyed to Pakistan from European Union, USA, Japan and Australia. The paper highlights issues which would adversely affect export of mango from Pakistan under the regime of WTO. An attempt will be made to analyze the marketing system (eg. grading, packing, storage, processing, quality certification etc.) of mango for identifying the weaknesses in the system. Appropriate Policy measures will be outlined to boost export of Mango from Pakistan by adopting requisite measures for meeting the challenges posed under the WTO regime.

10. FORECASTING AND GROWTH TRENDS OF PRODUCTION AND EXPORT OF KINNOW FROM PAKISTAN

The potential of fruit export in general and Kinnow export in particular from Pakistan has never been fully reaped. In the past fruit export has hitherto been made in the traditional and non-professional manner quite haphazardly. Due to Pakistan's agro-ecological conditions and comparative advantage of an existing vast Middle East market, and due to the likely impact of WTO, there is an enormous potential to increase Kinnow exports. The present study was undertaken to estimate the past growth trend in production and export of Kinnow and to forecast the production and export of Kinnow. The log in model was applied to estimate the past trend in production and export of Kinnow. ARIMA model was used to forecast the production and export of Kinnow for next twenty years. The forecast value of production and export of Kinnow for 2022-23 is 2617.45 thousand tons and 1110810 tons respectively.

11. WHEAT PRODUCTION AND MARKETING: A COMPARATIVE STUDY OF TRADITIONAL AND PROGRESSIVE FARMERS IN FAISALABAD (PAKISTAN)

The study was conducted in the Faisalabad district to compare wheat production and marketing of traditional and progressive farmers. Data revealed that progressive farmers sowed wheat in time and applied better seed rate. The use of seed drill was also found mare prevalent among the progressive farmers and application of fertilizer and irrigation was also better than traditional farmers. High price of fertilizers particularly of DAP, delayed payments and low price of wheat were the main marketing related grievances expressed both by the progressive and traditional farmers.

12. DEVELOPING AGRIBUSINESS SECTOR IN PAKISTAN

Agriculture is the linchpin, which has kept the wheel of Pakistan's economy going on since its birth. Although, agriculture in Pakistan has played its vital role in uplifting the socio-economic conditions of the people yet the Pakistani economy is dragging to ensure a fair return to its occupants i.e farming community. The slow pace of development in agriculture is a reason for a crawling industrial progress in Pakistan. Agriculture in Pakistan has long been a family profession and this created major hurdles in commercializing this sector. If, in the past, some efforts were made to make it more market oriented then inefficiencies and deficiencies in the marketing system wiped off all possible returns. The low returns to farming community made the reviving efforts more difficult. The good and bad time continued under different policy options and that fluctuating trend made it difficult to continue some creative efforts on sustainable basis and due to that gloomy past efforts, we are still struggling irrespective of such a resourceful agricultural base, which very few countries in the world have.

It short, under existing scenario, we not only need a strong agriculture sector as a base of economy but a

strong value added agriculture sector. This dream cannot be materialized until we will not improve the institutional linkages, policy framework, infrastructural support, financial and marketing constraints in the existing setup.

13. WHEAT PRICING POLICY IN PAKISTAN

Wheat is a staple food item for a dominant portion of the Pakistan's population. It occupies a supreme position in food grains in Pakistan as it covers 66% of the total area under food grains and contributes 74% of the total food grain production. In the year 2003-04, wheat was grown on an area of 8176 thousand hectares with a production of 19763 thousand tones. Wheat contributes 13.8% to the value added in agriculture and 3.4% towards Gross Domestic Product (GDP) of Pakistan. Punjab and Sindh together have got the lion's share in the production of wheat as 90% of the total production comes from these two provinces.

So it is a clear fact that there will be different scenario i.e. different opportunities and threats under WTO regime. In order to tackle the new challenges and to exploit the emerging opportunities, Pakistan needs to reorganize the existing policy areas and to frame new policies where necessary. Pricing policy for agricultural products is an important segment of the overall policy matrix. According to my point of view, we need to adopt an integrated approach which should cover all the segments of overall agricultural sector with the linkages development among the institutions through collaboration and cooperation to remove the inefficiencies and deficiencies in the existing system. Pricing policy now should be more open with the active participation of private sector but under he umbrella of rules and regulations set by the government.

14. WTO: GENERAL AGREEMENT ON TRADE IN SERVICES

Trade but this responsibility was transferred to WTO in 1995. GATT defined the rules for trade in goods efficiently but it failed to cover the services sector. It was negotiated during Uruguay round in response to huge growth in service economy over the past thirty years. The greater potential in services sector was brought about by the communication revolution. Services sector in the single largest sector contributing 60% of the global output, 30% of the global employment and 20% of the global trade. According to the World Bank report "global economic perspective for developing countries" liberalization of services in developing countries could provide as much as $6 trillion in additional income in the developing countries by the year 2015, four times the gains that would come from the trade in goods liberalization.

In case of Pakistan, there will be very tough competition in the services market so we need to be very careful and well prepared in this regard. Technical up gradation and diversification of existing services portfolio with a supportive attitude from the government is the only available recipe to Pakistan. One thing is crystal clear from the ongoing trend at global level and that is services sector is expanding at a rapid pace and those countries in the international trade scenario will be better off which will exploit the emerging opportunities in this sector and for this to happen with Pakistan, we need to prioritize our policies to create a conducive environment for the development of this sectors in Pakistan. Tourism industry in Pakistan has a lot of scope the full potential of which is still to be realized. With a frame work of investment in the infra structure and other supportive features this sector can flourish and can excel towards an industry. In case of Pakistan, all this planning is security sensitive and this dream in this sector and in all other sectors can only be realized if we assure the visitors and foreigners a well secure environment.

15. STANDARDIZING THE MANGO CULTURE IN PAKISTAN

There is a wide range of agro-climatic conditions in Pakistan which are capable of producing high quality flora and fauna. Besides the production of major crops there is a lot of potential in the production of

horticultural crops for which there exist a tremendous market. In the category of horticultural crops, Pakistani products are famous for their taste and fragrance which are special characteristics inherited to this region only. Like citrus, dates and other specialties of Pakistan, mango has also got a special range of customers both at the local and international level due to its special characteristics.

At the international level, minimum standards for mangoes are defined by the United Nations ECE Standard FFV-45: "in-tact, firm, fresh in appearance, sound (produce affected by rotting or deterioration such as to make it unfit for consumption is excluded), clean, practically free from any visible foreign matter, free from black stains or trails that extend under the skin, free from marked bruising, practically free from pests and damage caused by pests, free from damage caused by low temperature, free from abnormal external moisture, free of any foreign smell and taste.

Under the coming regime of trade liberalization only those producers will survive who will specialize in the production of competitive products. Pakistan, besides the production of some major crops, do has advantage in the production of horticultural crops especially fruits. For the time being Pakistan is not exploiting full potential of fruit culture and this is because of traditional farming methods which are out dated and without any net vertical addition. Need of the time is to adopt the methods and techniques which should be compatible with the international standards. Here Pakistan can learn a lot from the experience of other mango producing countries. This should be followed by exploring new avenues for investment in the processing industry so that the culture of value added and processed products in the country can be promoted.

16. POLITICAL SHADOWS OVER TRADE WITH INDIA

Pakistan and India have tremendous potential for a bilateral trade. The article explored the trade related issues between two countries. Trade and economics between the two countries has become victim of politics. Opening up of trade with India would help create economies of scale, make our products more competitive in the international markets, lower production costs and increased productivity would absorb more manpower. For this trade barriers need to be removed. The biggest hurdle is political. Pakistan does not extend the 'Most Favoured Nation' (MFN) status to India, whereas India in principle has granted MFN status to Pakistan in 1995-1996 but the meager imports from Pakistan suggest that India has found ways of imposing a de facto ban on most imports from Pakistan. Informal trade between the two countries is much larger, involving such goods as chemicals, medicines, videotapes, cosmetics, and viscose fiber. In order to improve the trade ties between the two countries, private sector in both the countries should be allowed a much greater role in the formulation and implementation of economic policies. Governments should permit visits of trade delegations, holding of trade fairs and business visits on the recommendation of the trade bodies. Governments need to improve the local conditions of business risk, costs and time of setting up and operating business, infrastructure and communications. Pakistan should grant MFN status to India. All possible modes of direct transportation should be opened to facilitate efficient movement of goods and people and reducing time and costs of travel and transport within the region.

17. THE WHEAT MARKETING ACTIVITY IN THE PUNJAB PROVINCE

The existing policy discourages investments in grain storage and distribution by the private sector. The element of subsidy in issue price puts a downward pressure on the producer's price because there is always a resistance against the increase in support price from the urban population. One of the weakest spots in wheat-distribution system is the lack of efficient and high-quality storage facilities. Wheat losses due to poor storage alone are about one-third of the total loss of wheat. Private storage is inadequate in quantity and quality. To compensate for inadequate storage capacity in the private sector, the public sector storage capacity has been expanded at a rapid rate. In view of the newly achieved self-sufficiency in wheat, the level of procurement should be de-escalated. The procurement activity should be reduced gradually because of the manifest inability of private traders to take on large marketable surpluses without

enhancing serious credit, storage and marketing problems. The government should maintain the present policy of permitting inter-provincial and inter district mobility of wheat to keep a balance between the deficit and surplus wheat producing areas. Storage is a critical factor in the marketing of wheat. The storage base has to be spread at farmers, traders and flour millers lever also. Speed is the most critical factor in the procurement policy of the public sector. If speed in the disposal of the wheat surplus is to be achieved then the useful services being provided by the beoparies and arties are to be recognized. Along with the farmers directly bringing their produce to the procurement centers, the involvement of market intermediaries also therefore, has been recommended. Due to superior quality the wheat for export purposes should be selected from southern region of The Punjab Province. Two laboratories, to test the quality of wheat and wheat Hour should be established at Faisalabad and Bahawalpur (in Punjab and one at Karachi), under the supervision of the Department of Food Technology, University of Agriculture, Faisalabad.

18. DOMESTIC SUPPORT IN PAKISTAN AGRICULTURE UNDER THE WORLD TRADE ORGANIZATION

The domestic support under WTO has been annexed with three boxes i.e. green, amber and blue. Since the green box measures are non-actionable i.e. are permitted therefore have been discussed. Provisions under green box measures include: general services, Public stockholding for food security Purposes, domestic food aid, direct Payment to producers, de coupled income support, government financial participation in income insurance and income safety-net programs, payments under environmental programs and payments under regional assistance programs etc.

The de minimis payments (10% of GDP for developing countries) are allowed to be paid in addition to the green, amber and blue boxes. The payments are exempt from reduction commitments even if the effects of such support are potentially production or trade distorting. Pakistan's GDP is Rs. 748 billion. Agriculture sector's share in total GDP is 25 Percent, 10 percent of it i.e. about Rs. 19 billion are allowed to be given as domestic support to our agriculture sector or rural development.

It is estimated that 80-100 billion rupees per year were being given as domestic support to WAPDA, Karachi Electric Supply Company PIA, Railways and Pakistan Steel Mills etc. About 53 billion rupees of supports have been committed to be given to WAPDA and KESC this year by the government. Huge - amounts have been given under tax holidays and tax relief to the industrial sector in Pakistan. Large amounts of loans to be paid by influential persons and incident industries have been written off.

In agriculture sector a meager amount is being given as subsidy in irrigation sector. Under the pressure of the international funding agencies like the World Bank, IMF and Asian Development Bank, subsidy and domestic support has not been allowed to be given to the agriculture sector in Pakistan.

To make our agriculture sector competitive serious consideration needs to be given to support this sector at the earliest.

19. BEYOND THE GREEN REVOLUTION: THE GROWTH AND SUSTAINABILITY OF AGRICULTURE IN THE PUNJAB

The province of Punjab in Pakistan has, in the last three decades, been one of the remarkable examples of agricultural growth. It has been argued that economic growth in the Punjab occurred mainly due to spectacular increase in the inputs used in the production process. Questions have arisen as to what explains the diffusion of new technology and associated changes in the quantities and kinds of inputs used in the Punjab. In an attempt to answer this question, the paper seeks to review studies that explain the pattern of innovations in the agriculture of the Punjab. It is argued that no single explanatory variable stands out in assessing the performance of agriculture in the Punjab. As such, the level of innovation and

investment in the agriculture has been understood in terms of three categories of variables: infrastructure, information and incentives (referred to as three 'I's"). The paper suggests that agriculture in the Punjab now reveal disturbing trends. Continuous and widespread resource degradation, as measured by the soil and water quality, has more than offset the productivity effects of technological change. De-gradation of agro-ecosystem health is in part, the outcome of modern technologies such as use of fertilizer and tube-well water, and has offset a substantial part of their contribution in productivity. An attempt has been made to propose policy options to arrest resource degradation in the Punjab

20. SPS MEASURES IN RELATION TO PAKISTAN'S CONDITIONS

Sanitary and Phytosanitary measures have been proposed to ensure that food is safe for consumers, and to prevent the spread of pests or diseases among animals and plants. Amongst others the rules of SPS apply to limits for pesticide residues, food additives, heavy metals, mould, microbiological contamination, decomposition, filth, low acid canned foods, labeling etc. Pakistan does not possess the financial, human and technical resources to implement the SPS agreement in its true letter and spirit and may be excessively burdened by the implementation costs of the agreement. Major problems in meeting SPS requirements and in exporting Agricultural and food products from Pakistan include insufficient access to scientific/technical expertise, incompatibility of SPS requirements with domestic production/marketing channels, Poor access to financial resources, insufficient time permitted for compliance, limitations in administrative arrangements for SPS requirements and poor access to information on SPS requirements. Necessary measures need to be taken at the governmental level for creating awareness among the stakeholders to cope with the challenge of WTO in general and Sanitary and Phytosanitary agreement in particular.

21. MAJOR IMPLICATIONS ON PAKISTAN'S AGRICULTURE IN WTO SCENARIO

The agreements of WTO allow six years to the developed countries and 10 years to the developing countries starting 1995 to notify their commitments. Child labour, environmental concerns due to pollution may inhibit free access of developing countries to markets in developed countries. With the implementation of WTO agreements, Pakistan's major exports would receive significant tariff reduction both from the developed countries and less developed countries (LDCs). Tariff on textile and clothing will decline by 8.9%, agricultural products by 5.1%, fuel by 13.3% and miscellaneous manufactures by 7.5 percent in LDCs. In developed countries, tariffs on agriculture and manufactures are expected to decline by 2.2% and 3.6% respectively. Pakistan has declared itself a net food Importing Country. Real prices of Pakistan's major imports are expected to rise by 3.8% in wheat, 2.3% in coarse grain and 1.85% in sugarcane, while the prices of rice will decline by 0.9% and cotton by 1.2% in 2002. Pakistan, with its cheap labour, diverse agro-climatic conditions and large agricultural sector can definitely gain through expansion of International trade in agricultural products. However, concerns relating to quality of products for seeking markets in the advanced countries need to be addressed on an urgent basis.

22. LAND OWNERSHIP PATTERNS AND YIELDS IN TWO PUNJAB'S

The two Punjab's have historically been the most developed regions and continue to be so both in India and Pakistan. In Pakistan, the Punjab province comprising around 26 per cent of the total area and a population of 81.5 million representing 57 per cent of the total population, 'dominates[1] the political and economic scene. In contrast, the Indian Punjab, comprising only 1.57 per cent of area and a population of 24.28 million, representing a mere 2.5 per cent of the total population, contributes significant share from its agricultural output to the central pool. It was reported that the percentage share of the Indian Punjab to the central pool in wheat and rice was 69 and 57 per cent respectively during 1996-97.

The two Punjab's have pretty much the same climate, both started off with similar agro-economic and land tenure systems and both share a common culture, language, historical traditions and institutional

arrangements. Furthermore, both regions have since the mid-1960s experienced rapid technological change associated with the so-called 'green revolution'. Yet, in terms of agricultural development, the Indian Punjab has shown relatively better performance. The superior agricultural performance of the Indian Punjab, as demonstrated by almost twice the rate of productivity, owes its origins to the well-established facilities in social infrastructure, higher irrigation intensity of private tubewells, a greater use of fertilizers and insecticides and a more stable price policy in agriculture in India compared to Pakistan. These policies may also be traced back to the nature of the political regimes and the consequent role of political leadership in the two countries.

23. HAVE THE FOOD DEPARTMENTS OUTLIVED THEIR UTILITY?

After over three decades of the Green Revolution, Pakistan has entered a new phase of wheat management. During the pre-Green Revolution era, the problem was that of scarcity, when need was felt for giving a fillip to the wheat production. But the recent wheat problem is different, it is that of plenty. With a view to having food grain security, between 2-3 million tonnes of wheat is kept as a buffer stock with the food departments and PASSCO. The surplus quantity, by no means, is a manageable stock and needs serious policy decisions at the government level. The stocks are sufficient to meet food requirements of entire population living below poverty line for almost one full year. It is reported that the post-harvest losses of food grains are 10-15 per cent of the total produce, which include storage, distribution and marketing losses. This puts a big question mark on the functioning capabilities of food departments. The food departments entered into the business of procurement at a time when the country was faced with the persistent problems of food shortages year after year and private traders were indulging in hoarding wheat to accentuate the shortages, resulting in artificial rise in wheat and flour prices in the market.

Notwithstanding its perceived benefits in other fields, the WTO would put Pakistan's agriculture in an extremely difficult position after January 2005. Agricultural productivity in Pakistan is one of the lowest in the world and withdrawal of subsidies would aggravate the situation, as the inputs would become costlier, increasing per unit cost of production even further. This would render Pakistan's wheat uncompetitive globally. Free import of wheat would increase the price fluctuation and adversely affect the agricultural production and the food security.

Another important area that requires improvements relates to the internal marketing procedures. The existing marketing network in the country was never designed to handle surplus wheat of the existing magnitude. It appears that Pakistan has to live with surplus wheat for several years to come, necessitating a new orientation to the post-harvest management of agriculture produce. This has to be supplemented by massive diversification and some shifting away from food grains to high value cash crops, which would not only augment the industrial sector, but would also provide sufficient exportable surplus with the industrial sector.

24. WHOLESALE MARKET MANAGEMENT AND OPERATIONS: A CRITICAL APPRAISAL OF FAISALABAD FRUIT AND VEGETABLE WHOLESALE MARKET

The study was conducted to investigate the working of the Faisalabad fruit and vegetable market. The managerial, operational and planning aspects of market were thoroughly thrashed and loopholes in this regard outlined. The study concluded that market malpractices were common in the form of short weighment of produce, misquotation of prices, exploitation of farmers in debt and excessive charges on various services. There was hoarding, topping and under cover settlement of prices of produce transacted. It was estimated that the producer got up to 55% share in consumer rupee for selected fruits and vegetables. While studying different commodities the retailer's share was found to be significantly higher as it ranged from 20-30% for the selected commodities. Dispute among the commission agents on allotment of shops was obstructing the smooth functioning of the market.

25. ESTIMATION OF CREDIT REQUIREMENT, OF SELECTED LANDLESS HOUSEHOLDS IN THE FAO/UNIVERSITY PROJECT AREA

The study was conducted to assess the credit requirement of selected landless households for new income generating activities. The results of the study showed that saving rate was higher in case of barbers and carpenters as compared to other categories of the landless respondents while the highest and lowest credit requirements were calculated for the carpenters and barbers respectively. The barber was found to be the best of the respondents in the research area. On the basis of these credit requirement new income generating activities were proposed for the betterment of landless people.

26. ESTIMATION OF CREDIT REQUIREMENTS OF SMALL FARM HOUSEHOLDS IN THE FAO/ UNIVERSITY PROJECT AREA

The study was conducted to assess the credit requirements of small farm households. The credit for improved farm activities were estimated at two levels i.e. at existing level of input use and at recommended level of input use on progressive and conventional farms. The results of the study showed that per acre credit requirements at existing level of input use were Rs. 1412.00 and 3027.00 on the progressive and conventional farms. Per acre credit requirements of the progressive and conventional farmers at recommended level of input use were worked out to be Rs. 1473.07 and 4462.34 showing that the progressive farmers were using the inputs close to the recommended level.

27. IDENTIFICATION OF FELT NEEDS OF FARMERS THROUGH PARTICIPATORY APPROACH

The study was conducted to identify the felt needs of the farmers in the University project area. The problems were identified and ranked according to the points referred to the problem according to their intensities. According to the results water shortage was the most important problem both for wheat and sugarcane growers. These results can be used to frame policies accordingly.

28. AN INVESTIGATION INTO THE FOOD SECURITY SITUATION IN THE RAINFED (BARANI) AREAS

It is considered a top most priority of every popular government to give its citizens a food secure environment. The food security situation was estimated by using Aggregate Household Food Security Index (AHFSI). The results showed AHFSI value of 66.27, a low level of food security in the research area. The study also identified different reasons or causes of food security with possible strategies adopted by the respondents to overcome food insecurity.

29. MARKET INTERMEDIARIES AND THEIR MARKETING MARGINS FOR INLAND FISH

Despite its arid climate, Pakistan has substantial inland water that offers great potential of fish farming inland both on small and large scale, the exploitation of which could help to meet the growing demand of animal protein for local consumption and for earning foreign exchange through exports. Nonetheless, there are problems on both production and marketing side associated with inland fishing. On marketing side, wide price fluctuations lead to uncertainties in securing favorable price upon harvest. Besides this, many market intermediaries are involved in the marketing of inland fish. The article in hand attempts to identify the market intermediaries involved in the marketing of inland fish, their marketing margins and the market channels through which the inland fish reaches to the ultimate consumers. The results of the study indicated that share of market intermediaries in the consumer's rupee is substantial and there is need to increase the government shops to reduce the marketing margins and thereby to enhance the producer's income.

30. PRODUCTION AND MARKETING CONSTRAINTS LIMITING SUNFLOWER PRODUCTION IN

PUNJAB (PAKISTAN)

Pakistan is a net importer of edible oil and is spending millions of dollars on its import every year, which is a major drain on the forex reserves of the country. Sunflower, a non-traditional oilseed has the potential to bridge the gap that exists between the domestic demand and supply due to its high oil and protein contents. Despite the hectic efforts of the Government, the area and production of sunflower have not increased up to the expectations due to certain production and marketing constraints associated with this crop. The study attempted to investigate these constraints that are limiting sunflower production in the Punjab by employing analytical techniques.

31. POPULATION AND RURAL ECONOMY OF PAKISTAN

Migration from the rural areas to urban centers has triggered changes in both farming and land tenure systems in the country. At the same time, the food needs and demands of urban areas have expanded on a massive scale, placing great pressure on food producers in rural areas. The growing burden of rural women's responsibilities in sustaining their families has yet to be systematically addressed in agricultural policies (including food security, pricing, extension, agricultural credit and agricultural research policies). What will be the long-term implications of rural- out-migration for food production, food security and sustainability remains an unresolved issue. The research outlines that a system approach to gender, population and rural development issues could help to put into sharp focus existing linkages and their potentially significant implications for policy and programme planning. Agricultural programmes have gender and population dimensions which can jeopardize the very success and sustainability of any rural development programmes, if not addressed properly. Similarly, population programmes have gender and agricultural dimensions which impact indirectly on demographic variables. At present, however, population programmes in Pakistan do not sufficiently address the dynamics of productive capacity of both the rural men as well as women, and their interface with demographic determinants such as fertility, mortality and migration. The research concludes that rural development strategies must aim at achieving multiple objectives. While the primary concern is poverty reduction and improving the quality of life of the rural population, the strategies that will lead to these outcomes (“win-a-win strategies”) must be broad-based and far-reaching. It is argued that government investments and policies to enhance the quality of life directly are particularly important for the rural poor and for women, because the trickle-down benefits from growth may take too long to realize

32. WTO AND ITS IMPLICATIONS ON PAKISTAN

World Trade Organization was established with the hope to steer global economic integration with a much broader scope in terms of commercial activity and trade policies. With the broader legal and constitutional element, WTO has extended its mandate to incorporate and standardize the strategies for global economic integration.

Agreement on Agriculture (AoA) of WTO forms an integral part of the Final Act of the Uruguay Round of Multilateral Trade Negotiations, which was signed by the member countries in April 1994 at Marrakesh, Morocco and came into force on 1st January 1995. The obligations and disciplines incorporated in the Agreement on Agriculture relate to (a) Market access; (b) Domestic subsidy or domestic support; and (c) Export subsidy. The implementation period for the country-specific commitments is six-year period commencing in 1995. However, developing countries have the flexibility to implement their reduction and other specific commitments over a period of up to 10 years.

The Agreement allows unlimited support to activities such as (i) Research, pest diseases control, training, extension, and advisory services; (ii) Public stock holding for food security purposes; (iii) Domestic food aid (iv) Income insurance and food needs, relief from natural disasters and payments under the environmental assistance programmes. (v) Investment subsidies given for development of agricultural

infrastructure or any kind of support given to low income and resource poor farmers are exempt from any commitments.

Implications of the Agreement on agriculture for Pakistan would depend largely on the overall agricultural scenario in the country. Pakistan's agriculture is characterized by a preponderant majority of small and marginal farmers holding less than two hectares of land. There is no doubt that during the last 30 years, Pakistan's agriculture has grown at a reasonable pace, but with stagnant and declining net cropped area it is indeed going to be a formidable task to maintain the growth in agricultural production.

Pakistan, with its cheap labour, diverse agro-climatic conditions and large agricultural sector can definitely gain through expansion of International trade in agricultural products. However, the concerns relating to quality of products for seeking markets in the advanced countries needs to be addressed on an urgent basis.

33. BARRIERS TO AGRICULTURAL EXPORTS FROM PAKISTAN: THE ROLE OF SANITARY AND PHYTOSANITARY REQUIREMENTS

The progressive liberalization of world trade has created opportunities for Pakistan to become integrated into the global trading system and to exploit its national and regional comparative advantages. Evidence suggests that Pakistan has a potential comparative advantage over developed countries in the production of many agricultural products, such as cotton, rice, fruits, flowers etc. However, the ability of the country to maintain or expand its world market share depends on its ability to meet the demands of the world trading system, not only in terms of competitive prices but also quality of exportable products and their safety standards. Technical measures such as food quality and Sanitary and Phytosanitary (SPS) requirements under WTO may likely impede future trade of agricultural products from Pakistan. It is argued that Pakistan lacks the needed resources to participate effectively in the institution of WTO, and thus may be unable to fully exploit the opportunities provided by the Sanitary and Phytosanitary (SPS) agreement. The research identified the means by which any negative effects of SPS measures on Pakistan can be reduced.

34. MARKETING INSTITUTIONS AND MARKET REFORMS IN PAKISTAN

Most of the rural markets in Pakistan are very old and in very poor conditions. While there has been considerable increase in the supply of and demand for the crops/products over the decades, there has been corresponding unplanned increase of markets sitting in the open sky without much space and improved market facilities. There is extreme congestion in those markets, in many markets due to limited/inadequate space the crops are assembled and transacted on the roads/lanes/bylanes seriously affecting the quality of the goods and efficiency of the marketing systems. Inadequate space in the markets limits the entry of newcomers and hence restricts competition. There is no efficient market accessibility of the small and marginal farmers in the market yard. The crops assembled in the open space are damaged in the sun and rains and the farmers sometimes are forced to sell their corps at lower prices in case of, particularly, no storage facilities where the farmers can store their crops and borrow money from banks against the stored crops. Most of the markets have no satisfactory transportation, communication, landing and handling facilities. There is no strong institutional mechanism for upkeepment of the markets advising fixation of the maximum market fees and enforcing the market fees and charges fixed by the market committees for realization from the market users. Introducing improved market practices like sales in uniform/standard/metric weights and measures and auction system which will raise the efficiency of the marketing system and settlements of disputes between buyers and sellers is the need of time.

Efforts are being made by the Government to increase productivity in agricultural sector. The progress has been done in different crop production. It is noted that the food grain production increased

significantly nearing self-sufficiency. Govt. has given thrust on diversified crop production. Accordingly need of sustainability thrust sector for rural Infrastructure development has been to ensure fair prices to the growers. The sustainability of increased production and its proper distribution is essential. As markets are erratically located here and there the efficient marketing practice is poorly done. With this object in view Govt. has recommended improvement of marketing system with proper development of new markets where the growers can dispose off their crops. The present condition of the markets is far from satisfactory. Markets need to be classified according to the development needs and layout plans showing approach roads, display sheds, internal roads, storage, loading/ unloading facilities with provision for drinking water and sanitary facilities. This will help successful implementation of the production progrmme in agricultural sector and improve national economy.

35. MANAGING WHOLESALE MARKETS

Wholesale markets in Pakistan are distinctly categorized into small rural markets, primary markets at the sub-divisional or tehsil level and central wholesale markets at the district level. The central wholesale markets absorb bulk of the marketed produce and are the basic source of supplies for retailers in the larger cities and for wholesalers supplying retailers in more distant centers. These markets also constitute the main outlet for nearby growers and through commission agents and contractors, for those further a field. In addition, these markets are the main centers for the sale of imported produce and that on which exporters also rely for their supplies. The agrarian economy of Pakistan is producing a considerable amount of marketable surplus for all major agricultural commodities. Except for a small part of produce retained at farm for home consumption, almost all these volumes have to pass through this system of wholesale markets in order to reach ultimate consumer. Karachi Lahore and Faisalabad are the typical examples of central wholesale markets. At present there are reported to be over 700 fruit and vegetable wholesale markets in Pakistan. The province of Punjab occupies the largest proportion followed by Sindh, NWFP and Balochistan. We can really quantify the benefits of our production system by improving wholesale market setup, which will ensure fair returns to the farmers and market intermediaries. These benefits then can be channelized to increase consumer's welfare, which will eventually lead us to the ultimate goal of national development.

36. WTO REGIME: MARKETING ISSUES

The slogan of globalization was promoted to enhance the overall welfare both for consumers and producers in the international market. World Trade Organization (WTO) was one of the most authentic tools used for this purpose. The basic theme of WTO, objective of which is to promote free trade, is based upon the principle of comparative advantage i.e. to utilize the available global resources in the best possible manner. In the coming days of trade liberalization, marketing of agricultural products will become a more sensitive issue than others. Developing countries like Pakistan, the existing infrastructure of which is not conducive for the efficient marketing, need to concentrate more on the provision of requisite marketing facilities on priority basis. Here many of the developing countries are little unfortunate in the sense that they have to observe two way obligations i.e. WTO and other IFI's, which are contradictory. In the domestic market setup, there are certain issues, which need to be addressed. After producing the agricultural commodities on scientific basis, we need to assemble and handle those in a more careful manner. Suitable transportation facilities, which will ensure less physical hazards, should be provided to increase the marketed surplus. Appropriate wholesale market setup with proper provisions for handling and storing the commodities, especially for perishables, is necessary for enhancing consumer welfare through the provision of quality products.

37. IMPROVING MARKET INFORMATION SERVICES

The decision making by the farmers in the past was easy because they planted the crops their neighbors planted and sold in the way adopted by the majority. The situation is now changing in a way that farmers

have to be more market oriented with individual decision making about what, when and how to market their produce. The major reasons behind this changing behavior include reduction in the govt. interventions, increased urban demand, improved cultivation techniques, increased opportunities of trade in local and international market and improved market information services. The availability of reliable information helps the farmers to bring their production pattern in line with market demand. The farmers, who are living in an information vacuum, are not sure of the prices they will be getting for their produce. Due to this constraint the farmers, who take or send their produce to distant markets, sometimes even do not cover their marketing costs such as transport, handling and marketing fees etc. This information gap also results in fluctuating market arrivals for agricultural commodities, which causes serious disturbances in the national economy. This often happened when we produced bumper wheat crop during the year and had to import the same in the next year. Same type of phenomena was observed in case of onion, potato and sugar. Sometime we find these commodities in bulk waiting for customers but next time we welcome them as 'Chief Guest' in the wholesale markets.

38. WTO REGIME: LIVESTOCK SCENARIO

Livestock is an important sector of agriculture in Pakistan, second largest contributor in agricultural GDP after crop husbandry, which accounts for 39% of agricultural value added and about 9.4% of the GDP. Its net foreign exchange earnings were to the tune of Rs. 51.5 billion in 2001-02, which is almost 11.4% of the export earning of the country. The role of the livestock in the rural economy may be realized from the fact that 30-35 million rural population is engaged in the livestock raising, having household holdings of 2-3 cattle/buffalo and 5-6 sheep and goat per family deriving 30-40% of their income from it. It has been observed in the developing countries that buffalo/cattle rearing have shielded the poor against poverty by ensuring them reasonable livelihood. The livestock include cattle, buffalo, sheep, goats, camels, horses, asses and mules. The major livestock products include milk and meat whereas livestock by products include wool, hair, skins, hides, blood and bones. In the coming regime of WTO the countries need to get their specialties patented under Agreement on Trade Related Intellectual Property Rights (TRIPS). So the species which are considered to be the special privilege of Pakistan should be documented with the World Intellectual Property Organization (WIPO). For this purpose, firstly we have to register these species with the Pakistan Intellectual Property Rights Organization (PIPRO) and then with the WIPO. Different important breeds of buffaloes (Nili-Ravi and Kundi), cattle (Sahiwal, Red Sindhi), goats (Beetal, Nichi and Kamori), sheep (Lohi, Keghani, Damani and Salt range) etc. are asset for Pakistan and need to be registered. Animal by products, such as skins, hides, blood, bones, hair, lard, tallow and various animal organs, can be processed into products of value. Hides and skins can be preserved and transported to tanneries.

39. PROMOTING A MARKET ORIENTED VEGETABLE AND FRUIT CULTURE

In Pakistan, total production of fruits and vegetables in the year 2001-02 was estimated as 5900881 and 2873741 tonnes respectively. Major contribution in fruit and vegetable production comes from the province of Punjab i.e. 60.67% and 72.45% in case of fruits and vegetables respectively. Balochistan stands second in the production of fruits with 15.96% share whereas in vegetable production NWFP has got the same status with 12.48% share in total production. Pakistan has various geographical pockets which are suitable for the production of one or the other commodity. Northern areas are suitable for the production of deciduous fruits, southern Punjab i.e. Multan, Rahim Yar Khan, is famous for mango production, Sargodha and Bhalwal are citrus growing areas and Okara and Sialkot are mainly known for potato production. Careful handling and packing can increase the time intervals between harvest and consumption. Timely availability of quality information is the basis for developing an efficient marketing system. When producers are quite sure about the demand in the market with expected prices only then they can plan their farming activities in a more positive way. Since fresh produce is usually seasonal, a market may exist for processed fruits and vegetables which are available year round. Processing can also be used to extend the life of the produce, reduce its volume for transport, or utilize the "surplus" supplies

that exist at the peak of the harvest season.

40. WTO: MAKING PEOPLE FOOD SECURE OR …….

Food security is recognized worldwide as a basic human right. Despite the fact that in the last decade global community had focused its attention on agriculture specially on food products but the problem of food insecurity continues to exist rather the gap has increased particularly in the developing countries. Food and Agriculture Organization of the United Nations (FAO) reports that about 830 million (792 million people in the developing and least developed countries and 30 million in countries in transition and 8 million in developed countries) are suffering from under nutrition or chronic food insecurity. Some two billion people are anemic because of iron deficiency while between 100 to 140 million children suffer from Vitamin A deficiency and another about 740 million are suffering from disorders related to iodine deficiency. Majority of those undernourished are found in Asia and Pacific (515.2 million). There are many losers and winners in the globalization of agriculture with reference to food production and trade. Losers are the marginal farmers and landless people in the developing countries the livelihood of whom is at the stake due to increased commercialization of agriculture. Winners are the few corporate giants who control the world food and agriculture system. They are the food TNCs that are producing foods which they assure are good for us from the cradle to the grave. Their dominance is shown by the fact that only few TNCs control the production and exports of these food commodities and agriculture-related businesses. There are only three corporations, Chiquita, Del Monte and Dole which control 65-70 percent of world banana exports, only two companies which control the distribution of 80 percent of world grain, three corporations which control 85 percent of tea trade, ten companies which corner 80 percent of sales of pesticides and five seed companies namely Monsanto, Novartis and Zeneca, Aventis, and Dupont virtually control 100 percent of the transgenic market and 23% of the global seed market. The new trend, in the international market, is more concentration of market power through the rapid vertical and horizontal integration, mergers and alliances of multinational firms. There are now fewer companies of the developed world but they occupy the lion's share in the trade of food stuff leaving very less market share for the firms from developing countries.

41. MARKETING OF JUTE IN PAKISTAN (NATIONAL AND INTERNATIONAL ASPECTS)

In this study all aspects of jute marketing were explored with special emphasis on exploring the possibility of substitution by artificial fiber as the technology advances. In the mail consuming countries, the demand will remain static as they have started using man made fiber. The increase in jute production could only be possible by diverting the acreage from other crops to jute. The study highlighted that attempts have not been make to rectify the various marketing flaws relevant to domestic and export trade to jute.

42. MATKETING OF WHEAT IN PAKISTAN (NATIONAL AND INTERNATIONAL ASPECTS)

A comprehensive study was conducted which covered domestic and international aspects of wheat marketing and production trends. The outcome of deficiencies in the marketing system is a substantial increase in the marketing margins without con-commitant benefits to producers and consumers. The disorderly marketing conditions result in disconcerting fluctuations in farm incomes which consequently effect the marketable surplus. Need for further research to diagnose the various market imperfections in case of wheat was emphasized.

In order to cope with the present and potential problems in wheat trade, all policies viz; price, marketing and structural policies for wheat ad other food grains need to be coordinated and changed in line with the international situation. This would give rise to system which is sufficiently flexible to absorb the internal and external shocks together with ameliorating the condition of producer's consumers, trade ad state at large.

43. MARKETING OF MILK IN THE PUNJAB

A study on marketing of milk in the Punjab concluded that supply is much short of demand and a shortage of 2717 thousand metric tons of milk was estimated. The shortage n the supply is met by processed imported milk. About 9 thousand metric tons of whole milk, 11 thousand metric tons of skimmed milk and 1.5 thousand tons of mild for infants was imported in the country in 1976-77.

The average marketable surplus was estimated to be 48 percent of total milk production. Losses in milk at various stages like handling, transportation and forced surplus (left unsold) etc., came about 3 percent of the produce sold.

The marketing margins of the milk carrier came at Rs. II per maund leaving him a net profit of rupees 2 per maund (28 percent). The arhatiya is only present in big cities like Lahore, his margins were rupees 9 per maund leaving him a net benefit of rupees 5 per maund (55 percent). On and average, the margins for milk, curd and sweets at retailers level were ass3essed at rupees 10, 30 and 192 per maund respectively. Deducting the cost of rupees 4, 33 and 55 the profit component arrived at rupees 6,27 and 137 per maund for milk, curd and sweets, respectively. The corresponding net profits were 60,90 and 7, percent of the total margins for milk, curd and sweets, respectively.

The distributive margins of whole milk, normal milk, curd and butter for Lahore milk plant were estimated around rupees 20,50, 1.12 and 368.36 per maund, respectively. After giving due allowance for the cost margins of rupees 34.37,34.37,23.84 and 297.67 for whole milk, normal milk, curd and butter, respectively, the corresponding net profit stood at rupees 14.32, 33.55, 22.73 and 70.69, respectively. The study came up with the following recommendations.

a. In order to bridge the widening gap between supply and demand for milk the government should (a) encourage dairy farming in the private sector through providing adequate incentives such as credit facilities, technical know how, health cover, etc (b) Propagate the indigenous high yielding dairy breeds, (c) establish grazing lands in low productivity areas of the province and (d) initiate large scale production of cheaper and quality dairy rations.

b. Mini milk plants or small processing units may be established in remote areas where milk production is in abundance.

c. For reactivation of the milk plants lying idle and for optimum utilization of operational milk plants, credit on easy terms should be provided/enhanced.

d. Credit to milk producers should be provided by banks against livestock sureties.

e. An effective competition should be provided to the milk carrier by organizing the producer cooperatives and by establishing chilling centers in the rural areas.

f. In order to curtail the excessive profit derived by the retailers, effective competition should also be provided at retail level. Like the sale booths of the Lahore milk plant, milk should be supplied I packets (or bottles) of adequate size through cooperative/utility stores and private stores.

g. Imported milk powder and other diary products have resulted in a tremendous loss to the local to the local dairy industry. It was, therefore, suggested that import may be restricted to match with the actual local demand and not the potential demand.

44. POST HARVEST LOSSES OF FOODGRAINS

Pro-harvest losses were calculated in a study on wheat crop. The study estimated the pre-harvest produce losses in wheat by birds. Some other factors had also been taken into consideration. The sampling technique developed to measure the losses is of special mention and of great benefit. Birds

were the main source o flosses in the standing crops. Then come the fallen ears and the diseases etc. The average losses was estimated to the tune of 4 percent. Variety wise losses ranged 4.14 in Maxi Pak and 3.66 percent in Chenab 70. Furthermore, the calculated loss was found out as 2.69 percent and according to farmer's opinion to was 5.6 percent.

Post harvest losses for various crops were estimated in another study based on nation wide survey of the country for the determination of post-harvest losses in wheat, rice and maize. It is based on the assumption that production and consumption stages of agricultural produce are inter-linked by an important segment of the post harvest stage which comprises a set of operation involving degrees of loss occurrences. A significant proportion of wheat that is produced get wasted in one form or the other. It brings about inefficiency of resource use, underutilization of production potential via lower returns to the producer, qualitatively poor as well as quantitatively inadequate availability of food grains to the consumer. Accurate identification and location of the stages of loss occurrence including the isolation of various casual factors has assumed over significance of researchers ad planners both at national and international levels. The present report summaries views expressed in previous five volumes of the series oh "Food grain Losses". Main findings of the present report are delineated as under:-I) Aggregate losses in wheat are estimated at 1.47 percent, being contributed by the stages of loss occurrence like storage 0-56 percent and transportation 0.48 percent.

i) Similarly, aggregate loss in rice (paddy) was estimated to be 1.37 percent which was shared partly by handling to the extent of 0. percent and by storage as much as 0.35 percent. In case of maize, the loss was estimated at 1.35 percent, being shared mai8nly by storage to th4e tune of 0.63 percent and sun drying to the tune of 0.45 percent.

ii) At market level, the aggregate loss in wheat stood at 7.884 percent, being mainly contributed by losses at processing and retail levels. As for rice, aggregate loss estimate stood at 10.640 percent was again contributed mainly by loss occurrence at the processing and retail stages, Similarly the losses in maize at market level were estimated at 3.175% being contributed mainly by the wastage occurring at processor and village beopari level.

iii) Aggregate food grain losses in the public sector were calculated to be 5.449 percent of wheat, 4.199 percent of rice and 3.05 percent for maize. These were contributed mainly b storage losses and only slightly by losses at terminal level.

iv) Consumer level aggregate losses were estimated at 7.97 percent for wheat. These were contributed mainly by loss occurrence at the food preparation stage, losses at hotels and messes, and losses during storage. Losses in rice were found to be 6.97 percent shared mainly by losses at the food preparation stage, losses at hotels and meases and the sun drying stage. As for maize, losses took place to the extent of 6.86 percent, contributed in greater part by loss during food preparation stage.

v) On Aggregates basis, the losses in wheat, rice and maize were found to be 15.37 percent in wheat, 17.185 percent in rice and 12.698 percent in maize. These were mainly contributed by losses at the stage of loss occurrence like consumption and market level.

vi) From functional standpoint, the losses in food grains mainly took place during storage, processing, threshing stage, sun drying and handling etc. No doubt, it was felt that these was need for the improvement of transportation operation also. The study made the following recommendations.

i) In view of the forgoing discussion, following suggestions are put forth for the minimization of produce losses which may be adopted. It well involve the consideration of all the relevant functions tighter as a complementary set, instead of treating each function in isolation from the other, because the solutions may be common to some of the problems, like mechanization may be one solution for the reduction of produce losses. So to say, use of mechanical

thresher/combine-harvester in place of bullock threshing will reduce threshing losses. Similarly, use of trolley will ensure lower losses and efficiency of transport, as compared to the bullock cart/rehra etc. Mechanization in sun drying and handling operations can reduce losses in the performance of these functions. The beneficial effects of such an approach will not be confined to food grains only, but also extended to other kind of agricultural produce.

ii) An important functions performed at post harvest stage is the storage of farm produce. Agricultural produce is stored at all important levels of marketing viz, farm, market and consumer levels etc, involving varying degrees of loss-occurrence. A multidisciplinary approach for the solution of storage problem is needs to examine the engineering, economics and entomological aspects of storage. IT will be more appropriate, if an optimum storage design is prepared keeping in view the requirement of producers, market intermediaries and consumers. Such a solution must be economical enough to be quickly adopted by the relevant agencies.

iii) Public sector is characterized by considerable storage loss in food grains. As the quantity stored in this sector ruins into millions of tons, even a small percentage loss implies the loss of millions of dollars which will be sufficient to cover the cost of any remedial measure, adopted for this sector. A suggested solution will be the adoption of quite modern storage designs like modern silos, for keeping bulk stocks of food-grain at certain strategic places in the deficit and surplus producing regions of the country. Such stores can be located at the level of a district for the receipt and disposal of food grain supplies.

iv) To minimize loss occurrence in food grain at consumer level, it is suggested that vast propaganda campaign and dissemination of literature relating to consumption losses may be distributed for the educations of consumers.

v) It is proposed that a department with the sole objective of loss prevention in agricultural produce may be created at Federal level with its sub-offices located in each province. The functions of such a department will be.

i) To promote research in the estimation and prevention of losses in agricultural produce.

ii) To encourage the development of technology aiming at the prevention of losses.

iii) To influence public policy relating to allocation of resources for the prevention of losses I farm produce.

iv) At present, almost whole of effort of the Government is directed towards increasing agricultural production and virtually no attention is being paid towards the minimization of produce losses. An objective analysis of investment in avoidance of losses would indicate that it will yield fairly high returns for two major reasons.

i) Investment in loss prevention would increase returns to the produce in the welfare function of all classes.

ii) Better returns to agricultural production will generate further incentives for increasing agricultural production.

45. IMPORTANCE OF FARM MARKETING

Small farmers have no capacity to use new technology for cultivation. Poverty also results due to the poor provision of services by middlemen (acting as a 2nd buyer between grower and consumers). They do not contribute in growing but get away 40-50 percent share and farmer gets only 50-60 percent share of his product. Direct marketing is considered as an alternative to ensure fair returns to farmers by eliminating the middlemen. In reality, the exploitation of farmers is due to their ignorance of farm marketing. Our farmers are illiterate ad unaware about post harvest and management practices like cleaning, sorting, grading, storage and proper packig. There is a need to provide training to all stakeholders who are

involved in the agriculture marketing like farmers, traders, trade supporters etc. Training to stakeholders is also needed in marketing functions like storing, grading, packaging, proper transportation and method of bargaining in the market. The importance of marketing has increased in Pakistan due to market surpluses being generated from various agriculture commodities like wheat, rice, etc. Therefore, effective and efficient farm marketing is important to reduce the poverty in rural area and to ensure fair returns to producers.

46. RURAL WATER MARKETS IN PAKISTAN; PREVALENCE, PROBLEMS AND PROSPECTS

Water markets have been in operation in many countries including Pakistan. Although informal water markets have been in operation since decades, they are gradually developed in Pakistan over the past two decades. The formal markets having well defined, private and transferable water rights are relatively of recent origin. The recent evidence in Pakistan shows that informal markets are developing over time and canal water is freely traded, often sold and bought. The survey results revealed that 6-7 percent of the sampled farmers buy and sell water at head and 20 percent sell water at the tail end of the distributaries. However, over 80 percent of head and middle farms trade water. The canal water rate varies from $ 2-$ 3 per hour mostly to neighboring farmers. The sale of ground water is quite common and due to short supplies of surface water; conjunctive use of water is increasing. Almost all tube well owners at and head middle reaches sell water, where as over 50 percent tail enders sell water. The tube wells water rate varies from $ 1.00 per hour to $ 3.00 per hour. The distance over which water can be transported provides a limitation to water market sales, but lined watercourses increase the distance over which tube well water can be sold. Unreliability of access to purchased tube well water is another problem for water buyers. Purchasers are more likely to have unreliable access to groundwater if they buy water from small-capacity, electric-powered tube wells, if they are young and own little or no land. Policy measures to improve access and reliability of groundwater through water markets include increasing the density of tube wells, especially by assisting small farmers to purchase tube wells; lining water delivery channels; and providing more reliable electrical power supply to rural areas. Furthermore, the replication of Participatory Irrigation Management will improve reliability of irrigation water and canal supplies will be increased.

RURAL SOCIOLOGY

WOMEN EMPOWERMENT THROUGH MICRO CREDIT SCHEME: (A CASE STUDY PRSP SARGODHA)

Pakistan has been blessed with abundance of natural and human resources, so it is necessary to utilize all of its resources to fulfill the desire for achieving maximum economic progress. Both males and females work and contribute economically for improving the living standards. Women constitute the major part of our population. Rarely, women are given equal rights and status with men. A woman, participation in national development is an important issue, which received considerable attention of several developing countries in recent years. Yet, there is a lot of discrimination on the basis of sex. Pakistan is facing, today rising poverty; almost one third of its population has been classified as poor, meaning 46 million people living below the poverty line. Majority of the loanees (Women) in different COS were having skills but shortage of income, they could not running successfully their business. It is concluded that micro credit for rural females is acceptable and effective method to reduce poverty and improved them economic and social lives.

EFFECT OF SOCIAL INSTITUTION ON MIGRATION

It is the need of the time to realize the influence of basic institutions such as social, economic, political, health, and religious on basic demographic process of migration. How migrants behave differently, when confronting dynamic changes particularly at the urban environment. The purpose of the study is to understand the rural to urban drifts concerning certain; aspiration and motivation, which compel people to migrate after, perceive institutional opportunities at the possible place of destination. The study focuses on the specific changes occurred in structure of social institutions that profoundly affects many aspects of an individual's life in the urban environment. The study was planned to investigate the factors which stimulate the migrants for migration and to examine the basic functional/structural changes in the social/ economic institutions after migration.

Migration is the term, which refers to change in domicile of persons. The initial migration is usually motivated by some feelings of inadequacy and insecurity within the structure of social and economic institutions of old place and by the hope of resolving this insecurity in the new setting. Availability of alternative pursuits and opening of new vistas of employment due to development in industrial sectors, people had migrated and are still migrating from rural to metropolitan areas. Economic and social motives such as opportunity of occupation, better facilities of education and health; religious, political and cultural activities and personal and family maladjustment of the children are determining migration dimensions. It involves considerable structural and functional changes in the social and economic institution both at place of origin and destination.

It is quite evident that migration from rural to urban areas is related to the cycle of prosperity and depression. In Pakistan urban population is increasing at the rate 4%. One of the major reasons of growing population of urban areas is rural to urban migration. It is adversely affecting the development process of rural and urban areas. Several types of economic and social disorders are creating in the urban areas like unemployment, and social disorders, inflation, lack of sanitation facilities, contamination of environment, transportation problems, shortage of living space and high rate of crimes. In order to control the flow of rural migrations, allocation of large share of developmental funds by the Government for the provision of basic amenities of modern and comfortable life i.e. educational and health opportunities, sanitation, nutrition, roads, transportation and recreational facilities are suggested along with economic opportunities. Children are the most valuable future assets of Pakistan. They are our future hopes. About 45percent of these under age of five in developing countries, including Pakistan, are living

in absolute poverty. Scour-economic pressures compel thousands of children in Pakistan to face the hardships and harsh realities of labour for small monetary gains. In Pakistan most children under 15who constitute 45 percent of the country's population, live below poverty line and are subjected to all sorts of exploitation are callously overlooked. A brief description of working children may be child who reforms adult roles. Child labour is the direct result of the usage of children by adults. The present study was designed to find out the major causes of child labour, Such as push the young children to work. the present study was limited to the children working in automobile and engineering workshops of Tehsil samundri but the magnitude of the problem is so large that a more comprehensive study on a wider scale needs to be conducted to gain further knowledge and incite in to the nature and magnitude of the problem of child labour in specific fields, in particular, in carpet weaving, tailoring, hotels, farming and agriculture. Newspaper selling, boot polishing and brick kilns. Only a through countrywide empirical investigation could enable proper planning and devise effective measures to overcome this complex problem.

SOCIO-CULTURAL AND DEMOGRAPHIC PROFILES OF PAKISTAN

Pakistan is facing the high rate of population growth along with high level of infant and child mortality. Although the economy of the country has an encouraging growth rate but incapable to afford the burden of accelerated population growth. Government's efforts to bring down the population growth down through popularizing the family planning programme in the country seem to be not very successful. Discussion pinpoints that the accelerated population growth rate is badly affecting socio-economic and environmental conditions in Pakistan. Many children particularly sons and are believed to the important in the socio-cultural context. The failure of the family planning programme in achieving population targets is also generally felt to be relevant within the framework of beliefs, values and norms of Pakistan people.

SOCIOLOGY OF CONTRACEPTION IN THE CONTEXT OF ISLAM

The high level of fatalism regarding procreation with low sense of personal effectiveness in controlling fertility and prohibition of contraceptive use (perceived by people) in Islamic for birth spacing are undoubtedly responsible for high fertility in Pakistan. The Islamic view point of the issue of fatalism and contraceptive use clearly demonstrates that pronatalist tendencies in Islam tem less from direct injunctions to procreate than from the support of other socio-cultural non Islamic values and misinformation about the religion. Islam imposes restriction, on procreation in terms of responsibilities involved in children's socialization. Islam does not encourage the view point that predestination that makes a human being skeptical with regard to control over his own actions. The use of wisdom to plan every day life for the betterment of family and society is according to the principles of Islam. A number of hadiths permit the use of Al-azl or coitos interruptus' as a method of contraception. From the findings of this study it can be argued that fertility declines is only possible when it is no longer regarded as fatalistic and comes into the realm of perceived personal control.

CULTURAL DIMENSIONS AND THEIR INFLUENCING ON REPRODUCTIVE BEHAVIOUR

It arises from the literature review that cultural is defined as totality of learned socially transmitted behaviour or customs. It describes and seeks general understandings about the human customs and behavior. Culture is concerned with actions, ideas, beliefs, and artifacts which individuals in the society concerned, learn, share, and value. These actions, norms, values and beliefs about ant particular issues are transmitted from one generation to the next generation through the gradual development of human mind. Desire for children or childbearing is reinforced by the social system through rewards and punishment. These decisions are socially reinforced internalized and recognized. Briefly, human reproduction is the biological phenomena assisted by a belief system and learned behavior. The literature review suggests that explanation of fertility and contraceptive behavior is seen within the framework of cultural ideology in terms of women's extra familial contacts, egalitarian roles of husband and wife, roles segregation, family values and obligations and fatalism. It is also suggested in literature that utilization

behaviour of health facilities and family planning attitudes in terms of subjective costs(fear of serious and minor side effects, normative and psycho costs) also offer explanation in fertility and

SOCIO –ECONOMIC IMPACT OF INFRASTRUCTURE PROVIDED BY PUNJAB RURAL SUPPRRT PROGRAM (PRSP) FOR THE DEVELOPMENT OF RURAL LIFE OF TESIL SAHIWAL

No program in rural development can be successful until and unless it can win the cooperation and favorable attitude of the people, for whom it is implemented. So, the addition to and improvement in the existing physical infrastructure with community participation is one of the essential elements of PRSP operations, physical infrastructure is normally considered as one of the strongest and the most visible indicators of development with a high demonstration effects, main objectives of study were to explore the socio-economic conditions of the respondents and to study the nature of infrastructure. Despite predominance of agrarian communities, the socio-economic conditions of the rural dwellers in about 45,000 villages, is far from satisfactory level. The present conditions in rural areas are dismal. An average villager has no access to the services and facilities accruing from development. In the past, a number of developmental programmers were launched but their impact on reducing the rural poverty was nominal. Identification of the problems followed by priority fixing decision is the first major step towards motivating the people to activate for community welfare. The rural people themselves are in the best position to identify their needs, and suggest solutions. Consequently, the people, who are the most important resource endowment in the rural areas need to be effectively involved in decision making, designing, planning and executing the developmental plans at local levels. Rural areas of Pakistan where 65 percent of its population lives are deficient in terms of infrastructure work in spite of the impetus given to this activity in the fifth five year plan, The sixth five year plan lays special emphasis on accelerating the pace of growth in the agriculture sector and improving the quality of the life in the rural areas. There has been considerable slippage in the growth of capacity in infrastructure sectors during the eight plan period, In view of this, even in the baseline scenario of 6.2 percent growth, there is a need to improve the efficiency and capacity utilization of the existing infrastructure assets .In the accelerated growth scenario of the 9th plan, such steps would need to be taken with even greater vigor. It is recommended that the government should allocate additional resources to the construction of infrastructure facilities in the rural areas. There is a need for an in depth study on this subject with adequate sample covering various parts of the Punjab province The co-operation of local community in the form of community organizations (COs) with the efforts of PRSP's workers is a best example for the development. It should be sought on a great extent than is presently the case and credit should be made available to the farmers with minimum bureaucratic formalities in such a plans.

A SOCIOLOGICLA STUDY OF PARTICIPATION RURAL WOMEN IN AGRICULTURAL ACTIVITIES IN DISTRICT KHANEWAL

Pakistan's economy has undergone considerable diversification over the years. Yet the agricultural sector is still the largest sector of the economy with its present contribution to GDP at 23.3%. It accounts for 42.1% of the total employed labour force and is the largest source and is the largest source of foreign exchange earnings by serving as the base sector for the county's major industries like textile and sugar. It also contributes to growth by providing raw material as well as being a market for industrial product (Govt. of Pakistan, 2004). The population of Pakistan is 148.72 million during year 2004 with a growth rate of 1.9% (Govt. of Pakistan, 2004). Whereas, in rural areas the population was 45.42 million for male and 42.70 million for female (Govt. of Paksitan, 2003). The unemployment rate has shown an increase from 7.8% in 1999-2000 to 8.3% in 2001-2002, this increase has been observed for males only. Females are highly unemployed (16.5%) as compared to males (6.7%). Pakistani women play a vital role in agriculture and livestock besides her household works. They participate in all operations related to crop production such as sowing, transplanting, weeding and harvesting, threshing, winnowing, drying etc. and livestock works like handling of milk production, animal care, fodder cutting etc. along with along the normal domestic cores of cooking. Taking care of children, elderly and disabled, fetching water and fuel, cleaning

and maintaining the house as well as some of its construction. They work for 12-15 hours a day on various economic activities and household chores.

Rural women are the workers seen as invisible farmers working in the field but their activity is grossly underestimated in all surveys and census e.g. that 1991-92 Labour Force Survey revealed that only 16% of women aged 10 years and over in the labour force and in comparison, the men's participation rate in agriculture was 73% and that women accounted for 25% of all full time and 75% of all part- time workers in agriculture households. Also, main objective were to identify the factors which affect female participation in agriculture activities. Pakistani women play a vital role in agriculture and livestock besides her household works. They participate in all in operation related to crop production such as sowing, transplanting, weeding and harvesting, threshing, winnowing, drying etc. and livestock works like handling of milk productions, animal care, fodder cutting etc. along with the normal domestic chores of cooking, taking care of children, elderly and disabled: fetching water and fuel: cleaning and maintaining the house as well as some of its construction. They work for 12-15 hours a day on various economic activities and household chores. In our country the female participation in livestock care and management is 60.0%to 80.0%. They spent most of their time in the collecting and bringing of green fodder form the field. Rural women engaged in various tasks like production of animals, sales of animal, s products and by products (ghee), cleaning, watering and bathing the animals. Government should took initiative with the collaboration of NGO's to eliminate the poverty especially in women

VALUATION OF GREEN SPACES IN SOCIAL LIFE A FOCUS ON PARKS AND GARDU

Urbanization has brought with it many transformations in cities. Congestion of homes, reduction in green areas, increased levels of greenhouse gases, smoke, and dust are making cities increasingly unhealthy. Open spaces are an integral part of cities and they contribute significantly to urban structure as well as are important for aesthetic sense. Urban vegetation plays an important role in providing pollution free environment. Urban vegetation includes parks, gardens, playgrounds, home gardens, roadside plantation, and cemeteries. Gardens and parks can be threatened, as can other monuments, by uncontrolled urban expansion and industrial development. A park is a pleasure ground suitably landscaped. In the urban park, the emphasis is on recreation and education about environment and ecology Gardens that are built and maintained by community residents had provided opportunities for neighborhood residents to develop and control part of their neighborhood, an advantage not afforded by traditional parks.

Gardens are active places that people use for socializing. To study the role of green spaces in urban environment and to identify the psychological, social, personal, environmental and health benefits to people from green spaces, a study is conducted. Valuation of green spaces and plants in improving social life is well known, The parks and gardens are considered lungs of a city. The parks and greens are not only aesthetically pleasing; they provide a number of social benefits along with some therapeutic values. Parks are needed now more than ever, as our lives have become so fast-paced, without parks, where we see the miracle of nature with each visit, merely exist. We don't really live. Gardens have also played a significant role in improving the environment. Much emphasis has been laid on development of gardens and public parks in many cities, towns, and residential areas. Keeping in view the importance of parks and recreation facilities, it seems imperative to study the social valuation of these facilities. There should be specific timing for males and females to visit parks and these parks should be full of basic requirements.

SOCIO-CULTURAL AND DEMOGRAPHIC FACTORS AFFECTING CHILD HEALTH

Child and maternal health and good quality of life is the need of all. Children are the future builders of every nation. Future of the nation depends upon the health of the children. Healthy children would turn up into healthy nation of tomorrow. Children's health can be best examined in the light of the level of infant and child mortality prevailing in the society and also it is the mortality is an indication of discouraging

socio-economic development and along with the poor Government commitment for improving health status of its nation. Like many developing countries, Pakistan too, is facing with problems of high infant mortality, the significance of phenomena of infant mortality is hardly irrevocable for its socio-economic and demographic implications. As infant mortality, in general is considered to explanative of overall socio-economic education of mother, household income occupation of father, standard of living etc., and other demographic factors such as age of mother at birth, birth interval and health care factors like medical facilities and immunization will be studied in observed infant mortality. Therefore, rural areas of Pakistan have become challenge to planners, sociologists, and administrators and even to politicians to chalk out some programmers to overcome the serious health problems particularly the high level of child morbidity and mortality. The social network plays an important role in shaping the community health behaviour witch adversely influences the health of child. Child health care practices refer to interaction between parents and children. This interaction includes expression, attitudes, values, behavior of parents and children. The health conditions of the children in Pakistan are not very encouraging. Children are suffering in many diseases. The level of infant mortality in Pakistan is around 80 infant deaths per 1000 live births, which is high as compared to neighboring countries. Government is spending a huge amount to improve the health status of mothers and children for achieving the agenda to improve the health status of mothers and children. Still we are far behind with respect to global realities.

THE PARTICIPATION OF FEMALES IN INCOME GENERATING ACTIVITES THROUGH MICRO CREDIT PROVIFED BY URBAN POVERTY ALLEVIATION

Women's participation in the National development is an important issue, which received considerable attention of several developing countries in recent years the objectives were to study the socio economic characteristics of the respondents. Women are an integral part of every society. However the status and role-played by her different from society to society. Generally in the developing countries, she is considered dependent. She in encircled by the age, old customs, low literacy level, un paid manned labor, and unbroken cycle of child bearing, The changing situations in these society has demanded new role for the women which thus now form a large part of the home industries labour force. Pakistan is facing today the rising of poverty, almost one third of its population has been classified as poor, 46 million people living below the international poverty line Approximate determinants of poverty are un-employment or low productivity of resources so that they can effectively meet their basic needs that ultimately help in up grading their status within and out side the home, It has been observed that monetary contribution to the household by women leads to their empowerment. So, along with the rural development, National Rural Support Programme (NRSP) desired to cater to the needs of Urban poor. This desire coupled with the Finance Ministry's request to rest the applicability of the Graman Bank model in Pakistan, initiated the thought process that culminated in to the launching of urban poverty Alleviation project (UAPAP). UAPAP commenced operations in June 1996 in the Urban/ pre urban areas of Rawalpindi and Islamabad. Now it is also working in the poor slums areas of Faisalabad District. The project aims at improving the quality of the low-income people living in urban areas as well as an indigenous model to alleviate poverty in the urban areas to Pakistan. The present study based on UPA Project with special reference to Faisalabad District. Study shows that although majority of the respondents were illiterate as 67.5% yet they wanted to improve their status in family and community. Some loanees complained about the less amount of credit, they said that it is less for the business, which they want to run. So the amount of loan should be according to the type of the business. In order to make UPAP scheme more successful it should be extended in to more districts so that it may be more useful for the people of other areas.

WOMEN PARTICIPATION IN DECISION MAKING PROCESS REGARDING AGRICULTURAL BUSINESS AND FAMILY: *A CASE STUDY IN GOJRA*

Decision- making is defined as a volitional act resulting in a sequence of actions leading to achievement of goal through transformation initial information in an uncertain situation. Decision making is the central process at all levels of data processing and psychological control within a system of purposeful activity,

Decision taken at farm and household are many, varying from economic to social nature. Objectives were to find out the basic characteristics of rural females and to investigate the participation level of rural female in agricultural activities. Major advancement in the cultural, intellectual and scientific fields is attributable to a few gifted and talented persons. The distribution of talent in any given populations is random. Women are thus as much likely to contribute to the national talent pool as men. In Pakistan especially in rural areas women are much exploited due to social taboos as well as ignorance, They are totally unaware of their rights in society and home as a mothers as wives and as citizen, The incidence of women labor force participation is very low in Pakistan. According to the labour force survey, 1999-2000 female participation rate was merely 14% of the total labour force. Women's economic participation is significantly influence by factors such as their, age. education and marital status; One of the obvious reason of low participation women in labor force is the role and status accorded to women folk in our society. Most of them are considered housewives responsible for household activates. Women are silently contributed for the welfare of their families and society. It is generally observed that there contribution remain unacknowledged both at family and the society level, due to this attitude the women social status is severally affected and ignored. Effective education with out discrimination of area and gender should be given to the women

WOMEN PERCEPTION ABOUT DOMESTIC VIOLENCE: A CASE STUDY IN DISTRIC FAISALABAD

The status of women in society is neither a new issue nor is it a fully settled one. The social science affirms that a women's place in society marks the level of civilization. Every civilized society accepting the importance of equality of sexes has therefore, made affirmative provisions against gender discrimination. Objectives were to study the socio-economic characteristics of the respondents and to study the type and causes of violence against women Pakistan is a developing country and almost half of its population consists of females. Females as compared to males are regarded inferior and are permitted correspondingly low levels of activity in social and economic domains. Man outside the family does not only exploit them, but now days she is frequently facing violence with in the family. The effects of violence can be devastating to a women's reproductive health as well as to other aspects of physical and mental well being. Violence against women hinders women's participation in public life and undermines the economic well being of societies. It hinders women's participation in development projects and lessens their contribution to social and economic development. The present study was designed to see the women perception about domestic violence. Main suggestions were that women should be educated about their existing rights and about the structures that perpetuate and justify their abuse. And as our society is male dominated, so noble intentions and policy statement in the light of Islamic Principles is needed from the Government for Women's

THE INVESTIGATION INTO ATTITUDE OF RURAL WOMEN TOWARDS EXCHANGE MARRIAGES (A CASE STUDY IN DISTT. JHANG)

Man is a social animal. Everywhere and in all areas of the world, the individual lives in life in contact with his fellows. His happiness depends greatly on his success in interpersonal relations in the family and other social groups. A family unit come into existence upon a union of marital partners and its life cycle varies from one cultural society to other. Marriage is the most important event in the life of a person and is the seed of all future existence. The study explores the traditional values of exchange marriages, the socio-economic characteristics of the respondents and the consequences of exchange marriages among spouses and families.

Marriage in Islam is not a private and personal affair of an individual or between the two individuals as in the Western world, but is a matter of concern for the society he belongs too. The main rather sole aim of marital union between a man and woman is the cultivation of higher qualities of peace, mutual love and integration, self restraint, self sacrifice and devotion not only between the two contracting necessary for perpetuating the mankind. Marriage has got many important functions to perform.

In rural areas of Pakistan, mostly exchange form of marriage is vogue. It may be an account of certain, reasons such as to keep the property within the family, security and affection. But now in rural areas some of the people are shifting from exchange to simple arrange form of marriages. This may be attributed to various factors, which are the end result of social change. Generalization cannot be made on the basis of such a sample. But still this study can leads to a better understanding on the existing patterns and problems of exchange marriage in 'Janglee' communities. The role of social change agent should be increased in this way the attitude of the people towards exchange marriages could change. Only through positive and strong role of change agent socio-cultural norms of the people could positively modify.

SOCIO-CULTURAL IMPLICATIONS OF ILLEGAL WEALTH ON THE SOCIALIZATION OF CHILDREN

Children are the assets of the societies. Mentally, physically and socially healthy children are the potential resources of any society. At present it has been admitted that the better socialization of children requires paramount attention for future good citizens. To an educationalist, "the term socialization can mean either the process of teaching a child those rules and customs, which govern the way, a society works or it can mean a child's access to peer contact" Objectives were to examine the socio-economic and psychological characteristics of respondents. to examine the believes of the respondents about illegal wealth and its effect on the socialization of the children in Faisalabad City.

The first who take responsibility for primary socialization, therefore, is some from of family and the main agents of socialization are the parents of a child and in many cases the relatives. The family group doesn't just teach the physical or mechanical aspects of human being. The parents also try to shape the child's psychological development, by trying to teach them things like the difference between right and wrong behavior and how to relate appropriately to others (family, friends, strangers etc.). Children are all born into their particular environment, and is what usually set their perspective. Each particular environment has inherent values, prejudices, modes of behavior, and naturally enough, they assume that these are "normal". The word normal comes from the word "norm" and automatically implies some standard or rightness. Norma may be approved behaviour or may be disapproved behavior is considered as crime or deviance from expected behavior. There are various forms of crimes committed in a society. One of them is white collar crimes. It is violation either of law or of social welfare. Most of the white-collar crimes occur in the business world, but government corruption and police brutality also included in white-collar crime. Corruption affects children socialization and will continue to have. Children living in a dysfunctional and corrupt economic society grow up with the feeling that the world is basically dishonest, that they have no resource of mechanism to make systemic changes, and that the only way to survive and stay out of danger, if they don't succeed in leaving the country, is to acquit and watch organized criminal group consolidate power. It is, therefore suggested that more studies on large scale should be under taken to draw broader conclusion about problem of corruption and its consequences for human life. and Increase in education level and facility of Islamic education be provided to all segments of society.

THE ROLE OF ISLAM IN DEVELOPING TOLERANCE IN INDIVIDUALS

One of the realities of life is that differences and divergence of views exist between man to man, among and within families, communities and societies that play an important role in human development. No one is perfect in this world. If a man is endowed with some good qualities, he may be lacking in others, therefore, one's differences may compensate for the shortcoming of others. But on the other point diversity and heterogeneity arise conflicts and clashes. The objectives of study were to know socio-economic characteristics of the respondents and the belief system of the respondents. In this Global World of diversities peace along with development can only be achieved by being tolerance by being tolerant to other's differences that is a great enabling factor in collective human development. Literally the word tolerance means, "to bear". As a concept it means respect, acceptance and appreciation of the rich diversity of the world's culture, forms of expression and ways of being human. Islam recognizes all these

principles. Islam is a religion, a framework that offers a complete code of life to its followers. Two elements of Islam, supporting and interlocking are firmly and unequivocally located in one book and one life. The Holy Qur'an is the single divine book of the Muslims and the life of the Prophet Muhammad (PBUH), which constitutes the Sunnah. The "Path" for Muslims is in following teachings of the two i.e., the book and the Sunnah . The Qur'an speaks about the basic dignity of all human beings. The Prophet (PBUH) spoke about the equality of all human beings, regardless of their race, color, language or ethnic background. Shari'ah recognizes the rights of all people to life, property, family, honor and conscience. Islam unequivocally affirms the right of each individual to freedom of thoughts and religion. Islam emphasizes the establishment of universal equality, justice and peace. It does not allow its followers to have any coercion not only in the matters of faith and belief but also in the matters of cultures and other worldly practices. It is concluded that the Islam is vitally important in developing tolerance in the society which is key for development of the society.

THE SOCIOLOGICAL STUDY OF MALES ATTITUDE TOWARDS FEMALES EDUCATION AND EMPLOYMETN (A CASE STUDY IN THESIL DARYA KHAN, DISTT. BHAKKAR)

Education is an important aspect of socialization – the lifelong process of learning the attitudes, values, and behavior appropriate to individuals as members of a particular culture. Education is a socialization process, which continues from birth to death. Education is a process where by the socially approved parts of culture, values and norms are transmitted from generation to generation and in this process the acquired knowledge is shared by the members of society. Education is a consciously controlled process whereby changes are produced in a person behavior and through a person within the group. Education is considered as one of the important factors in speeding up the process of social change in any society. Main objectives were to study the attitudes of males towards female's education and employment and to study the socio-economic factors and their effects on female's education and employment. Education is very important determinant of development process. The countries with high Level of development, and the countries with low level of literacy are at the early stage of development and the people of these countries are living in very poor conditions. A vast majority of the people in developing societies are below the poverty line. The factor which hinders the way of development is the education particularly women's education. Woman has always been man's dependent, if not slave. The two sexes have never shared the world in equality. And even today a woman is heavily handicapped though her situation has improved tremendously. Almost nowhere her status is the same as a man's and frequently it is much to her disadvantages. Even when rights are equally recognized in the abstract, long-standing customs prevent full expression.

In a developing country like Pakistan, division of labor in responsibilities and decision-making power at home and outside are usually determined by men, women are generally considered only good for taking care of children and other household members and performing household chores such as fetching water, collecting firewood and fodder, purchasing household goods, and providing meals to male members of family who work outside to earn money. A women job is not only disapproved but also strongly discouraged in Pakistani society. The socially prevalent attitude is that a father or a husband feels undignified to live on earning of her daughters and wife respectively. Such attitude had been responsible for discouraging many qualified women for joining various vocations. Adult literacy programs should be extensively carried out in rural areas for females, so that the education may influence their decision regarding the female's education and favorable social and secure environment should be created for female education and employment.

THE EFFECTS OF AIR POLLUTION ON THE HEALTH OF PEOPLE IN RURAL AREAS OF FAISALABAD DISTRICT

Air pollution is woven all through the fabric of our contemporary life. A by-products of the manner in which we build our cities, air pollution is waste remaining from the ways we produce our goods, transport

ourselves and our goods, generate energy to heat and light the places where we live, play and work and it is defined by the law of state of

Wisconsin as “the presence in the atmosphere of one or more contaminations in such quantities and of such duration as is or tends to be injurious to human health or welfare, animals or plants life, or property” objectives were to study the socio-economic characteristics of the people living in rural areas through community based survey and to determine the awareness level of the people regarding the sources of air pollution. The swift urbanization of numerous cities in developing world with its allied industrial and transportation system expansion has led to stern intensity of air smog. Air pollution has momentous health threats and deemed as a foremost environmental health crisis, causing death or disease to millions of people each year. It is estimated that approximately three million people expired due to air pollution annually, represents 5% of the annual deaths happening around the world. Not only the cities affected by risky levels of air pollution but also the rural vicinity may bear even more due to lofty levels of indoor air contamination. Air pollution has adverse effects on crops and forests especially in areas in close proximity to the source of pollution. Mostly respondents were males, in the age group of fifteen to thirty years, married, illiterate, non professionals and had their monthly family income in between one thousand to five thousands and Majority respond that their family member’s health affected due to air pollution, generally suffered from coughing and allergy The present study was limited because it covers only two villages, it is therefore suggested that research trials on broader horizons should be undertaken to draw broader conclusion. It is further suggested that Industries, drains and brick kilns should be build far away from residential areas. It should be the responsibility of the industry to manage proper disposal of waste and conversion of effluents through the recycling plants in to less injurious from.

CAUSES AND CONSEQUENCES OF CHILD LABOUR IN CARPET WEAVING INDURIES IN TEHSIL FAMISALABD

The term child labor has been defined by the Encyclopedia of America, as “The employment of boys and girls when they are too young to work for hire or when they are too young to work for hire when they are employed at job unsuitable or unsafe for children of their age or under conditions injurious to their welfare”.

Child labor refers to institutions / organizations where children are completed to work on regular basis to earn a living for them and their family and as a result are disadvantaged educationally and socially, where children work under conditions that are exploitation and damaging their health and their physical and mental development. Objectives were to find out socio-economic background of the working children and to find out social causes of child labour and to find out the effect of child labour on the health of children.

Child labour has been a mixed curse for all of southern Asia. Child labour is a social problem. The determinants of the problem of this magnitude in the country, are embedded deeply in the root causes of growing poverty, lack of opportunities and awareness, large family sizes, disparities in the distribution with a widening gap between have’s and have nots and an education system not responsive to the needs and preferences of its clients, both in terms of quality and access.

In Pakistan, over 50 percent of the total population is under 16 years of age. They are put to work to assist in house hold enterprise and to supplement family income by the parents, however for the employer, child work is cheap, easy to monitor and can be forced to work for longer hours and both feel no hesitation while doing this neither parents nor employer. Therefore, the present study is designed to find out the factors, which push them the children to work at a very early age.

Poor economic conditions, large families and social deterioration are the reasons emerged for child labour. Though children are not well paid, they still serve as major contributors to family income. Child weavers pay the cost in terms of more frequent illness, stunted physical growth, like headache, cold

cough, fatigue, conjunctivitis, cuts and bruises, knock knees, legs and muscular-skeletal disorders as carpet tunnel syndrome and backache were the common diseases. However children are happy with this industry in spite of the fact that they are paid at much lower rates and their work condition cause illness of various kinds, but they are satisfied and want to continue their work. In the area of child labour, child labour and carpet weaving industries seems to be one of the worst occupation and hence there is need to get rid of this job. Working children were poorly paid. Their wages much be increased so that they can maintain good economic condition. And Parents must be informed about the ill effects-of child labor and they should be motivated for education of their children and they should also be informed that their children poor income would not improve the economic conditions of their families.

PERCEPTION OF THE MALE CHILDREN: SATISFACTION AND EXPECTATIONS

The main objective of the study is to examine the prevalence of sex preference and its causes within the socio-economics and cultural framework along with the parents, material and non-material's expectation of help from their male children. 360 women aged 24-45 years with at least one living child residing in the rural areas of three major districts of the Punjab province Lahore, Rawalpindi and Multan were interviewed. The analysis of the data identified the prevalence of son preference and sex discrimination in the selected areas, preference for boys is explained in social, economic psychological and cultural context and this irrational attitude towards family preference has health implications. Material and non-material expectations of parents from their sons seem a prime reason for preferring sons over daughters in Pakistan. Islam condemns all forms of gender discriminations and preferential treatment. It is recommended that people should be informed about the Islamic teachings of marriage, procreation, husband and wife roles, family size and sex preference (sex discriminations) along with the parents' responsibilities in upbringing the children as prescribed in Islam. The parents should also take into account their own circumstances, as well as the implications of their decisions for the balanced development of the children and the society.

INVESTIGATION OF REPRODUCTIVE HISTORY AND FERTILITY PREFERENCES: A STUDY OF RURAL PUNJAB: PAKISTAN

The main objective of the study is to examine reproductive history and fertility preferences along with respondents' perceptions about ideal family composition, concept of small and large family. 360 women aged 25-45 years with at least one living child residing in the rural areas of three major districts of the Punjab province Lahore, Rawalpindi and Multan were interviewed. It emerged from the study findings that conceiving more than 6 or 7 times is a normal behaviour of women in the selected area. Desire for additional children reflects the existence of the preference for sons in the society. The respondents' had no clear concept regarding small and large families as promoting by the Government of Pakistan. It is concluded that women's health is at great risk due to the closely spaced repeated pregnancies, which they deliver, in unsafe environment under the supervision of traditional birth attendants. Attitudinal change regarding family size is a pre-requisite for the effective and efficient implementations of the family planning program in the country.

A MULTIVARIATE ANALYSIS OF FERTILITY DIFFERENTIALS IN PAKISTAN

An integrated model, combining aspects of Daviss and Blacke's "Social Structure" and Stycos' International model is developed and empirically tested with survey data obtained from the married fecund women aged 25-45 years having at least two living children from two urban centres (Lahore and Faisalabad) of Pakistan. In the model one demographic variable (age at marriage) three institutional variables (women's education, husband's education, family income) are treated as "Predetermined" variables. The dependent variable (life time fertility) is hypothesized to be affected not only by the predetermined variables but also two intermediate variables (child mortality and contraceptive use). Four informational variables (husband-wife communication about family size, attitude towards contraceptive

use, opinion towards the side effects of contraceptive use and knowledge about the safe and fertile period) are postulated to have direct effects on contraceptive use that in turn affect fertility. Multivariate analysis demonstrates that preferences for smaller families were found to be consistently associated with the informational variables. Family income offered no explanation for fertility differentials. It is concluded that institutional variables (women and husband's education) are necessary but not sufficient condition for fertility decline in Pakistan. Informational variables influence fertility behavior independent of development in economic realities.

NON-LINEAR MODELS FOR FERTILITY BEHAVIOUR AND MARITAL STATUS IN PAKISTAN

The demographic models have been one of the most important developments in demography for the last twenty years to understand demographic phenomena. Age-specific fertility rates (ASFR) and age at first marriage (AAFM) are important measures to represent the reproductive behaviour. A number of models are fitted on ASFR and AAFM using PHDS-1990/91 data. A highly positive skewed trend with steep rise in beginning was observed for Pakistan. A-square values indicate that a modified long-normal function and double exponential function are the best to describe fertility and marital status variables, respectively.

MODELLING THE CONTRACEPTIVE BEHAVIOUR OF MARRIED FEMALES

The study objectives were to examine the relative significance of socio-economic and cultural factors in relation to reproductive behaviour and classify 1100 respondents (users and non-users) into their exact categories. Logistic regression analysis technique was applied to investigate research objectives. The analysis indicated that women education, family size preference, media exposure, number of living children, family income and religious beliefs are the important predictor variables in predicting contraceptive behaviour. Overall 76.45% respondents were correctly classified.

DETERMINANTS OF MARITAL FERTILITY IN PAKISTAN

Pakistan is at an early stage of demographic transition and experience rapid rate of population growth. Many strategies have been adopted to slow the pace of population growth but limited success has been achieved so far. The differential of fertility levels demand careful assessment. The present study is based on Pakistan Demographic Health Survey (PDHS, 1990-91). The bivariate and multivariate statistical techniques are used to understand the relationship between fertility and social and demographic factors. The regression analysis demonstrates that background variables such as type of residence, duration of marriage, education of respondents and number of dead children exert an important influence on reproductive behaviour. It is recommended that social aspects of women life in terms of education, mother-child health facilities should be improved and a conducive environment should be provided to them so that they can freely participate in development process.

REPRODUCTIVE MOTIVATIONS AND FAMILY SIZE PREFERENCES AMONG PAKISTANI WOMEN: DISCRIMANT ANALYSIS

This paper deals with identifying differentials influencing women's reproductive motivations in Pakistan. Different methods of analysis, qualitative as well as quantitative, have been applied to explore the role of social-economic, biological and demographic determinants of reproductive behaviour on different sets of data. The work consists of three models. Descriminant analysis was applied to identify the factors which differentiate users' of contraceptives from 'non-users', who want to cease production of more children, from those 'desiring more' after having completed their family and the women having 'low' fertility from those having 'not low'. The data analysis revealed that duration of marriage and inter-spousal discussion about family size are major forces in determining the family size. It is suggested that family planning program should give more weight to men to change their attitude about family size preferences than in the past.

WOMEN AUTONOMY AND ITS INFLUENCE IN REPRODUCTIVE HEALTH

A study was designed to investigate reproductive behaviour within the socio-economic and cultural context of local population. A random sample of 120 married women aged 15-45 year having at least one living child was selected from two tehsils of district Faisalabad. It emerged from the study that explanations of reproductive behaviour were consistent with modern attitude and behaviour towards family life. Women age at marriage, women education and their participation in the decision-making process and the husbands' participation in domestic chores have established their significance in explaining fertility behaviour independent of material circumstances.

VALUE OF CHILDREN AND REPRODUCTIVE BEHAVIOR IN URBAN PUNJAB: A CASE STUDY OF FAISALABAD CITY

The main findings of the study indicate that a huge majority i.e., 85 per cent of the women was married, under age 24. Only a small proportion i.e., 17 Per cent of the respondents was married beyond age 24. 22.80 percent of the respondents wanted, to have another child. 17.2 percent respondents were having small families, 28.4 percent having medium families and 54.5 percent of respondents were having large families, 84 percent of the respondents expected- from their sons to give part of their salary, 90 percent of the respondents expected from their sons to support their younger brothers and sisters through school and. 90 percent respondents expected from their sons to support them in old age. 14.2 percent of the respondents expected their daughters to give part of their salary. 19.00 percent of the respondents expected their help for younger brothers and sisters through school. 15 percent respondents had expectation to get support in old age from their daughters. 6 percent of the respondents were government servants, 54.OO percent were businessmen, 7 per cent were skilled workers, 26 percent were laborers and. 6.8 percent were others. 3 per cent of respondents were literate as compared with 67 percent of illiterate respondents.

More than half of the respondents had. six or more than six children. Only 14,40 percent of the respondents had children 1-3. This implied that Pakistani people had: favor able attitude towards large family size. Chi-square value indicated that family size differed significantly by the age of the respondents.

There was strong association between respondents' income and their family size. In other words higher the income, lower was the family size. Chi-square value was 16.2,also supported the above findings. The percentage of the respondents whose income was less than 24 thousand, had. large family size was 27.00 as compared with 5 percent of the respondents whose income was Rs. 50,000 + and had large family size

Age at marriage played a significant role in determining the family size. It was also observed that as the age at marriage increased, the family size was decreased. It may be due to as the age at marriage increases, the risk of the infecundity and male sterilization is also increased. Davis (1975) discussed the "Institutional patterns favoring high fertility in under developed areas". He argued that low age at marriage was one of the major causes for higher fertility in joint family system. Soomro (1986) concluded that age at marriage had a significant role in determining the fertility.

Respondents having longer marriage duration had higher fertility as compared with the respondents having shorter marriage duration. 67.20 percent of the respondents were illiterate and 33 percent were literate. It was observed that illiterate respondents had larger families as compared with literate respondents. In other words, illiterate respondents had more favourable attitude to have larger families as compared with literate respondents. The similar relationship between education and family size was also supported by Pakistan Fertility Survey (1976). According to Becker (1960), Friedlander and Silver (1967)

and Mueller (1972), schooling reduces the economic utility of children in a number of ways. First, educated parents are better to assess the relative costs and benefits of children under changing economic and social conditions. Second, by promoting economic and social mobility rising educational levels of parents enable them reduce their dependence on children for economic assistance. The high-paid jobs held by those with better education provide them with a growing security towards old age.

Level of education played a significant role in lowering family size. As the level of education increased, level of family size decreased. In other words there was inverse relationship between level of education and family size. The value of Chi-square was 22 which was significant at 5 percent level of significance. It means higher the education, smaller the family size. The similar observation is given by Rukanuddin and Farooqi (1987).

The respondents who belonged to the occupation of shopkeeper/businessman and labourer had the largest family size as compared the Government servants and skilled workers. The reasons underlying this trend may be found in terms of that the more hands are needed for businessman and labourer to help them in their work and earning. Chi-square value was also calculated which was significant means that family size differed among different categories of occupation. Censuses in several countries had provided data on the number of children borne by married women, classified by the economic activity of their husbands. The classification of economic activity varied from country to country, and included industry, or status (employer, employee etc.). The primary aim had generally been to study the variations in fertility among a small number of major social groups. In spite of the differences in the classifications, a number of broad features had been observed. Generally, it had been found that these engaged in agriculture had particularly large families; miners had also been shown to be a highly fertile group in those census where information for them was tabulated separately.

At the other extreme, professional workers and. clerical workers had. particularly lower fertility. The various groups of manual workers outside of agriculture, forestry and mining differed widely in their level of fertility (UN, 1973).

Majority of the respondents were of the opinion that they were happy on "whatever Allah gives to them" because they themselves, did not have any desire for sons or daughters. On the other hand, desire for son was lesser among literate persons as compared with illiterate persons. The logic behind this pattern may be that the importance of son decreases with increase in education because educated people do not depend on their sons economically. There was strong relationship between ideal number of sons and level of education. In other words as the level of education increased, the ideal number of sons was decreased. The value of Chi-square also confirmed this association. So, it was found that education .was important factor in eliminating son’s preferences 'prevailing in Pakistani Society.

Level of income was inversely related with ideal number of sons. In other words, the people having higher income had lesser ideal number of sons as compared with people with poor income. The rationalization for this relationship may "be found in terms of economic independence of the higher income group people. So, they make no difference between sons and daughters.

There was no relationship between qualification of the respondents and ideal number of daughters. But it was noted that majority of the respondents did not want to have a daughter in spite of a few respondents who did not hesitate to have a daughter. No relationship was found between income and ideal number of daughters. It was observed that people who belonged to lower income group did not want to have any daughter. The logic behind this finding may be found in socio-economic and cultural constraints and responsibilities of the parents of a daughter. Data also indicated that majority of the respondents did not want to have any daughter. So, this is a good indication of the sex preference in Pakistani Society, which leads to the high level of fertility,

About half of the respondents gave too much importance on the dependence of children in their old age, out of these respondents 55 percent of the respondents had large families. There was inverse relationship between the education of the parents and degree of dependence on children. In other words higher the level of education, lesser the dependence on children. Chi-square was also applied at 5 percent level of significance which also confirmed the above findings.

Those respondents who had low income gave more importance to the dependence on children in old age. It was also observed that higher the level of income, lower the dependence on children. Mostly people who had already attained 6 + children were not in favor of getting another child. Chi-square test was also applied which indicated association between family size and desire for another child. There was no strong relationship between qualification of the parents and desire for another child. In Pakistan most families have the larger number of children. It is due to that they actually desire small number of children, but these are unwanted children due to socio-cultural and many other reasons. People with low income had more desire for another child as compared with people with higher income.

People of higher income group had lesser desire for care another child to take care in old age. The reasons may be that these families are rich enough that they can arrange everything for them due to their higher status by hiring or purchasing things needed to them. There was a strong association between parent's level of education and their expectation of getting salary from their children. In other words, higher the level of parents education, lesser the expectations of getting salary from sons. Chi-square test was also applied that approved the above findings. A huge majority of the respondents had expectations of getting salary from their sons, whereas 66 percent of the respondents having large families had expectations to get salary from their sons. So, we may say that economic factors were one of the major determinants of large families in Pakistan. There was inverse association between income of the parents and their expectations for getting salary from sons. The reasons may be found, in terms of parent's economic self-sufficiency and to want their children to enjoy their own life. None of the respondents in the income group less than Rs. 2000 denied such expectations. Only 35.7 % of respondents in the last two incomes groups (2001-5000) and (5000+) answered the question in the negative. However, the highest income group secured to have least interest in seeking help from their children as compared to other groups (7.2 per cent against 42.2 percent).

A huge majority of the respondents had no expectations of getting salary from their daughters. Only -14 percent of the respondents were in favor of getting salary from their daughters. Although parents had no expectations from their daughters for economic participation, but still their family size was very large. Only 14 percent of the respondents were in favor of getting salary from their daughters. But it was observed that as the level of education increased, the expectation of getting salary from daughters decreased.

ATTITUDE TOWARDS FAMILY SIZE AND SEX PREFERENCES AMONG WOMEN IN RURAL PUNJAB: A CASE STYDY OF FAISALABAD DISTRICT

Almost all of the women under study were in their reproductive age. The highest frequency of female marriages was contracted between the age groups 15-20 years. The results are quite familiar to the marriage patterns generally prevailing in Pakistan. As different surveys show that the majority of marriages in Pakistan are conducted i n the age groups 15-20 years for females (Population Planning Council, 1976). More than half i.e., 55 percent of the women had four or more children ever born in the rural Faisalabad which might be because of favorable attitude towards large family size and boy preferences. About half i.e., 50.6 percent of the respondents had three or less living children. The remaining i.e., 49.4 percent of the respondents had four or more living children. 65.20 percent of the women reported no child death, representing very astonishing situation regarding the child mortality in rural Faisalabad because the over all child mortality in Pakistan is very high. The level of formal education was very low among the wives as compared with their husbands. On the other hand, the level of religious education was very high among the wives as compared with their husbands. Majority of the respondent's

occupations were traditional and static, a characteristic of a developing country. The data showed a vast gap between the knowledge and use of contraception among the women of rural Faisalabad. These characteristics of the respondents showed that the women residing in the rural Faisalabad were not going to control their fertility and had relatively large families. The reasons behind the trend to have large families might be seen in terms of fundamentalism prevailing in Pakistan.

A great majority i.e., 88 percent of the women stated four to seven children as their preferred family size. However, family size measured in this way is not much reliable. The women of rural Faisalabad were inclined to have large and very large families. Evidence from IN scale values indicated that there was a substantial potential for large families, even among those women with a stated desire for a small family, in rural Faisalabad. Thus data on stated preferences could be miss—-leading in that underlying preferences, as they are much higher than would be inferred from single valued statement.

The impact of variables like demographic, socio-economic and other factors may cause a variation in the underlying family size preference. The data, in overall, suggested that a large majority of women were in the high end of the size preference scale and most of the variation that existed were between preferences for large and very large families. However, older women were more inclined towards very large family size preference as compared with teen-age mothers. The older women seemed more traditional in their outlook and hence had a strong preference for very large families.

Age at first cohabitation showed some systematic association with the underlying size preference. Women with low age at first cohabitation were more inclined towards underlying preference for very large preference (IN 6-7) as compared with the women with higher age at first cohabitation. The logic behind this pattern may be found in terms of that younger age at first cohabitation means living in husband's family at an early age, which might provide a setting for socialization with older traditional ways. Parity did not show much systematic relationship with underlying size preference. The same results were found when the association between number of living children, number of dead children and IN scale values was searched out. We may conclude that the demographic characteristics like age, parity, number of living children, etc. Of the women of rural Faisalabad caused a little variation in underlying family size preferences. But in general, women of rural Faisalabad had an underlying size preference for very large families.

Education of wife was negatively related to family size preferences. The proportion at the highest end of the scale dropped with increased education. The exception to this pattern was for women with religious education. The religious education obtained by Muslim women includes learning of parts of Quran and prayers, instructions in the beliefs and regulations of Islam. The teachers are usually local religious leaders, many of women believed that family planning is contrary to the teachings of Islam (9). It is possible therefore, that women with such an education would be more sensitive to the religious issues concerning family planning and contraception. In fact for such women number preferences were higher than for any other group, including those with no schooling at all. Further, the patterns of size preferences by husband and wife's education were roughly to be similar. Skilled workers showed comparatively lesser preference for very large families as compared with unskilled workers and businessmen had lesser underlying preferences for very large families as compared with agriculturist. In this way husband's occupation showed little association with wife's size preference. The response that the unskilled workers and agriculturists had the highest (IN 6-7) scale values may be found in terms of occupational stricture of the country. The economy of Pakistan is mostly agrarian and labor-intensive which makes large size of families highly desirable. Knowledge of and use of contraception did not show any systematic association with underlying size preferences. It may be concluded that formal education was one of the major factor for lowering the underlying size preferences among the women of rural Faisalabad. Knowledge and use of contraception did not show any systematic association with underlying size preferences. However, reasons for underlying size preferences for very large families (IN 6-7) and non-use of contraception may be seen in terms of fundamentalism prevailing in Pakistan.

Fundamentalism was found to be associated with family size preference. Using questions on family commitments, the ideas about the family and reason for having a third child and cross tabulating with the family size preference distribution, we were able to produce some evidence on the relationship between fundamentalism and size preferences. Though the relationship found between family commitments and underlying family size preferences was not very strong, yet we may conclude that fundamentalism in terms of family commitments like shared home, shared income arranged marriages, etc. was determining the fertility behavior and responsible for underlying large (IN 5) and very large (IN 6-7) family size among the women residing in rural Faisalabad. Fundamentalism is one of the most important factors for large and very large family preferences among the women of rural Faisalabad. Ideas about the family selected to see the association between the fundamentalism and underlying size preferences gave a good way to see the reasons behind large and very large family bias among the women of rural Faisalabad. In the same way the data on reasons for having a third child suggested a strong association between fundamentalism and underlying size preference. The data suggested that women of rural Faisalabad had a strong boys preference. The reasons underlying this preference may be found in terms of fundamentalism prevailing in Pakistan. The impact of variables like demographic, socio-economic and other factors may cause a variation in the underlying sex preference. Overall, a very large majority of women were in the higher end of the sex preference scale values. Women of all ages had a preference for strong boys preferences. However, older women were more inclined towards strong boys preferences compared teen-age mothers. The older women seemed more traditional in their outlook and hence had a strong boys preference.

Age at first cohabitation showed more systematic association with the underlying preference. Women with low age at first cohabitation were inclined towards strong boys preference as compared with the women with higher age at first cohabitation. The logic behind this pattern may be found in terms of that younger age at first cohabitation means living with husband's family at an earlier age, which might provide setting for socialization with older traditional ways. Surprisingly, parity was not strongly associated with sex preference. The same results were found when the association between number of living children and IS scale values was searched out. The number of dead children also did not show any systematic association with underlying sex preference. We may conclude that the demographic characteristics, like age parity, number of living children etc. of the women of rural Faisalabad caused a little variation in underlying sex preference. But, in general, women of rural Faisalabad had an underlying strong boys preference. Education of the wife was negatively related to sex preference. The women having six or more years of schooling showed comparatively less preference for (IN 6-7) scale values as compared with women having primary or no education. The proportion at the highest end of the scale dropped with increased education. The exception to this was women with religious education. Though the impact of husband's education on son preference was weaker as compared with the association between wife's education and son preference, yet the patterns of sex preference by husband's and wife's education were roughly to be similar.

Skilled workers showed comparatively lesser inclination towards a strong boy preference as compared with unskilled workers. The businessmen had comparatively weaker underlying boy preference as compared with the persons associated with the occupation of agriculture. In this way husband's occupation showed some systematic association with wife's son preference. Knowledge of and use of contraception showed a systematic and negative association with son preference. It maybe concluded that education was one of the major factors for lowering the underlying son preference among the women of rural Faisalabad. However, the reasons for underlying strong boys preferences (IS 6-7) may be seen in terms of fundamentalism prevailing in Pakistan.

Fundamentalism in terms of family commitments like shared homes, shared income, arranged marriages etc., was responsible for underlying strong boys preference (IS 6-7). Among the women in rural Faisalabad. Further the association between family commitments and son preference was stronger as

compared with the association between commitments and underlying family size preference. Fundamentalism was one of the most important reasons for prevalence of strong boy preference among the women of rural Faisalabad. Ideas about the family selected for this analysis were proved to be good indicators of fundamentalism and gave a good way to identify the reasons behind the prevalence of strong boy preference. Though the four reasons for having third child were not proved as good indicators of fundamentalism, yet the data suggested, that women of rural Faisalabad were fundamentalist in their idea about sex preference.

Education was negatively related to fundamentalism. The strength of fundamentalism decreased with the increased education. The exception of this pattern was for women with a religious education. In fact for such women extent of fundamentalism was higher than the women with any formal education. Comparison with Bangladesh showed that the women in rural Faisalabad had a larger family size preference. 74 per cent if these women scored IN 6-7, as compared with 57 per cent of Bangladesh women.

Very interestingly women of both the areas had it IS values i.e., about 75 per cent, in both the cases, had IS 6-7. Comparisons with four other countries (Philippines, Taiwan, Korea and Malaysia) showed that the women in rural Faisalabad had larger family size preference and stronger son preference. Seventy five per cent of the women in rural Faisalabad had IN 6-7 and same was the percentage for IS 6-7. This was in contrast to 48 per cent and 31 percent respectively of Malaysian women and 24 percent and 54 percent of Korean women.

Finally, it is generally, believed that rural Faisalabad is not very different from other rural areas of the country. So that the results obtained here may be generalized to most of the rural Pakistan. Further, in the light of Coombs (1979) finding in Taiwan that scale measures are more predictive of future fertility than single valued statements on desired family size, it seems that a fertility decline in rural Pakistan can not be expected, unless a change in fundamentalism is brought about.

THE IMPACT OF SOCIO-ECONOMIC FACTORS ON INFANT MORTALITY IN THE PUNJAB: A CASE STYDY OF URBAN LAHORE

The current age of mother was found, to be significantly associated with the level of infant mortality. Infant mortality of mothers aged less than 20 years was 55% higher as compared with mothers of aged 40. The age at marriage was found to implies that the marriage patterns in Pakistan is concentrated in early ages. Education of mother was found to be inversely associated, with infant mortality. In this study, level of infant mortality is 60 per 1000 live births, which is lesser than our national figures. The reason under lying may be that the respondents are literate but this rate is still higher considering the level of the education. It seems that the educational level of mothers is the strongest most effective single factor determining the level of infant mortality.

The occupation of the respondents was found to be strongly associated with infant mortality. The infant mortality rate was higher among the children whose fathers were laborers or working as clerical staff i.e. the infant mortality rate was lowest among the children born to the fathers who were businessmen or Govt. officers. Family income was found to be negatively related with infant mortality and the results agreed with what was found by Irfan (l986). The infant mortality was higher to among the children whose fathers' belonged poor socio - economic status. The reason for low infant mortality is that higher income is to be associated with a higher expenditure on food. Shelter and Sanitation and this can have a positive influence on survival of household members. This association was stronger when compared with education, income and female education all were negatively related to level of infant mortality. There was no clear association between the live births and infant mortality rates. It may be due to small sample size, under reporting of deaths, etc.

Births order was founded to be positively related with infant mortality. Majority of deaths of children occurred in the first birth order. It may be because of that the first birth occurred mostly to women of teenage. The mortality rate was much higher among the women with large family size as compared to the women of small family size. The reason for positive association is that large family size leads to increased chance of the infections, diseases and lesser amount of attention, which the mothers could devote to her children. The length of preceding birth interval founded to be negatively related with infant mortality and this relationship was found to be strong. This finding is in accordance with the many previous studies (Frenzen and Hogan, 1982, Celand and Sathar, 1984; Irfan, (1986). No doubt, short birth interval causes premature birth.

Infant mortality rate was higher among the male children as compared with infant mortality rates among females. When feeding practices of mothers was related with infant mortality, it was found that mothers who breasted their children experienced low infant mortality rate. In other words the level of infant mortality 'was inversely related to the duration of breast-feeding. Chances of survival of infants were higher among breast-feeding mother as compared with bottle-feeding mothers. Bottle cleaning was found to be strongly associated with infant mortality. Higher infant mortality among mothers who did not adopt bottle cleaning practices may be due to infectious diseases among the families of these mothers that resulted'^ higher mortality. The boiling water was found to be strongly associated with infant mortality. Infant mortality rate was very high among the mothers who did not use boiled water as compared with the mothers who used boiled water. The additional diet was found to be associated with infant mortality. Infant mortality among mothers who had any additional diet was slightly higher as compared with the mothers who had not any additional diet.

The medical services were found to be associated with the level of infant mortality. Only a few respondents were getting advice from non-qualified persons. The level of infant mortality was lesser in the urban areas than the rural areas in Pakistan. This is only due to medical facilities. Place of delivery was found to be associated with the level of infant mortality. Infant mortality rate was higher among the mothers who had deliveries at home as compared with the mothers who gave birth to their babies at hospital. The most of the deliveries were normal in the areas under study. Because that the areas under study is well developed area of Lahore City. Medical check up was found to be strongly associated with infant mortality. Almost all of the respondents cared for their children’s health. It may be due to that all of the respondents are educated and living in an urban area of Lahore where Medical facilities are easily available.

Knowledge of Nimkol was found to be associated with the level of infant mortality. The mortality rate among the respondents having knowledge of Nimkol was lesser as compared with the mother having no knowledge of Nimkol. The major causes of infant death were peneumqnia and Anemia. The probability of dying of children under one year was inversely related to the size of the house. As the size of the house increased, the level of infant mortality decreased. Size of the house is one of the important indicators of standard of living and other facilitate for leading a happy and easy life.

When the immunization variable is related with infant mortality, it was found to be highly associated with infant mortality. That is, babies who got immunized were having lower infant mortality rate than those who did not got vaccination. Our findings agreed with what Foster (1984) found in his study. The reason being that vaccine efficacy protect children against infectious diseases, Housing facilities was related with infant mortality. Highly low infant mortality among the respondents having every day life luxuries in their house may be due to that these peoples are highly educated and their economic condition is very sound, so they have awareness of protecting their child's health.

SOCIAL ORGANIZATION FOR IMPROVED SYSTEM MANAGEMENT AND SUSTAINABLE IRRIGATED AGRICULTURE IN SMALL DAMS.

The small dams systems offer a precious opportunity for the sincere promotion of reform in the irrigation sector. They are independent of the large-scale Indus Basin Irrigation System and, therefore, more easily managed by smaller units of water users organizations and support service personnel. The pilot projects have demonstrated the willingness and ability of farmers and SDO staff to become “Irrigation partners” capable of leaving behind old antagonisms. They have also demonstrated that the process of getting to this point is long and difficult, and far from complete. Therefore, it is hoped that the accomplishments of the pilot projects are not abandoned, but can be consolidated by the continuation and expansion to the Federation and Area Water Board levels of the reform process initiated at the small dams.

INITIAL SOURCES OF INFORMATION AND PIONEERS OF RAPID ADOPTION OF BASMATI-385 IN THE RICE ZONE OF THE IRRITATED PUNJAB

A new variety of rice Basmati-385 was developed by the RRI, Kala Shah Kaku Lahore, which was approved and released during the third quarter of 1985. this new variety got attention of every concerned person about its popularity of having almost double production than the old rice variety Basmati-370. Due to its high yield and shorter maturity, it occupied about 88 percent of the total rice area in 1989. This wider and abrupt adoption of Basmati-385 stimulated the social wheat belt of Punjab, Pakistan. For this purpose, District Gujranwala, a rice-growing district, was selected. The methodology of data collection followed was unique in the sense that man to man path of information and seed traveled was followed backward from the latest adopters to first adopter, who got seed directly from the RRI or PSC or Extension Department.

PRELIMINARY RESULTS FROM A PILOT STUDY IN THE HAKRA 4-R DISTRIBUTARY’S OF THE EASTERN SADIQIA CANAL SYSTEM OF PAKISTAN’S PUNJAB PROVINCE

The pilot project on water users organizations in the Hakra 4-R Distributary command area stated its work in the midst of skepticism,. There were doubts about its potential success in a context which was known to be hostile to popular participation. A study on “decentralization” had commented that local government institution in Pakistan had been traditionally dominated by the ruling elites comprising feudals and bureaucrats (Nasir, 1972). They had developed monopolies over these institutes and made it difficult for poor and middle class people to share power with them and this was seen as a major reason for the wastages corporation and poor performance in the present resource management system. This pilot project has taken a challenging task to confront these deep routed social problems. However, after the first two phases of its endeavors the project has cleared some initial institutional hurdles and succeeded in farming and organization to under take decentralization management responsibilities so far it has proved itself to be socially viable.

SOCIAL ORGANIZATION FOR IMPROVED SYSTEM MANAGEMENT AND SUSTAINABLE IRRIGATED AGRICULTURE IN SMALL DAMS

The issue of ensured water supply is arising due to lack of a proper warabandi system in the area. Though there exists an agreed warabandi in both of the pilot small dams, yet farmers are not strictly following it. Whenever crops need water, the farmers just unplug the nakka and start irrigating their fields. During this process, farmers at the tail reach of the canal are deprived of dam water. This is true under both the Mirwal and Shahpur Small Dams. Therefore, the introduction of an effective warabandi system in the area is very much required in order to have equitable water distribution. This issue basically stems from a lack of clear water rights for the users.

MAINTENANCE AND OPERATION ACTIVITIES IN THE COMMAND AREAS OF SHAHPUR AND MIRWAL SMALL DAMS”.

The physical condition of the Shahpur Small Dam irrigation system was not satisfactory. The maintenance

activities that had been undertaken were largely inadequate for ensuring satisfactory operation of the irrigation system. This was mainly due to non-availability of financial resources (according to the SDO) for undertaking adequate maintenance of the irrigation system. Proper maintenance of the irrigation system is essential to achieve the anticipated benefits, as well as economic justification of the investments made. Motivating, strengthening, awareness and capacity building of water user's on maintenance and operations of their respective irrigation system can ensure water users participation in sustaining the irrigation system. Water users' participation in the planning and implementation of the maintenance activities can reduce the maintenance costs substantially and increase the efficiency of both human and financial resources available for maintenance activities. Operations of both the irrigation systems were left to water users without any temporary or permanent schedule. Water users were using water as and when they needed. Lack of a water distribution schedule both at the secondary and tertiary levels was the major factor for the substantial irrigation water wastage in both irrigation systems.

DEVELOPMENT OF MODEL VILLAGES IN DISTRICT FAISALABAD, PUNJAB, PAKISTAN".

Over the past decade, the CIRDAP has been increasingly involved in action oriented projects with the disadvantaged largest beneficiaries and their communities. In the early years of the CIRDAP, the governing council and the evaluation missions laid stress on action research projects and training linked to these projects, in order to promote skill formation for income generation. The CIRDAP Action Research Project (CARP), aims at using strong participatory research methods for mobilization human and other resources in the villages. With the efforts of the project field workers and research staff, the rural poor were organized into an organization entitled "Teddoy Goat and Poultry Bird Production Society". At the later stage, other income generating activities, like tree plantation, seed of new wheat variety and vegetables distribution, veterinary coverage, health facilities and above all two industrial homes were the outcome of long debate and considered opinion of the members of the organization at both project villages.

FAISALABAD HOUSEHOLD SURVEY 1993

The findings imply that family planning programmes should focus on very young mothers for reasons of baby's health and survival, apart from usual reasons of reducing fertility and improving mother's health and well-being. The finding also implies that policies with regard to women's marriage age should be raised and be implemented strictly. Further more, these results imply that programmes should provide health care early in infancy for babies of very young mothers. It is suggested that special education regarding more spacing of births in Pakistan, particularly in rural areas, should be imparted, which may bring about a substantial reduction in infant mortality.

SOCIAL ORGANIZATION FOR IMPROVED SYSTEM MANAGEMENT AND SUSTAINABLE IRRIGATED AGRICULTURE IN SMALL DAMS

With the construction of a small dam and the associated water channels/canals, a mogha was constructed for whosoever applied, without considering the size of the outlet and the area to be irrigated by that outlet. Presently, farmers of the area consider watercourses as their property and are not allowing other farmers, who have developed their land in the recent past, to irrigate their fields through their watercourses. This point was raised by the sufferers in the process of awareness and consultation meetings with farmers in connection with the formation of Farmers Organizations at Mirwal and Shahpur Small Dams. Management of the irrigation system is not property established and the influentials use more water than their authorized share of dam water. With water being such a crucial input, the issue of water rights (that every farmer in the command area should get water according to his share) will continuously be a source of problems unless it is resolved by the concerned agency, such a s the Small Dam Organization, Department of irrigation and Power, Government of the Punjab.

SOCIAL MOBILIZATION FOR POVERTY ALLEVIATION: EXPERIENCE AND LESSONS FROM SMALL DAM AREAS IN PAKISTAN

Today, almost one-third of the population in Pakistan in poor. This translates into 46 million people currently living below the poverty line. At the beginning of the 1990s, one in five families was living in poverty, however, this proportion has increased to one in three in late 1990s. overall, the incidence of poverty has increased in the last decade. The incidence of poverty varies substantially across Pakistan, with poverty being significantly higher in rural areas. Pockets of extreme poverty, in which over half of the population lives, exist in rural Singh and Baluchistan. Poverty tends to be concentrated in large families that have few earners and high dependency ratios; households in which the head of the household is illiterate or has only primary education and is under employed; and households that do not own assets.

INFLUENCE OF MASS MEDIA ON CONTRACEPTIVE AND FERETILITY BEHAVIOUR

The main objective of the study is to examine the influence of the mass media on contraceptive and fertility behaviour. A comprehensive study of 1100 women aged 25 to 45 years with at least two living children living with their husbands residing in the urban centers of Lahore and Faisalabad was conducted in 1991. 200 users of modern methods from family planning clinics and 350 non users of family planning methods from the community from each of the two cities were selected through systematic random sampling. Focus group discussions with women and Mosque Imams were also conducted to have in-depth information.

Analysis of the data and focus group discussion demonstrate that the exposure to the mass media influences contraceptive use and fertility behaviour through linking people with modern world and contributing towards a sense of efficacy. Local religious leaders strongly opposed the government population program and viewed all the birth control measures are unislamic. Communication channels should be planned according to the nature of the cultural climate and ideology. Performance of the mass media can be improved by integrating action oriented and attitudes-focused approaches.

FERTILITY REGULAR BEHAVIOUR: A STUDY OF RURAL PUNJAB PAKISTAN

The main objective of the study is to examine fertility regulation behaviour in terms of knowledge attitude and practice of contraception and to explore the socio-cultural obstacles in relation to acceptability and accessibility of birth control methods. Three hundred sixty women aged 25 to 45 years with at least one living child residing in the rural areas of three major districts of the Punjab province Lahore, Rawalpindi, and Multan were interviewed. Findings the study demonstrate and cultural forces in terms of religious belief systems, husband's opposition, performance for large families and normative and psychic costs of contraception are vitally important in shaping fertility regulating behaviour. Organized efforts are required to provide contraceptive information, counseling and services about mother-child health, pregnancy complications and others reproductive health problems to reduce the health risks from mistimed and unwanted pregnancies. It is also argued that the contraceptive methods offered to couples should have minimum side effects and assistance should be readily available to those women or couples who fund difficulty with a method and wishing to shift another. The performance of the family planning program can also be enhanced if it meets the multiple reproductive health needs of the Pakistani couples.

ESTIMATION OF INFANT AND CHILD MORTALITY, LIFE EXPECTANCY AND CONSTRUCTION OF ABRIDGED LIFE TABLE

Abridged life tables for both sexes, separate for males and females have been constructed to study the mortality pattern at different ages. The Pakistan demographic survey data for 1999 have been used. From these life tables, the life table functions 0q1 – 1q4 and e0 are used to estimate the level of infant and child mortality and life expectancy at birth. The analysis demonstrates that the levels of infant and

child mortality are still very high in Pakistan. The life expectancy at birth is improving but still low as compared to many developing countries. It has been argued to improve the women status through improving their education for enhancing their abilities to seek better health care and nutrition for their newborn children. The effective role of health practitioners to address the issue of infant and child mortality should also ensured.

NATURAL RESOURCE MANAGEMENT THROUGH COMMUNITY BASED APPROACH IN KOTLI, AJK: THE ROLE OF NATIONAL RURAL SUPPORT PROGRAMME (NRSP)

The failure of developing countries to deliver required socio-economic development through their masses paved the way for non-government organization to play their role in this regard. NRSP is a national level NGO working in Pakistan and Azad Jammu and Kashmir (AJK). The study was conducted to examine the impact of NRSP community based natural resource management in Tehsil Kotli, AJK. A random sample 120 respondents was drawn from three villages and data were collected through formal survey. The study concluded that NRSP community formation proved an effective strategy in mobilizing local potentials. A significant majority learnt livestock care and vegetable production skills and realized benefits in the form of increased production. However 85% of the respondents who were trained to control soil erosion reported credit complexities included lengthy procedure, delay in disbursement and high interest rates have been identified.

RELIGIOSITY AS A FACTOR OF FERTILITY CONTRACTIVE BEHAVIOUR IN PAKISTAN

A study was conducted in two major urban centers Faisalabad and Lahore of Pakistan to know the views of respondents about the contraceptive use and family size and composition. 1100 women (400 users and 600 non-users of contraception) were interviewed to explore objectives. The high level of fatalism regarding procreation with low sense of personal efficacy in controlling fertility and prohibition of contraceptive use (perceived by people) in Islamic for birth spacing are undoubtedly responsible for high fertility in Pakistan. The Islamic view point on the issues of the fatalism and contraceptive use clearly demonstrates that pronatalist tendencies in Islam stem less from direct injunctions to procreate than from the support of other socio-cultural values and misinformation about the religion. Islam imposes restriction, on procreation in terms of responsibilities of children's socialization. Islam does not encourage the view point that predestination makes a human being skeptical with regard to control over his own actions. The use of wisdom to plan every day life for the betterment of family and society is according to the principles of Islam. A number of hadiths permit the use of 'Al-azl coitus interrupts' as a method of contraception. From the findings of this study it can be argued that fertility decline is only possible when it is no longer regarded as fatalistic and comes into the realm of perceived personal control.

IMPACT OF MASS MEDIA ON YOUNG GENERATION

Media influences social components of human personality. It mainly focuses how human feelings and emotions can be altered or changed. This study examines the impact of mass media on young generation. The study was conducted in three colonies of Faisalabad City. It was concluded that mass media, especially the electronic media and internet are making young generation irreligious, aggressive and materialistic. Media promotes fashion phobia and vulgarity. The study findings also demonstrate that media increased awareness about political. social and environmental issues. It contributes in business promotion and in improving standard of living

SOCIO-ECONOMIC AND PSYCHOLOGICAL PROBLEMS OF CARDIO-VASCULAR PATIENTS

The prime objective of the study was to investigate the problems of cardiovascular patients and to explore the effect of the disease on their socio-economic and psychological life. For this purpose, a well – designed interviewing schedule consisting of closed ended and open-ended questions was framed. A

sample of 120 patients admitted in Divisional Headquarter, Faisalabad was selected. Descriptive analysis demonstrates that major cause of the patients suffering were tension, anxiety, stress and overworking followed by the food adulteration as the patients perceived and inferential analysis identified age, sex, residence, income, occupation, education and smoking habits as the determinants of cardiovascular diseases such as hypertension, angina, coronary heart disease and myocardial infarction. The socio-economic life of the patients' families is adversely affected due to the disease. Family members lived in stress, strain, tense and depress environment. It is concluded that tense circumstances adversely affect the children education, their development and personality, spousal relationship, relationship with the relatives, family health and social mobility.

SOCIO-CULTURAL FACTORS INFLUENCING MOTHER'S' ATTITUDE TOWARDS THEIR DAUGHTERS' EDUCATION IN RURAL FAISALABAD.

The present study was designed to inartificial the socio-cultural factors influencing mother attitude towards their daughter education. The study was undertaken in Chak No. 7/JB.Panjwara on Sargodha Road on Faisalabad District. The sample consisted of the married female. The number of the total respondents selected systematically form the population of 300 household was 100. Thus data were analyzed and interpreted for drawing conclusions. The study findings show that mothers have infusing the socio cultural attitudes for their daughters. The major reasons not sending their daughter to school due to family tradition, educated girls one good housewives, educated girls note in domestic work, education girls can solve their problems. Difficult selection of life partner for educated girls, the mother attitude infusing of their daughters education, higher income level favorable aspiration of their daughters educations, describe this study.

PARENTS' DIFFERENTIAL ATTITUDE TOWARDS THEIR DAUGHTERS' AND SONS' EDUCATION IN RURAL FAISALABAD: A COMPARATIVE ANALYSIS

The present study was conducted to investigate parents' differential attitudes toward their daughters' education. Faisalabad tehsil was selected at random and five Union Councils from selected tehsil were selected randomly. Of each Union Council, three villages were selected at random. Five males (fathers) and five females (mothers) totaling to 10 respondents were randomly selected and interviewed from selected villages. Thus making a total number of 150 respondents were interviewed. The data were analyzed and interpreted for drawing conclusions. The study findings show that parents' have preferential attitudes for their sons' education as compared to their daughters. The major reasons included family traditions, family problems, social need, better future and good manners.

SOCIO-ECONOMIC DETERMINANTS OF CHILD LABOR IN AUTOMOBILE AND ENGINEERING WORKSHOPS

This study was undertaken to identify the socio-economic factors responsible for child labor in automobile and engineering workshops in tehsil Samundri district Faisalabad (Pakistan). For this purpose, 120 respondents under 15 years of age were randomly selected. A comprehensive interviewing schedule was designed to collect the required information. Almost one half of the respondents was below 14 years of their age, and had attained primary education. Majority of the respondents belonged to the rural areas, living in nuclear family system, having both parents alive but with low income. Majority of the respondents were not willing to work, but financial problems and motivation by the parents forced them to work. There is a need to enhance educational facilities of children and employment opportunities for adults particularly in the rural areas.

SOCIOLOGICAL ISSUES IN CHILD LABOUR AT AUTOMOBILE AND ENGINEERING WORKSHOPS

This study was aimed at investigating some sociological issues related with the child labor employed in

Automobile and Engineering Workshops in tehsil Samundri district Faisalabad. The children under 15 years of age were randomly selected for the study. Nature of job, employer's behavior and sufferings of the respondents were some of the major variables included in the analysis plan. A significant association was found between employers' general behaviour and respondents' satisfaction with their work.

FACTORS AFFECTING SKILL DEVELOPMENT AND JOB OPPORTUNITIES FOR YOUNG FEMALES IN RURAL FAISALABAD-PAKISTAN

The present study was designed to identify the factors affecting the parents' attitude towards the skill development and job opportunities for their daughters. The study was conducted in Faisalabad district, which comprised of five tehsils. One tehsil was selected at random and five Union Councils from this tehsil were selected randomly. Out of each Union Council, three villages were selected at random. Five males (fathers) and five females (mothers) totaling to ten respondents were randomly selected from selected villages, making a sample of 150 respondents for interview. The data were analyzed and interpreted for drawing results. The results show that parents were in favour of males' technical education because males extend more support to the parents than females and males have more opportunities for job than females. Furthermore, daughters do not work due to family traditions and male members do not allow daughter for paid job because of bradary pressure. Bad environment at the work place was also one of the important factors affecting skill development and job opportunities for females.

DOES GENDER PREFERENCE AFFECT CONTRACEPTIVE USE BEHAVIOR IN NORTHERN PAKISTAN?

The study portrays the influence of gender preference on contraceptive use behavior in Peshawar, Pakistan. A total of 613 married male respondents (J5-49 years old) in five different bazaars were selected out of total fifteen bazaars through cluster sampling procedure. Both dependent (contraceptive use behavior) and independent (gender preference) variables were devised while using semantic and likert scales respectively. Dependent variable was indexed and gamma statistics was adopted for carrying out bi-variate and multi variate analysis. Majority of the respondents was found moderately consistent of contraceptive use behavior and had a clear concept of family planning. Most of the respondents belonged to joint family system; however, raising a girl was negatively and significantly ($P<0.05$) influenced by nuclear family system and illiterate respondents. Social and cultural raising of a girl was positively and significantly ($p<0.05$) influenced by literate respondents Certain recommendations like, equal status for daughters to avoid uncontrolled family size, redress of family system with respect to girls raising portraying a girl an economic asset in the form of paid job and convincing of all income group for discouragement of preferential gender treatments for policy implementations.

INTEGRATED DEVELOPMENT MODEL FOR PORVERTY REDUCTION

This study instigates the development process through organization for improvement of life undertaken by three NGOs namely NRSP, AAPK and Bunyad in the district of Punjab (Khushab, Bahawalnagar, and Lahore). They study is based on field work including visit to 78 villages and more than 100 villages organizations and interview of 600 persons (309 males and 285 females). They study also includes the review of NGOs in terms of their structures, approaches and interventions.

Information on family size, agricultural land, business, labor, livestock mentioned by community organization members (respondents), their income, facilities available, access to credit and government departments, role of women etc. was collected through a well designed questionnaire. Their opinion and comments about the working of NGOs and the benefits derived by the community were obtained. Suggestions for improvement and better utilization of sources were got through discussion after having them in confidence. The data thus collected was analyzed by using statistical techniques which showed that although the NGOs were working for poverty reduction but they were emphasizing only one or two

sectors, where as it needs integrated approach. The problem is determined by their own needs and problems of the people and priorities are fixed by themselves. Village based organizations are strengthened through peoples participation their involvement in policy decision making and their empowerment to utilize the resources for their own benefit by themselves.

The new model developed is the outcome of present research and is based on the philosophy "development without dependence"

IMPACT ASSESSMENT OF KATCHI ABADI DEVELOPMENT PROGRAMMES

Squatter settlement/katchi abadis can be seen all over the world and particularly in developing countries. The successive generations of the government have recognized he positive role, which these settlements play in housing the million of poor families. The issues of their regularization and improvement have been recognized universally.

The different governments of Pakistan have taken keen interest to regularize and improve the katchi abadis. However, a countrywide katchi Abadi Improvement programme (KIP) was launched in 1985 and continued up to 1990. The KIP included the granting of proprietary rights to the squatters and providing the utilities and community facilities in all recognized kathci abadis. A research study was conducted to assess the impact of KIP in Punjab, a province of Pakistan. The overall objective of the study was to assess he effects/changes of KIP intervention on the demographic, social, physical and economic aspects of the inhabitants of Kathi abadis as well as to assess their impact on perception and satisfaction level about the environmental and social improvements undertook through the implementation of KIP. The study universes consisted on Rawalpindi, Faisalabad and Multan, which are the true representatives of three geographical regions of Punjab. A Sample of 700 respondents was taken through systematic random sampling technique. Both the quantitative (secondary sources as well as field survey) and qualitative(focus groups interviews) studies were conducted with the aim to produce most robust results possible.

The uni-variate, bi-variate and correlation analysis demonstrated that demoraphic, social, physical and economic variables are the correlates of the perception and satisfaction with utilities and community facilities. The multivariate analysis identified the social, physical, mobility and health index variables as the most predictor variables in explaining the respondents, perception about environmental and social improvement and satisfaction with utilities and community facilities.

It is deduced that the KIPhas been a relaitively successful programme in improving the socio-economic, dempgraphic, environmental and physical dimensions in the katchi abadis.

It is recommended in the light of conclusions drawn that a participatory (components sharing) approach may further improve the effectiveness and sustainability of KIP.

FACTORS AFFECTING MALES CONTRACEPTIVE BEHAVIOUR A CASE STUYD OF NWFP

A total of 613 married males (15-49) were randomly interviewed in five bazaars selected through cluster sampling from the total fifteen bazaars located in old city area of Peshawar to study the influence of gender roles on contraceptive use behavior. Average birth rate 4 was 4.13, while number of surviving children per couple was 3.51, representing 1.89 sons and 1.62 daughter. Majority of the respondents showed moderately consistent behavior to contraceptive use and had a clear concept of family planning. Taking income, literacy and family type. A as control variables, literate men favored ($p<0.05$) women's rights and women's involvement in reproductive decision making and family planning communication. Respondents in low income group favored ($p<0.05$) women's involvement in reproductive and contraceptive decision making while medium income group favored ($p<0.05$) women's involvement in

reproductive decision making only. Respondents in joint families favored ($p<0.05$) women's involvement in decision-making on reproductive matters but opposed their participation in family planning communication. Literate respondents, having nuclear families and low level of income strongly opposed women's involvement in household decision-making and family planning communication. The respondents had consider above reservation to in-public discussion/advertisement of family planning being against the social norms. Although, sons were preferred over daughters, raising girl was not considered a burden. Gathering information about family planning and deciding to develop relationship with relatives excluding friends was favored by most of the respondents. Although, majority of the respondents favored giving due respect of women in the society, sometimes respondent was positive to one aspect of women's right but negative to another at the same time, keeping in view social/cultural obligations. Women's involvement in decision making on house purchase/construction, number of children and their education and discussion about contraception was favored by most of the respondents.

Husband/wife mutual discussion on fertility control societal acceptance of contraceptive use and raising a girl was significantly ($p<0.05$) and positively affected by educational status of respondents. Literate respondents significantly ($p<0.05$) favored women's higher education, paid jobs, husbands also responsible for bareness, contraception being having lesser side effects as compared to reputed pregnancies and women's involvement in deciding contraceptive uses.

Similar response was shown to women's higher education, consultation about selecting children's marriage partner, men also responsible for bareness, societal acceptance of contraception and raising a girl in nuclear family system. Positive and significant ($p<0.05$) relationship existed between low income and women's higher education, women's paid job, contraception being having laser side effects as compared to repeated pregnancies, family planning and preference for sons as security against old age higher income status significantly ($p<0.05$) and positively affected women's higher education and men also responsible for bareness. For general acceptance of contraceptive use, men along with women should be included in the target group as most of the decision regarding family planning and contraception necessitate prior approval of males/husband as under the prevalent culture. Public Propagation of contraceptives should be initiated under the concept of "Azzal" having religiously tacit support and special centers be established to accomplish the task of involving men in the process.

ENVIRONMENTAL AND RESOURCE ECONOMICS

Aggregate Farm Income Analysis

The study was based on primary data and was carried out in District Toba Tek Singh and Jhang. In this study crops and livestock contributed to the extent of 76.31 and 23.69% respectively toward the total farm income on overall basis. An inverse relationship was observed between farm size and shares of livestock sector and was estimated as 27.54, 24.82 and 17.07% for the small, medium and large farm categories respectively whereas contribution of crops continued to increase as the farm size became larger., Aggregate income per acre was found to be Rs.3561.54, Rs.3557.75 and Rs. 3715.97 for the above mentioned farm categories respectively. Per acre income on overall basis was estimated to be Rs.3524.74. As far as the income from the crop sector was concerned, wheat crop was found at the top contributing 36.65%, 34.99% and 33.96% towards the total crop income for the respective three categories and was followed by sugarcane in case of small, and cotton for the rest of the two categories.

Rapid Rural Appraisal of PARL Pilot Project.

The PARL Pilot Project has been initiated by the University of Agricuture, Faisalabad for an expeditious transfer of the latest and on farm tested technology to the farm community at a selected site on the main Faisalabad – Sheikhupura Road. Two villages namely, Gujar Singh Wala and Ghaseet Pura situated at a7 km. From Khurrianwala towards Shahkot have been selected for this purpose. The major objective of the project is to effect substantial improvemenmt in productivity levels at the common farm level. The first step to innate the project was to conduct Rapid Rural Appraisal (PRA). The results of RRA revealed that the average yields per acre of all crops are very low. Major causes of low yield are lower use of inputs. Weeds also pose a serious problem to various crops. Top borer and termites have been observed to cause heavy damage to sugarcane crop. The existing use of chemicals at the farm level for the control of insect pests, diseases and weeds is just negligible. Farmers also reported that the inputs supplied in the area were highly adulated. These results suggest that there exists a reasonable large potential for improvement in crop productivities through the supply of good quality inputs as well as dissemination of latest technologies to the farmers of the project area.

Economics of Livestock Production and Management.

This book consists of six chapters. The first chapter is devoted to the role of livestock industry in the economy of Pakistan. Besides, it is concerned with the growth rate of various categories of animals and constraints to livestock sector. The second chapter deals with the theoretical concepts and their application to livestock sector. The third chapter entails the cost of production of livestock products i.e., milk and meat and their profitability. Farm business analysis is another important aspect covered here in. It includes information pertaining to farm records, net worth statements and efficiency measures with special emphasis on livestock enterprises. Another chapter deals with the farm budgeting and planning. Finally, it covers the important aspect of project appraisal.

Farming Income Analysis of Rice Production in the Rice Based Farming System.

The study was carried out in the rice zone of Punjab Province. Due to resource constraint, one district was picked for detailed investigation. A cluster of four villages was selected from this district. After a through preliminary survey, a sample of 102 respondents comprising different farm size groups i.e., small, medium large, was finally drawn. Data were collected with a well planned questionnaire and analyzed by

applying different statistical techniques.

The Mungbean Green Revolution in Pakistan

This study was carried out in the province to Punjab that accounts for more than 80% of Pakistan's total mungbean area. A sample of 250 representative farmers from the Punjab Province was used in this study. The allocation of the sample to various districts of Punjab was based on their relative share in the total mungbean area of the province.

Mungbean research has concentrated mainly on developing high yielding, disease resistant, large seeded, and shiny coated varieties. Breeders in Pakistan have been successful in increasing the yield frontier by 100 percent, increasing the seed size by about 33%, developing resistance to Mungbean Yellow Mosaic Virus (MYM) and Cercospora Leaf Spot (CLS), and in making the seed shinier. They have also shortened the crops duration from 90 days to about 60 days, and have synchronized maturity.

Priorities for Improvements in Rural Welfare in the Mixed Farming Zone of the Punjab.

Faisalabad district was chosen as the study area because of its proximity to the University of Agriculture, Faisalabad. This district lies within the mixed cropping zone of the Punjab. The villages for survey were selected to give an even geographical spread across the district and one respondent was chosen in each village. The respondents who were selected were key informants, that is the Number Dar, a school teacher, or an opinion leader. The latter are particularly successful farmers, who obtain high yields, possess good tools, or are otherwise well-established persons. The objectives of this report have been to assess the levels of satisfaction with the existing facilities in rural villages and to assess priorities for improvements. The levels of satisfaction were assessed through rankings and direct questions on the levels of satisfaction.

Dynamics of Vegetables Production, Distribution and Consumption in Asia.

This study has tried to quantify trends in vegetable production, consumption and trade and to review the existing literature on various vegetables related issues in Pakistan. Production of various kinds of vegetables has reflected varying trends and so has trade and per capita consumption. Although total vegetable production (and that of potato) increased significantly over the past two decades, the main contributing factor to these increases came from area increase, while yields remained almost stagnant. A large part of total vegetable production took place under traditional management practices. Heavy dependence on farmyard manure, as well on chemical fertilizers, is common. Despite mechanization of some tillage operations, sowing, hoeing and harvesting remained by manual operations. At the same time, cost of production studies pointed out that vegetable cultivation was a highly profitable enterprises both in absolute and relative terms (e.g., compared to the field crops). In relative terms, profit rates for vegetables could be 5-10 times those of field crop depending on the particular vegetables and field crop under consideration.

Development of Disadvantaged Rural Farm and Landless Households Through Participatory Approach.

The activities of this project are carried out at two locations i.e. Faisalabad and Khushab. In Khushab project area, a total amount of Rs,4,00,000 was disbursed to 23 different groups. An amount of Rs.2,59,500 was disbursed to 14 males groups while a sum of Rs.1,40,500 was advanced to 9 female groups. A sum of Rs.3,80,000 has been recovered from 20 groups while an amount of Rs.20,000 is still to be recovered from three groups. In the Faisalabad project area, a sum of Rs.5,00,000 was advanced to various male and female groups formulated since the beginning of March, 2002. Thirteen male and seven female groups were constituted. A sum of Rs.3,25,000 and Rs.1,75,000 was disbursed to these groups

respectively. The experience of advancing small loans to both the male and female groups indicates that these are zero risk loans and Agricultural Development Bank of Pakistan and other banks must advance such loans to the poor sections of the society. These loans generate income and employment for the marginal households.

Economics of Growing of Tinda Gourd

This study was carried out to work out the economics of tinda gourd. Data were collected from 96 tinda growing farmers of two districts i.e. Layyah and Khanewal. The main findings are given below:

Majority of the respondents used their own seed and source of seed was statistically significant between the two districts. The most common method of tinda sowing was recorded as broadcasting in both the districts. However, in Khanewal flat pora method was also reported and a significant difference was found in sowing time of tinda between the selected districts. A small percentage of the farmers applied farmyard manure while the application of inorganic nutrients was below the recommended doses. The estimated tinda yield per acre in Khanewal (1589.6 kg) was statistically lower as compared to that in Layyah (2692.8 kg). However, it was found that tinda growers of Khanewal received a higher price compared to those in Layyah. That's why gross income was reported higher in Khanewal (Rs.8615.63) and lower in Layyah (Rs.7108.99). Total cost per acre was statistically higher in Layyah (Rs. 6399.62) compared to that in Khanewal (Rs.5592.34). Cost per 40 kg was found to be Rs. 95.20 and 140.80 in Layyah and Khanewal respectively. The net returns per 40 kg were Rs.76 and 10.40 in Khanewal and Layyah District. On the basis of the findings, the farmers could increase yield per acre by adopting better land preparation, plant protection measures, timely sowing and efficient use of labour for weeding/hoeing.

Economics of Growing of Muskmelon

Keeping in view the economic and nutritional importance of muskmelon, the study was conducted to determine the economics of the muskmelon crop. For this purpose, data were gathered from the farmers of R. Y. Khan and Bahawalpur districts as these districts occupied the maximum acreage in the Punjab province. The results of this study show that the yield per acre of the respondents of R. Y. Khan (3337.30 kg) was statistically higher as compared to that of Bahawalpur (2908.57 kg). Gross income was estimated to be higher in R. Y. Khan (Rs.15718.68) than Bahawalpur (Rs.12157.82). The respondents of R. Y. Khan district applied more inputs to their crop as compared to Bahawalpur district. Therefore, total cost per acre was found higher in R. Y. Khan (Rs.10878.01) and lower in Bahawalpur (Rs.9514.77). Application of fertilizer, irrigation number and use of pesticide were statistically different between the two districts. Gross margin per 40 kg was significantly higher in R. Y. Khan (Rs. 83.20) compared to that in Bahawalpur (Rs.64.80). The respondents of R. Y. Khan obtained higher net returns per 40 kg (Rs. 58) than those of Bahawalpur (Rs.36.40) while cost per 40 kg was almost the same in R. Y. Khan (Rs.130.40) and Bahawalpur (Rs.130.80). Three varieties were reported in the sampled districts. These were local, Tuma and Chichawatni. Chichawatni variety gave significantly higher yield than other varieties. The results of the study suggest that the farmers should allocate more area to Chichawatni variety and apply optimum quantities of nitrogen, phosphorus, potassium, manure, irrigation and proper weeding. In this way, they could obtain higher yield of muskmelon.

Economics of Growing of Bitter Gourd

The present study consisted of a farm survey of the top two bitter gourd growing districts i.e. Faisalabad and Rahim Yar Khan of the Punjab province. A total of 90 bitter gourd growing farmers were purposively selected for interviews. Following are the main findings of the study: The bitter gourd growing farmers of R. Y. Khan obtained statistically higher yield per acre (2974 kg) than those of Faisalabad (2763.6 kg). Gross income per acre was found to be higher in R. Y. Khan (Rs.21603.13) as compared to that of Faisalabad (Rs.19537.27). The use of inputs on bitter gourd was recorded higher in R. Y. Khan compared

to that of Faisalabad. Therefore, total cost per acre was estimated higher in R. Y. Khan (Rs. 14802.91) and lower in Faisalabad (Rs. 12541.01). Application of fertilizer, irrigation, use of pesticide and labour used for weeding was statistically different between the two districts. Gross margin per 40 kg was Rs.140.56 and 132.23 in Faisalabad and R. Y. Khan respectively. The respondents of Faisalabad obtained higher net returns per 40 kg (Rs. 101.26) than those of R. Y. Khan (Rs. 91.46), whereas cost per 40 kg was statistically less in Faisalabad (Rs. 181.51) as compared to R. Y. Khan (Rs. 199.09). Three varieties were being planted in the sampled districts. These were local, Bengali and Karishma. Karishma variety gave higher yield than other varieties. The findings of the study indicate that manure, fertilizer and labour used for controlling weeds and earthing up are important in increasing the yield of bitter gourd.

Economics of Growing of Radish

This study was conducted to work out economics and profitability of radish. For this purpose, data were collected from the farmers of Sheikhupura and Sahiwal districts as these districts occupied the maximum acreage of radish in the Punjab province. The results of this study show that the yield per acre of the respondents of Sheikhupura (6535 kg) was statistically higher as compared to that of Sahiwal (5331 kg). Gross income per acre was estimated to be higher in Sheikhupura (Rs.15372.42) than that of Sahiwal (Rs.11844.37). The respondents of Sheikhupura district applied more inputs to their crop as compared to Faisalabad. Therefore, total cost per acre was found higher in Sheikhupura (Rs.10575.82) and lower in Sahiwal (Rs.9800.09). Application of fertilizer, irrigation, use of pesticide and labor for weeding was statistically different between the two districts. Gross margin per 40 kg was significantly higher in Sheikhupura (Rs. 37.28) compared to that in Sahiwal (Rs.32.13). The respondents of Sheikhupura obtained higher net returns per 40 kg (Rs. 29.36) than those of Sahiwal (Rs.14.67) while cost per 40 kg was relatively less in Sheikhupura (Rs.64.73) as compared to Sahiwal (Rs.70.36). Because of large variations in the yield of respondents at district level, the farmers were arranged in an ascending order of yield to identify the factors responsible for productivity differential. Two yield groups i.e. low yielders and high yielders were defined. The high yielders of Sheikhupura obtained higher yield compared to the low yielders mainly because of the difference in quantity of seed, nitrogen and phosphorus and use of labor to control weed infestation. Similarly the respondents of the high yielding level obtained significantly higher yield than the low yielding farmers in Sahiwal district by applying more quantity of nutrients, irrigation, number of sprays to control insect and pest attack and labor used for weeding and hoeing. Cost per kg and per 40 kg for the low yielders was significantly higher than that of the high yielders of both districts, whereas net returns per kg and per 40 kg of the low yielders were significantly lower compared to those of the high yielders in Sheikhupura and Sahiwal. Low price of the produce and inadequate availability of good quality of radish seeds were the most important factors inhibiting the production of radish in Punjab. The results of the study concluded that quantity of seed, fertilizer, irrigation and labor used for controlling weeds played a significant role on the farms that experienced high radish yield.

Economics of Growing of Carrot

The study was carried out to work on the economics of growing carrot. Data were collected from 100 carrot growing farmers of two districts i.e., Sheikhupura and Kasur. The main findings are given below. The yield per acre was statistically far higher in Sheikhupura (8010.00kg) as compared to that in Kasur (6516.80kg). Applications of tractor hours used for the land preparation, quantity of seed and phosphorus nutrient were statistically higher in Sheikhupura than those in Kasur. However, the respondents of Kasur made more use of irrigation as they planted carrot earlier. Total cost per acre was found higher in Kasur (Rs.12874.00) and a little bit lower in Sheikhupura (Rs.12571.95). Nevertheless, gross income and gross margin per acre were estimated higher in Kasur (Rs. 20397.58 and 9103.92) than those in Sheikhupura (Rs.16981.20 and 6296.56) because of the high price of the produce in Kasur. Gross margin per 40 kg was significantly higher in Kasur (Rs. 56.00) compared to that in Sheikhupura (Rs.30.80). The respondents of Kasur obtained higher net returns per 40 kg (Rs. 46.40) than those of Sheikhupura (Rs.22.00) while cost per 40 kg was significantly less in Sheikhupura (Rs.65.80) as compared to Kasur

(Rs.79.20). Productivity differential was made to quantify various factors responsible for yield variation. The estimates of resource-use efficiency can be used to identify the room for improvement in input management. Resource use efficiency in the high yielders was compared with the low yielders. It was found that the high yielders of Kasur district were using significantly higher quantities of seed, fertilizer and pesticide on carrot crop. In Sheikhupura, use of phosphorus, labour used for manual weeding and harvesting were statistically different between the yield groups. That's why the yield per acre was far higher on the high yielders than on the low yielders. Further, net returns per acre and per kg were also higher on the high yielders compared to the low yielders. Similarly, cost per kg and per 40 kg was lower on the high yielders than on the low yielders in both districts. This report also provides necessary information to identify constraints on carrot cultivation in the selected districts. Low price of the produce, inadequate availability of funds, high input prices and non-availability of good quality seed were some of the crucial constraints on carrot cultivation. It is concluded from the analyses of this study that great potential exists in improving the carrot yield per acre in the selected districts. Farmers' access to certified seed, better land preparation, recommended dose of seed and fertilizer and availability of credit are the major factors that can enhance the carrot produce.

Economics of Growing of Potato

Keeping in view the economics and nutritional importance of potato, the study was conducted to determine the economics of potato. For this purpose, data were gathered from the farmers of Okara and Kasur. A total of 100 farmers were interviewed from both districts for the year 2002 to 2003 spring crop. The results of this study showed that per acre yield was statistically higher in Okara (8396.80 kg) than that in Kasur (7971.52 kg). Quantity of seed, farmyard manure and inorganic nutrients (N, P and K), number of irrigations and labour used for harvesting were statistically different between two districts. Total cost per acre was estimated as Rs. 26601.05 and 31608.37 in Okara and Kasur respectively. High cost in Kasur was the result of irrational use of fertilizer and irrigation and high price of seed. However, gross income and gross margin per acre were statistically higher in Okara (Rs. 24938.50 and 1054.63 respectively) and negative gross margin per acre was estimated for the respondents of Kasur (Rs. -7789.77). Positive gross margin per kg and negative net returns per kg were found in Okara (Rs.0.12 and –0.20) while the above were negative in Kasur (Rs.-0.98 and –1.44). Cost per kg was estimated for each district and it was Rs. 3.16 in Okara and Rs.3.96 in Kasur. To identify various factors responsible for yield variation, productivity differential was made for each district. Resource use efficiency on high yield level was compared with that that on low yield group in each district. It was learnt that high yielders of Okara made more use of seed and potash nutrient and those of Kasur applied more of farmyard manure, potash nutrient and labour used for weeding. Hence, per acre yield on high yielders was statistically higher in each district. Gross margin and net returns per acre and per kg were negative for both yield levels in Kasur, however, gross margin per acre and per kg were positive in Okara on both yield groups. Net returns were negative in Okara like Kasur district. The reason was that potato fetched low price per kg during this cropping season. Cost per kg was higher on low yielders as compared to that on high yielders in both districts. Results of production function analysis indicated that seed, farmyard manure and farming experience were positively impacting potato yield while nitrogen, Desiree variety and small and medium farms were reducing yield per acre. Low price, inadequate funds, high prices of inputs and non-availability of good quality seed were identified as crucial constraints/ problems in potato production. It is concluded from the study that farmers could enhance potato yield per acre if seed, farmyard manure and particularly fertilizer are applied according to the recommendations given by Department of Agriculture. Availability of funds, access to good quality seed, cold storage and transportation facilities and stable output price could further increase potato production in the province.

Opportunities and Constraints in the Production, Marketing And Export Of Citrus In Punjab

In Citrus group, Kinnow is the largest produced fruit in Pakistan. During 2001-02, total Kinnow production was 1.168 million tons, having market value of Rs.8.92 billion. During the same year, the fruit amounting

Rs.5.083 billion was exported, out of which citrus exports accounts to Rs.1.238 billion. The domestic per capita availability of citrus was estimated as 8 kg/annum. About 95% of the total citrus area lies in the Punjab. The productivity of citrus in Pakistan is lower than in other countries of the region. Substantial scope exists in terms of income and employment generation in the farm and non-farm sectors through the development of citriculture in Pakistan. Improving citrus productivity can enhance Pakistan's competitiveness in the international markets. However, the information on agronomic and economic and economic aspects of production and functioning of the domestic and export market in Pakistan is highly scanty. This creates fluctuation in production and prices, produces often mismatch in supply and demand both in terms of quality and quantity, and generates disincentive for the investor to invest in the sector. All these factors keep the productivity of the sector far below its potential. This study aims to fill the information gap in production and marketing of citrus in Punjab. We have specifically generated quantitative data on citrus production, domestic and export marketing systems in Pakistan's Punjab. It is expected that these data will be useful for policy planners to improve the efficiency in citrus production and marketing in the province, enhance its contribution in income and employment generation and poverty reduction, and improve country's competitiveness in international market. This study concentrates on Punjab as this is the major citrus producing province. Imary and secondary data were used in this study. The primary data were collected through a formal survey consisting of interviewing citrus growers (125), pre-harvest contractors (25), commission agents (20), wholesales (44), retailers (41), Kinnow processing and exporting factories (19). The purposive stratified random sampling was used in selecting the citrus growers. The survey was conducted in Sargodha district as it is the largest citrus growing district of Punjab, and most of the citrus processing/exporting factories are located here. The secondary data on citrus prices, area, production, and export were collected from Government of Pakistan's publications such as the Agricultural Statistics of Pakistan and the Economic Surveys. The citrus nursery business was found highly informal. No information exists in the nurserymen about the type of rootstock or the productivity record of the scion. On sample farms, Kinnow is the only dominant variety planted and the mean plant population per hectare was nearly 241 trees/ha. Wheat and Berseem were two crops planted in citrus orchards. The NPV of the flow of costs and returns clearly indicate that sole orchards were more profitable than intercropped ones. The NPV technique gives equal value to the future 20 years. However, more risk adverse farmers, go in for intercropping because they value the immediate future more highly. This justifies the existence of intercropping despite low NPV. The optimum economic life of citrus orchard was estimated as 20 years. In the production function analysis, the variables positively and most significantly affecting citrus production were number of sprays, tree population and total nutrients applied. This signifies that farmers should concentrate relatively more on plant protection measures and tree population along with total nutrients applied. The estimates on Allocative efficiency parameter illustrates that the growers were under-utilizing spraying and plowing while over-utilizing all other inputs. The underlying reason of sub-optimal use of inputs is the lack of orchard management knowledge of citrus growers in the area. In domestic citrus marketing, the overall producer's share in consumer rupee was 35% followed by contractor and retailer obtaining 32% and 20% respectively. The further deconstruction of these margins into the components of marketing activities performed reveled that (i) profit absorbed most the marketing margin: (ii) retailers received the highest gross retunes: and (iii) the highest rate of wastage occurs at the level of contractor. Therefore, efforts are required to minimize the post-harvest losses through making improvements in packing methods and material. The market integration analysis showed that Sargodha market is relatively better integrated with Faisalabad (0.98) and Lahore (0.98) than Multan (0.96), however, the statistical test on the coefficient for integration did not support this. This signifies that further research on fruit marketing integration is required. Perhaps daily price data may give better results than the weekly or monthly data. In any case, it is clear that certain markets in the province are not integrated, requiring policy steps to improve market integration. On the export side, the net returns to the exporters amounting Rs.5.01, 4.66, 4.37 and 4.90 per kilogram were estimated for Middle East, Far East, Europe and Russain markets, respectively. At Karachi port, the trade-off between selling the export quality Kinnow locally or exporting it to various destinations of the world revealed that the overall rate of return on the additional costs incurred by exporter was 9%. Based on these estimates, the returns to additional costs (i.e. sea transport, taxes and duties etc.) incurred by

the exporter were computed as Rs.260 million, which is the earnings to the society from the citrus export by sacrificing the domestic consumption of export quality fruit. In the light of above findings, the farmers need to be educated on the optimal use of various critical inputs and not practicing intercropping in mature orchards. Special orchard care is recommended for the gardens aged more than 20 years. The Department of Agriculture, Livestock Products Marketing and Grading (DALPMG) is suggested to disseminate the marketing related information to all stakeholders in more effective manner by establishing Agricultural Marketing Information System (AMIS). There is a need for citrus varieties such as seedless Kinnow that have small canopy size, high yield, salt tolerant and disease resistant varieties. The horticultural research work under the National Seed Registration and Certification Department (NSCRD), Agricultural Extension department, Pakistan Horticulture Development and Export Board (PHDEB), DALMB and the citrus exporters should be coordinated. The Development of the market will provide an initiative for the private sector to step in. This includes certification laboratories and nurseries. With a well functioning market farmers will be able to buy quality certified stock and maintain quality. They will also be able to meet the sanitary and phytosanitary measures required under the WTO. It is, therefore, important that the impediments to the development of these markets be addressed. Our estimates of the different measures of protection indicate that the Kinnow is largely a dis-protected crop. Based on these estimates, Punjab has a tremendous potential to increase the welfare of its people by maximizing on this comparative advantage through international trade.

Use of Linear Programming Model to Determine the Optimum Cropping Patterns for the Irrigated Punjab with national and WTO Price Options

Linear programming model was applied to calculate the optimal crop acreage, production and income of the irrigated Punjab. We have taken 25.6 million cropped acres from seven civil administration divisions encompassing three crop regions and nine crops of the irrigated Punjab representing 77.34% of the irrigated area and 66.23% of the provincial cropped area. In all 25 national and international prices were used to work out 27 optimal solutions. Crops included in the models were wheat, Basmati rice, IRRI rice, cotton, sugarcane, maize, potato, gram and mong/mash. The results show that the irrigated agriculture in the Punjab is more or less operating at the optimal level. Over all cropped acreage in the optimal solution decreased by 0.37% as compared to the existing acreage. However, in the optimal cropping pattern some crops like cotton and pulses gained acreage by 9-10% each, while maize and Basmati rice will be remained unchanged. On the other hand crops like wheat, IRRI rice, potato and sugarcane lost acreage by 4-11%. As a result of optimum cropping pattern income increased by 1.57%. Varying the national prices of a single crop by 10-20 on both sides, while keeping prices of the other corps constant at the existing level, did not stimulate the acreage and production of the concerned crop substantially, except that of cotton and Basmati rice. Increased prices of wheat and sugarcane, on the other have adverse effect on the exportable crops. At the International prices, especially when these are reduced by 10%, all the crops included in the model survive except IRRI rice and sugarcane, whose acreage decreased by 55 to 90% respectively. Potato suffered in acreage by 20%. This shows that food crops and exportable crops would be able to remain in the field; the WTO as such would not be a major danger to Pakistan's agriculture except the sugarcane economy, which would be totally washed out. The results show that the Punjab agriculture is short of capital. A 10% increase in capital, increased acreage by 9.82 and income by 10.5%.

An Analysis of Technical Efficiency of Wheat Farmers in the mixed farming system of the Punjab, Pakistan

Empirical results obtained from the model included that the elasticities of wheat production (i.e. the best production practices) was the highest for (0.783) area planted with wheat (0.783), it was followed by cultivations (0.323) and fertilizer (0.201). Next in importance were irrigations (0.046) availability of family labour (0.041), use of weedicides (0.029) and farm yard manure (0.007). Higher seed rate tender to surprise efficiency because the farmers were already using higher seed rates than recommended doses.

Low elasticities for fertilizer and farm yard manure mainly due to their nominal use as compared to the plant nutrient requirements. Pakistani soils are generally deficient in humans content and are vastly saline/sodic in characteristics. As a result crop response to fertilizer was low. Moreover extensive use of poor quality tubewell water in the study area, also explained poor crop response to fertilizer. Weedicides, too, were used sparingly, that is why their elasticity was not only low but also non-significant. The variables which reduced inefficiencies included drilling, timely sowing, age, experience and education of the farmers. Liming of water courses and location at the head also reduced inefficiency. Same was true of farm size.

Economics of Growing Onion

Keeping in view the economic and nutritional importance of onion, this study was conducted in Okara and Kasur being importance in terms of area and production of onion. A total of 100 respondents, 50 from each district were purposively selected and interviewed for detailed information regarding cost of production, output and constraints in onion cultivation. Significantly higher gross income per acre in Kasur (Rs. 6480.66) was attributed to high price of onion per kg. Other important factors that contributed towards high yield were cost of farmyard manure, cost of nursery and labour used for weeding. Comparatively low gross income (Rs. 4045.46) per acre was estimated for the respondents of Okara district. Low price of onion and disease and pest attacks decreased considerable gross returns in Okara. Total cost per acre and per kg was Rs. 4043.63 and 2.56 respectively in Kasur and the respective costs in Okara were Rs. 4374.62 and 3.30. Net returns per acre and per kg were negative in Okara and these returns were positive in Kasur. Productivity differential was made on the basis of yield per acre to quantify various inputs affecting yield level in each district. High yielders of Okara obtained statistically higher gross returns per acre as compared to low yielders. High yielders made more use of nitrogen and phosphorus and labour used for weeding/hoeing. Total cost per acre was Rs. 4923.27 and 3773.33 on high yielders and low yielders respectively in Okara. Cost per kg on the respective yield levels was Rs. 2.72 and 4.46. While the respective net returns per acre were Rs. 717.69 and -1255.95. In Kasur, significantly higher cost of nitrogen, phosphorus, potassium, irrigation and plant protection measures were attributed to high yield on high yielders. Cost per kg was much more less on high yielders as compared to low yielders. Net returns per acre and per kg were Rs. 5047.51 and 2.11 on high yielders and Rs. -396.10 and -0.51 on low yielders respectively. Results of Cobb Douglas type production function indicated that costs incurred on thorough land preparation and nitrogen were significantly affecting onion gross income. Low price of the produce, non-availability of good quality seed, transportation problem and inadequate funds were crucial constraints in onion cultivation.

Economics of Growing Watermelon

Keeping in view the importance of watermelon in terms of income, a study was conducted to determine the economics of growing this vegetable. Two districts, namely Rahim Yar Khan (R. Y. Khan) and Bahawalpur were selected on the basis of higher concentration of this crop. Crop budgets on the basis of district level indicated that yield per acre was statistically non-significant between the selected districts; however, gross income per acre was statistically higher in R. Y. Khan (Rs. 12614.80) as compared to Bahawalpur (Rs.9454.94) mainly due to price difference. Land preparation, plant protection measures, and labour for weeding were statistically different between two districts. Total cost per acre estimated as Rs. 11797.04 and 8873.33 in R. Y. Khan and Bahawalpur respectively and the respective cost per kg was Rs. 2.85 and 2.27. Net returns per kg were Rs. 0.20 and 0.15 in R. Y. Khan and Bahawalpur respectively. Results of Cobb Douglas type production function indicated that fertilizer, plant protection measures, labour for weeding, age of the respondents and consulting with input dealers were significantly affecting watermelon yield. Low price of output, water shortage, transporting the production to the market, inadequate funds to purchase inputs, and adulterated inputs were the most important constraints in watermelon cultivation. Better land preparation, proper plant protection measures, weed control and appropriate application of fertilizer could increase watermelon yield per acre to a great extent. On the

other hand, Government should take appropriate steps to control prevailing malpractices in input and output markets.

Technical and Allocative inefficiency in Carrot Production, Pakistan's Punjab

The study estimates technical and Allocative inefficiency in carrot production by employing stochastic production frontier approach and duality theory. The carrot production is concentrated in two districts, Sheikhupura and Kasur in Pakistan's Punjab and this study based on data collected from these two districts. Farmers are, respectively 49, 17 and 55 percent technically, allocatively and economically inefficient. The results indicate that there exist a large potential that can be explored to increase the income of vegetable farmers. The improvement in technical efficiency to 100 percent will generate an additional amount of Rs. 349.73 ($ 5.83) million per year. Education and distance from market is found to be highly significant to improve technical efficiency, indicating that investment on education and to improve physical infrastructure (especially development of rural markets) are the most critical areas to eliminate technical inefficiency in carrot production. This implies that provision of basic education at rural level and improvement in physical infrastructure can significantly contribute to push agricultural growth rate and to alleviate poverty.

An Econometric Approach to Quantify Sources of Risk: An application to three Cropping Patterns in Claveria, Philipines

The study develops formulation to decompose variability in profit into price and production effects. The production effect is further segregated into management and weather effects. The formulation is used to compare and decompose risk in the profit of three existing cropping patterns (corn - corn, corn - fallow, and rice - fallow) in the rainfed areas of Claveria, northern Mindanao, Philippines. High variability and low profitability of the crops in a more risky season (dry in our case) can limit cropping intensities in rainfed areas. However, intensification of the crops during the less risky season (wet in our case) can provide the necessary stake to invest in the risky season crops. Although weather is the dominant factor in explaining total variability, this should not be interpreted as a general rule for all agricultural environments. In an environment where input intensity is high, and input-output markets are inefficient, management and price effects can dominate the weather effect.

Diversification with vegetables to improve competitiveness in Asia

Albeit well recognized advantages of diversification in terms of improved income, enhanced sustainability and reduced risk, it is never considered as a development tool. It is usually treated as a function of income and commercialization. In this approach, emphasis is placed on income generating strategies, which in turn can bring diversification. This paper reverses the notion on diversification, and provides empirical evidence to show that it as a tool of economic and social development. The emphasis of the study is on the diversification with vegetables, as they have a special advantage in term of high nutritive efficiency for supplying many individual micronutrients as well as overall nutrients of the diet. On the other hand, diversity in production also improves productivity through reduced production and marketing risks, enhanced sustainability, and improved resource use efficiency of the cropping system. Looking at the diversity level of other developed countries, such as Taiwan and Korea, 100 percent increase in production diversity may not be an ambitious plan for Pakistan agriculture. This will enhance productivity by 56 percent, more than the effect of the Green Revolution during 1965-94 (Ali and Byerlee, 2002). Actually, crop diversity has a potential of generating a Second Generation Green Revolution. More particularly, increase in the share of vegetables in the cropping system will enhance its productivity. It is estimated that a 10-percent increase in the share of vegetable area in total crop area will increase the productivity of the cropping system by 0.83 percent. This is in addition to the effect of such changes directly on the income of the farmers. Surprisingly, food diversity is less affected by incomes as speculated by earlier studies, but more by improved human and physical infrastructures. Therefore, food

diversity is not a phenomenon that people will not automatically initiate to achieve the productivity gains. It needs investment on physical and human infrastructure, such as better access to markets, improved food-preserving capacity of the households, and strong basic educational institutions at the village level. Decreasing vegetable prices through technological innovation is another way to encourage diversity with vegetables. Despite these advantages of diversification with vegetables, however, policy-makers in Asia were preoccupied with the development and stabilization of the cereal-based systems. Most institutional setups and policy incentives were directed to increase and stabilize cereal production. This helped to partly overcome energy deficiency in food, while availability of vegetable remained far below the minimum required level in most developing countries of Asia. In addition, vegetable production remained highly seasonal, and annual production unstable. This caused serious imbalance in the diet reflected in micronutrient deficiency, and cereal dominated production system became vulnerable to insect, diseases, and soil mining. Policies to encourage diversification need to go a step farther than the simple economic development policies. While economic development policies focus on physical and human infrastructure improvement alone, diversification policies need to combine these improvements with appropriate incentives for micronutrient-rich foods and crops, such as vegetables, fruits, and minor crops, and remove the policy biases against these crops.

Development without environmental pollution

The objective of the article was to highlight the major sources of pollution, economic damages due to different pollutants, and to suggest their possible remedies by keeping the view of maintaining the growth of development. It is observed that automobiles, industrial sector and solid wastes are the major sources of environmental pollution. According to an estimate, the country is loosing 25 percent of its potential crop production. According to a study conducted by Brandon of World Bank in 1992-1993 and later updated by Mathew in 1997, the environmental cost to Pakistan economy was estimated as $1.8 billion. Pakistan currently spends about $17 million per year on pollution-related cleanup but it requires $84 million to resolve the country's environmental problems in order to save $1.8 billion per year, which we are losing due to environmental damages. At the end study suggests a mixed of research and administrative based solution to tackle the environmental pollution related issues without letting affect the development phase in the country.

FACULTY OF SCIENCES

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1. STUDIES ON SALINITY TOLERANCE

The effect of sodium chloride induced salinity on the germination, growth, yield and chemical composition of Helianthus annuus var. Shams was assessed. The plants were grown on EC6 - EC18 salinity levels and harvested at regular intervals with control. The results of different plant growth parameters showed highly significant difference indicating that at lower salinity level (EC6) there was stimulation of growth while there was a supressing effect at higher salinity levels as compared to control. Total yield increased by 15.6% at lower salinity level and decreased by 38.93% and 68.5% at EC12 and EC18 respectively. Sodium and chloride contents were increased in the treated plants relevant to control. The contents of potassium and calcium plus magnesium increased at low salinity level and decreased at higher levels.

Zea mays var. Punjab-32 was subjected to osmotic stress at seedling stage ranging from ECo to ECi5 (combination of NaCl + $CaCl_2$) in controlled environment growth chamber. There was a decrease in germination, fresh and dry weight of seedlings, plant height and root growth, leaf area and total chlorophyll with rise in salinity. Chl. a was more sensitive to stress as compared to Chl. b. There was a slight increase in carbohydrates at ECu in stem and shoot as a whole. Behaviour of roots was exactly opposite to that of shoots. Total proteins also decreased with rise in stress but this decrease was relatively lower in stem as compared to leaves and roots.

2. NITROGEN FIXATION

Five local grasses *Zea mays. Sorghum bicolor, Oryza saliva, Cynodon dactylon* and *Dactyloctenium aegyptium* were selected for Una study. All the plants except rice showed higher nitrogenase in preihcubated roots as compared to fresh roots. Five different types of diazotrophs wore isolated from the rhizosphere and they were chracterized by applying standard morphological, physiological and biochemical tests.

Modulation in cowpea started 41 days after germination both in control and in plants treated with cycocel at 600, 1000 and 1400 ppm concentrations. Maximum number and size of nodules was observed in plants treated with 1400 ppm. concentration of cycocel and the number of nodules decreased with decrease in concentration of cycocel. Minimum number was observed in the control. Nitrogen contents also showed the same results.

3. PHOTOSYNTHESIS

Thirty six grasses were examined to look for the Kranz anatomy distribution of starch, interveinal distance, number and size of stomata, and carbon dioxide compensation points. €4 species showed typical Kranz anatomy while C_3 plants wore non-Kranz type. IKI tests showed starch in bundle sheath of 64 plants with the exception of *Cypcrus rotundus* where it was present both in the bundle sheath as well as mesophyll. Interveinal distance and number of interveinal cells was smaller in C_4 plants as compared to C_3 plants. Carbon dioxide compensation points were low in C_4 plants and high in C_3 plants.

4. WATER BALANCE STUDIES

Three varieties of maize i.e. Akbar, Sadaf and Sultan were compared for water balance studies. Water stress was imposed by withholding water for different durations. On the completion of stress period water balance studies were made in leaves after technique of relative turgidity (Weatherlay, 1950). Variety Sadaf was noted to be comparatively more resistant than the other two varieties.

Two varieties of wheat viz. Pak-81 and Punjab-81 were investigated for cycocel response under water stress conditions. Water stress was applied at different stages of growth. On the completion of each stress period water balance studies were conducted. Pak-81 was found to be slightly better than the other variety. Cycocel application induced stress resistance in both the varieties.

5. TISSUE CULTURE STUDIES

A study was conducted to invonligate the bent combination of temperature and light to induce vigorous development of shoot and callus initiation *in vitro* from mcrislem of *Cicer arietinum.* Medium for shoot growth and callus formation was already established at N1AB. For shoot growth different combinations of light and temperature ranged from 100 to 110 lux and from 15 °C to 35 °C respectively. For callus growth the temperature ranged from 20 °C to 29 °C and the range of light varied from darkness to 900 lux. Maximum shoot length (3.25 cm) was obtained at 27 °C at 1625 lux. Maximum callus growth was obtained at 29°C with 900 lux.

Protoplasts were isolated from leaves of chickpea (*Cicer arioiinum* L.). The leaves were pre-plasmolysed with different concentrations of sucrose in water solution. Sucrose at concentration of 1M was found to be the best. *In vitro* grown plants at the ago of 2-3 weeks were found to be the best source material. The leaves from these plants gave the maximum yield of protoplasts with low concentration of enzymes. It was noted that leaves where lower epidermis was peeled, produced the best yield of protoplasts.

The aim of the work described was to obtain optimum number of clones, when single cell in suspension or small aggregate of cells in suspension were plated on Gamborg's B-5 medium. B-5 medium was used as a basic medium modified with various hormones, vitamins and amino acids without conditioning. An increase in concentration of 3 uM NAA and addition in modified agar medium of .75 uM Kinetin and 7 uM glutamine with small amount of conditioned medium were found to be most suitable for the development of brittle calli and for the growth of plated cells respectively. Two hours of agitation was observed satisfactory for the isolation of cells in suspension. A plating efficiency close to 8% was obtained in dark incubated plates.

6. TAXONOMIC STUDIES

The morphological and anatomical characters are mostly used in the classification and description of plants. Characters of external morphology provide the prime basis for identification of plant categories at all ranks. Various morphological and anatomical characters wore studied from 200 plants for taxonomic description of *Drunken curinata* L. cv. UCS 8201 and *Brassicarinata,* L. cv. Poorhi Raya and Raya L-18.

Brassica juncoa L. and *B. carinata* L. are important oil seed crops of Pakistan, therefore, investigations were also undertaken to increase its yield per unit area and to overcome the problem of lodging. This objective was achieved to a great extent by the application of chlormequat which increased the yield by about 31% and prevented lodging significantly. The number of lodged plants in control was 38.8X whereas it was 10% in the plants treated with chlormequat at the cincentration of 1000 ppm.

7. GROWTH ANALYSIS

Growth analysis studies were conducted to evolve the high yielding strains suitable under the cultural and ecological conditions of this region. Growth analysis in terms of dry weights, is a useful tool for elucidating

the response of crops to cultural and fertilizer treatments.

Total dry matter production and growth analysis of wheat, and Mung bean varieties were carried out. The results of the investigation on wheat varieties (Pak-81, Sandal, Pb.-81, LU-26S, Chenab-79 and RS-17) have revealed that on the basis of leaf area arid dry matter production, it can be safely concluded that Punjab-81 was the highest yielding variety followed by LU-26S and RS-17 because the former has better efficiency to utilize its leaf area for the production of dry matter.

In another study on six wheat varieties (LU-26, Yakora, WL-711, RS-17, Chenab-79 and Indus-79), the results revealed that high yielding Chenab-79 responsive to high fertilization tended to show high specific leaf weight and leaf blade nitrogen contents in most of its growth stages. The specific leaf weight and leaf nitrogen contents were positively correlated with each other as well as with calculated net assimilation rate. Total dry matter production and leaf area tended to be the highest in WL-711.

The growth analysis and dry matter production of six maize varieties (Akbar, Neelam, Sadaf, Sultan, SD & SD_4), revealed that newly released cultivar SD_4 competed to some extent with variety Sadaf in dry matter production, leaf area, growth parameters and leaf nitrogen contents than SD_4 in the final harvest by recording highest dry matter production, leaf area and other growth parameters.

Six cultivars of Mung bean (*Vigna radiata)* (6601,588, 589, 562-1, MG-1 &233) were compared for variation in dry weight, leaf area, derived growth parameters and leaf nitrogen contents to evolve efficient cultivar, best suited under the ecological conditions of this region. The two newly released cultivars MG-1 and 233 competed to some extent with cv. 6601 in dry weight, leaf area, derived growth parameters and leaf nitrogen contents but cv. 6601 performed better by recording highest dry weight, highest values of NAR, SLW and leaf nitrogen contents in the later stages of growth, an indication of the suitability of the cultivar under the ecological conditions of this region.

8. STUDY ON WEEDS

The research work on weeds with a view to determining the weed spectra and degree of weed infestation of wheat, cotton, and rice crops by different weeds, and weed-crop competition studies were undertaken under a PL-480 research project "Biology of Farm Weeds". The effect of variable temperature and light treatments on germination of some weed seeds was also studied. The data of these studies and subsequent surveys carried out in the various districts of the Punjab Province indicated that the following weed species infested, wheat, rice and cotton crops during the period 1971-86:

8.1. Wheat weeds

Botanical Name	Common name	Family
Anagallis arvensis L.	Billi booti	Primulaceae
Asphodelus tenuifolius Cav.	Piazi	Liliaceae
Astragalus punjabicus Sirj.	Rut phuli	Leguminosae
Avena fatua L.	Jungle javi	Gramineae
Carthamus oxyacantha Bieb.	Pohli	Compositae
Centaurea iberica Stev.	Pohla	-do-
Chenopodium album L.	Bathu	Chenopodiaceae
Chenopodium murale L.	Karund	-do-
Cirsium arvensis Scop.	Laih	Compositae
Convolvulus arvensis L.	Lehli	Convolvulaceae
Coronopus didymus L.	Junglihaloon	Cruciferae
Cynodon dactylon Pers.	Khabbal	Gramineae

Cyperus rotundus L.	Deela	Cyperaceae
Eragrostis spp.	Eragrostis	Gramineae
Euphorbia helioscopia L.	Chhatri dodak	Euphorbiaceae
Euphorbia prostrate Ait.	Hazar dani	-do-
Fumaria indica (Haussk) Pugsley	Pit papra	Fumariaceae
Iberis amara L.	Chandanibooti	Cruciferae
Koeleria phleoides (Vill) Pers.	Winter grass	Gramineae
Lathyrus aphaca L.	Dokanni	Leguminosae
Lolium temulentum L.	Rye grass	Gramineae
Malva neglecta Wallr.	Saunchal	Malvaceae
Medicago denticulate Wild.	Maina	Leguminosae
Melilotus indica L.	Sainji	-do-
Poa annua L.	Poa	Gramineae
Phalaris minor Retz.	Dumbi grass	-do-
Rumex dentatus L.	Jungli palak	Polygonaceae
Saponaria vaccaria L.	Takla	Caryophyllaceae
Sonchus oleraceous L.	Sonchus	Compositae
Sorghum halepense Pers.	Baru	Gramineae
Spergula arvensis L.	Spergula	Caryophyllaceae
Trigonella incise Benth	Methi	Leguminosae
Vicia sativa L.	Rewari	-do-
Other weeds (unidentified)		
8.2 Rice weeds		
Cyperus difformis L.	Ghooin	Cyperaceae
Cyperus iria L.	Booin	-do-
Cyperus rotundus L.	Deela	-do-
Cynodon dactylon Pers.	Khabbal	Gramineae
Dactyloctenium aegyptium (L) Beauv.	Madhana grass	-do-
Echinochloa colonum (L) Link.	Swank	-do-
Echinochloa crusgalli Beauv.	Dhidin	-do-
Fimbristylis littoralis L.	Chhoti booin	Cyperaceae
Marsilea minuta L.	Chaupatti	Marsiliaceae
Paspalum distichum L.	Naru	Gramineae
Sagittaria guayensis H.B & K.	Chiri-napay	Alismaceae
Sphenoclea zeylanica Gaertn	Mirch booti	Companulaceae
Others weeds (unidentified)		
8.3 Cotton weeds		
Amarantus viridis L.	Chaulai	Amarantaceae
Convolvulus arvensis L.	Lehli	Convolvulaceae
Cynodon dactylon Pers.	Khabbal	Gramineae
Cyperus rotundus L.	Deela	Cyperaceae
Corchorus tridens L.	Wild jute	Tiliaceae
Desmostachya bipinnata L.	Dhabb	Gramineae
Euphorbia prostrate Ait.	Hazar dani	Euphorbiaceae
Heliotropium europium L.	Oont chara	Boraginaceae
Portulaca oleracea L.	Kulfa	Portulaceae
Prtulaca quadrifida L.	Kulfa	-do-
Panicum colonum L.	Panicum grass	Gramineae
Solanum xanthocarpum Schrad & Wend.	Mamoli	Solanaceae
Sorghum halepense L.	Baru	Gramineae

Trianthema monogyna L.	Itsit	Ficoideae
Tribulus terrestris L.	Bhakra	Zygophyllaceae

The weed-crop competition studies carried out in wheat and cotton revealed that the critical period of competition lasts from 6 to 10 weeks in cotton and 4 to 6 weeks in wheat after sowing. In rice the critical weed-crop competition was observed to bo 6 to 8 weeks after transplanting.

The herbicidal weed control studies were also undertaken in wheat, rice, and maize crops under another PL-480 research project "National Research Programme on Weeds of Cereals". The data, so far collected, showed that the populations of grass weeds and broad-leaf weeds could be effectively controlled by the use of Arelon, Buctril-M, Dicuran M.A., DMA-6, Dosanex, Tribunil and Tolkan in different wheat cultivars.

The application of Machete 60 EC, Saturn 10 G, Saturn 50 EC and Ronstar 12 L within 0-4 days after transplanting increased the paddy yield significantly in Basmati-370 and KS-282 rice cultivars.

Some herbicides were also tried in maize fields. Primextra-500 FW was found to be an effective herbicide to control weed populations in maize and increase grain yield significantly.

Triticum aestivum was subjected to compete with different densities of *Chenopodium album* and *Asphodelus tcnuifolius* under different water conditions. Increase in weed population and decrease in irrigation rates significantly reduced various growth parameters of wheat. However, *Chonopodium album* had more pronounced effect than *Asphodclus tonuifolius.*

Phalaris minor Retz. was allowed to compete with wheat variety Pb.81 for different time periods. Weed competition significantly reduced the crop yield when allowed to grow for more than ten weeks after crop emergence.

A survey of weeds in cotton fields of different districts of Multan Division was carried out. *Cyperus rotundus* occurred most frequently and formed dense stands than all the other weeds. Comparative nutrient uptake by cotton and weeds showed that weeds removed more nutrients than cotton during early stages of crop growth.

9. EFFECT OF GAMMA IRRADIATION ON PLANTS

Exposure of *Drassica* spp. and *Carthamus tinctorius* to gamma irradiation stimulated the growth and development of plants and induced early flowering. Doses upto 20 KR affected the yield positively. The percentage of oil contents was not altered in *Brassica* spp. while it increased in *Carthamus tinctorius.* In *Hordeum vulgare* grain yield showed an increase upto 5 kR while the higher doses produced injurious effects. Lower doses of gamma irradiation were found to have increased the protein percentage in *Hordeum vulgare* and *Vigna radiata,*

10.GERMPLASM RESOURCES

A realization of the importance of the plant genetic resources became clear in the sixties and it was immediately perceived that in many parts of the world irreparable losses were occurring due to the multifarious activities of the man in their endemic areas.

Realizing the gravity of the situation, the Department of Botany initiated programmes in collaboration with the FAO/IBPGR, Britain and Motherland for planning, collection, preservation and evaluation of the genetic materials of major agricultural crops, namely, wheat, barley, maize food-legumes, etc. endemic to the primitive areas of Pakistan. Arrangements were made to scan Northern Areas of Pakistan (Skardu,

Gilgit, Chitral, Swat) and Western & North Western parts of Baluchistan (Quetta, Noshki, Dalbandin, Quila Satfullah, Loralai, Sibbi). Three germplasm collecting expeditions were carried out in 1974, 1976, and 1981. Pakistan Agricultural Research Council also collaborated in the first two expeditions. The materials thus collected were deposited in the stores of PARC and some foreign countries.

The research activities centred around the evaluation of agronomic, physiological, biochemical and academic interest with regard to germplasm. Over a dozen research projets pertinent to the genetic potential of primitive land races such as adaptations to high and low altitudes, xeromorphic features, morpho-anatomical features, vernalization requirements, total protein contents, drought resistance/tolerance disease reaction, grain characteristics etc. have been completed. Currently, further research is being undertaken on epidermal, mechanical and storage tissue, evapotranspiration, fetilizer responsiveness, drought resistance/tolerance and protein content. The students of several disciplines including those of the Botany have been trained in this vital aspect of agricultural research. The genetic materials collected/evaluated have been distributed to the agricultural scientists of the country and abroad for their utilization in the national research programme. This timely collected genepool will prove an asset for the future agricultural research programmes as well as future generations of the human race.

11. EFFECT OF GROWTH REGULATORS ON SOME CROP PLANTS

Studies on the effect of cycocel (Chlormequat) on growth, morphology, anatomy and yield of various wheat varieties were undertaken. Concentrations ranging from 600 to 1400 ppm were applied as seed soaking. The concentration of 1000 to 1200 proved to be optimum for most of varieties used. There was a significant increase in such growth parameters as the number of tillers per plant, number of leaves and leaf area and a significant decrease in the length of internodes and total length of the plants. The anatomical studies in wheat var. Pak-81 on treatment with cycocel showed that the stem of treated plants had increased the number of vascular bundles, area of vascular bundle and increased diameter of protoxylem and metaxylem and greater thickness of hypodermis. In leaves of treated plants there was an increase in the area of mid-rib and the vascular bundle. The treated roots showed an increase in the area of the cross section and increased vascular region.

In the study of yield and related characters the different varieties of wheat on treatment with cycocel showed a general tendency to increase the number of tillers, number of flowers, number of ears per plant, number of grains per ear and grain weight, and increase in yield in various varieties of wheat ranged from 25X to 80%.

In gram var. C-727 different concentrations of cycocel when applied as seed soaking produced significant and promising results on growth and yield. At the concentration of 1000 ppm the number of primary, secondary and tertiary branches, the number of flowers, number of pods, pod size and number and weight of seeds. increased significantly and the yield doubled as compared to non-treated plants. This was accomplished through increase in the number of branches per plant.

In jute species *Corchorus olitorius,* aplication of this growth regulator significantly increased the base diameter and fibre yield. Fibre and yarn strength was also significantly increased.

In sunflower variety 'Noor* results of four harvests indicated that the mean, relative growth rate and mean relative rate of leaf area increased with the aplication of 1000 ppm treatment with cycocel. There was significant reduction in height. The disc diameter, number of seeds/plant, seed weight and average yield per plant was significantly increased.

The effect of cycocel was also studied on Maize var. Neelum-82 and Akbar-82. In both the varieties there was significant increase in the number of leaves, number and length of ears and number and dry weight of grains per plant. In var. Akbar the optimum dose was 1000 ppm while 1200 ppm proved to be optimum

dose for var. Neelum-82.

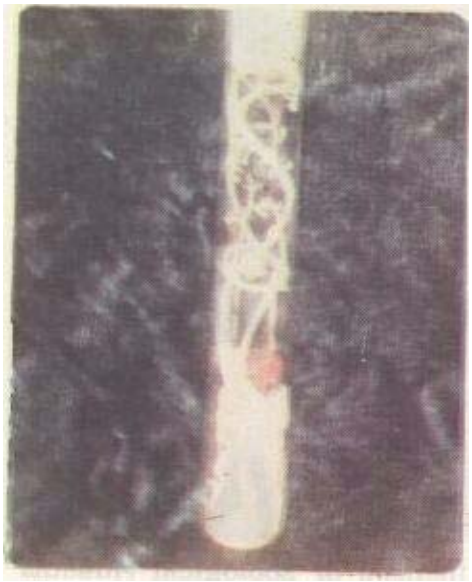
In *Vigna radiata* (Mung) plants, treated with 1000 and 600 ppm concentrations there was a significant increase in the number of branches, number of pods per plant and dry weight of seeds.

Cycocel at the concentrations of 400, 800 and 1200 ppm was used to soak the Okra seeds. 800 ppm produced significantly higher number of fruits and consequently increased the yield. In another experiment the influence of cycocel on wheat revealed that 600, 1000 and 1400 ppm concentrations increased the grain yield significantly.

Cycocel treatments in cotton variety B-557 significantly decreased plant height, number of branches and length of internodes when applied either as seed soaking and as foliar spray. However, it increased slightly the number of bolls, leaf area and chlorophyll contents when applied as seed soaking alone but decreased them when applied as seed soaking and foliar spray.

Application of Ergostim and Planofix to wheat exhibited significant increase in tillering capacity. Doth the chemicals proved bolter for yield parameters whore a fairly good percentage way obtained for ear length, number of spikelets and grain weight with their combined treatments.

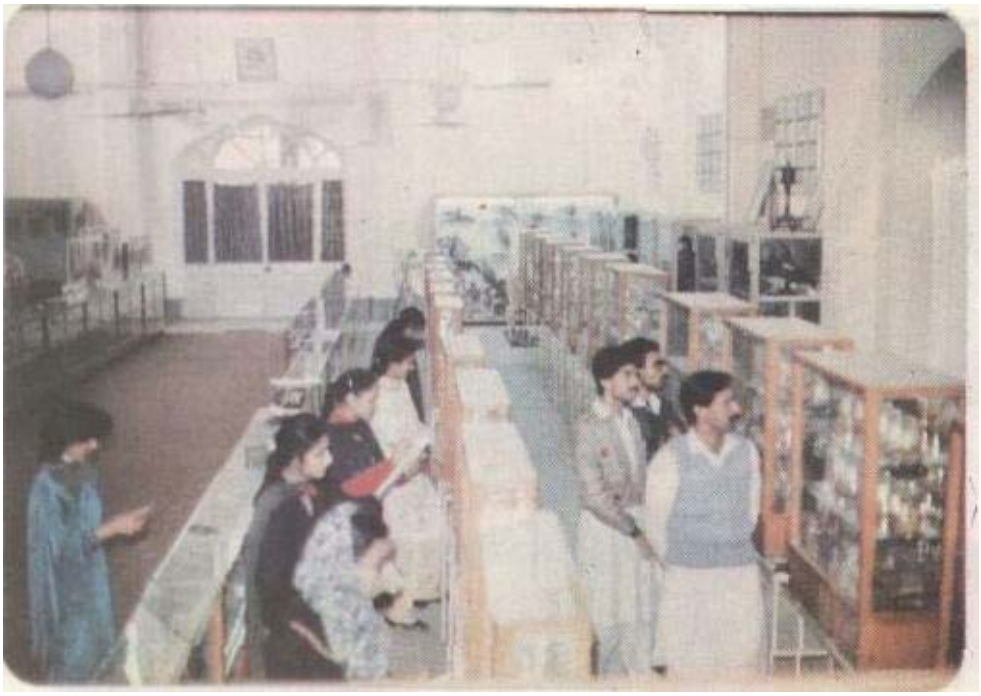
The studies on the effect of Mixtalol, a Lever Brothers' commercial growth regulator, in combination with fertilizer were carried out on chillies, cotton, potatoes, rice, sugarcane and wheat crop. The results achieved revealed that 2 ppm Mixtalol applications in combination with the half recommended fertilizer dose significantly increased the yield of the produce in all the above mentioned crops.



Chickpea seedling-a source of explant

Chloromequat Studies on legumes

Glimpses of Zoological Museum



Glimpses of Zoological Measure

The influence of Alar (Succinic acid 2-2 dimethyl hydrazide) on the growth and yield of *Abelmoschus esculentus,* wheat cv. SA-75 and *Cicer arietinum* was investigated. Various Alar concentrations ranging from 2000 to 3500 ppm were used at fortnightly intervals.

Application of Alar was relatively ineffective in altering the growth pattern of Okra plants, whereas on cv. SA-75 plants. Alar reduced plant height and leaf area and showed no effect on leaf number, dry wieght of root, shoot and grains. However at 2000 ppm concentration length of spike, number of grains and number of spikelets per spike was increased.

Alar treatment on *Cicer arietinum* showed significant increase in number of flowers, pods and seeds with the progressive increase in concentrations. Maximum increase in yield was obtained at 3000 ppm concentration.

Different growth regulators were applied separately and in various combinations to different crop plants. Six different concentrations of GA were tried as a foliar spray on maize varieties Akbar and Agatti-72 at 3 different stages of growth. Maximum increase in plant height, number of grains, 100 grain weight and yield per plant was observed with 150 ppm while minimum increase was recorded in 25 ppm GA treatments. However, both the varieties exhibited significant differences for various characteristics in all the treatments. In *Vigna radiata* 50 ppm GA proved to be more effective in increasing plant height, and internodal length at different growth stages while 10 ppm NAA (Naphthelene Acetic Acid) increased the number of branches and leaf area. In another study 10 ppni NAA sprayed twice after germination of *Vigna radiata* varieties viz. M-6601 and 588 showed the best results for protein percentage in seeds.

In *Triticiim aoiftivum* 10 ppm concentration of GA and NAA provod to be better for yield components. Variety LIJ-31 proved better as compared to Pari-73 in response to growth regulators.

Application of IAA significantly increased the height of plant, number of leaves, number of tillers, flag leaf area, number of spikelets, ear length, total dry weight, 1000 grain weight and grain yield in wheat, Foliar

application was more effective than seed soaking. Application of 20 ppm at 45 days produced biggest increase for all the growth parameters.

The response of two varieties of cotton i.e. B-557 and LII-62 to NAA and IAA foliar applications, alone as well as in combination sprayed once and twice 30 and 55 days after sowing was compared. A significant increase by hormone application in various growth parameters like height of plant, number of branches, number of seeds per boll, 100 seed-weight and seed cotton yield was observed in both the varieties. NAA proved more effective than IAA and their combination and double spray yielded better results than a single spray. The two varieties differed significantly from each other for days taken to flowering and boll formation. B-557 exhibited less shedding than LII-62 after hormone application.

12. STRESS PHYSIOLOGY

Salt Tolerance

1. Study of morpho-anatomical and ionic changes associated with waterlogging, normal irrigation and drought on *Zea mays* L. was conducted, Waterlogging and drought reduced, fresh and dry weights of leaf, stem and leaf area. Drought showed drastic effects in fresh/dry weights of stem. Drought increased Na, K and C1 concentrations of shoot. Water-logging and drought reduced the cross-sectional area of root, vascular bundles, cortical cells, metaxylem vessels, endodermal and perieycle cells. Thickness of cortex, endodermis, pericyele, and epiblema were also reduced with the introduction of water-logging or drought. Water-logging showed-the, induction of aerenchyma in root while drought and normal irrigation did not show any sign of it.

   Adaptability potential of cholistan *Sprobolus iocladus* (Nees ex. Trin) against different salinity levels was studied. Plant height showed an increase With increase in concentration of NaCl , but a clear cut reduction was seen in leaf area from 10 ppm to 20 ppm for all the four ecotypes and leaf area ratio also showed reduction like wise. Angle and position of flag leaf showed a continuous increase as the salt concentration increased. Maximum degree of angle was exhibited by ecotype E_2 under salt stress. Thickness of stem, length of sheath, fresh weight of roots, dry weight of plant, dry weight of roots, crown spread of the plant, length of ear, total number of spikelets and number of spikelets of first crown of highest tiller showed a gradual increase with the increased in salt concentration. All the four ecotypes showed a similar trend of change. Length of the root and number of fertile tillers per plant increased as the NaCI concentration increased. Ecotype showed the highest number of fertile tillers but longest roots were recorded in E_3 and E_4. Fresh weight of the plant and total water contents of the plant recorded a gradual increase with the increase in salt concentration up to 15 ppm of NaCl and then declined in 20 ppm. Only one character, that is number of sterile tillers per plant, showed highest value in 10 ppm and gradual decrease in upper salt levels but the lowest value was observed in control. Most of the morphological characters showed a direct relationship with increasing salinity levels, while number of sterile tillers behaved independently. On the basis of morphological characters 15 ppm was the optimum level of NaCI salinity for *Sporobolus iocalclus*. E_2 exhibited more tolerance as observed in some characters and equally followed by E3 and E_4. Salinity also had certain noticeable effects on anatomy. It increased epidermis thickness and cell area of E, at 10 ppm. Induction of aerenchyma was another prominent feature.

2. Eight mung bean accessions and seven accessions of wheat (*Triticum aestivum* L.) collected from different parts of country as well as two (*Zea mays* L.) cultivars were induced different salinity levels. All the growth parameters showed a decreasing trend with the increasing levels of salinity. Seven accessions of wheat (*Triticum aestivum* L.) performed almost equally at lower levels of salinity. However, at high Ec levels only accession 243/1 performed better and could attain fairly good member of productive and non-productive tillers. Similarly a decreasing in all vegetative characters and yield components was recorded for maize cultivar when induced higher salinity levels.

3. Stage-wise studies on the affect of increased levels of NaCl and Na_2SO_4 salinity were conducted on the growth and yield of chickpea and barley. Both the species behaved differently to the applied salinities but greater biomes was noted in barley up to 16 dS m^{-1} of both the salinities. Both the species were more sensitive to chloride of sodium than its sulphate.

4. In a separate study, ionic relations of *Panicum antidotale* were determined under NaCl salinity. Na^+ accumulated in the leaves but to a lesser degree in younger leaves, whereas K^+ elicited a reverse behavior. As a strategy of salinity tolerance, *P. antidotale* was able to retranslocate beneficial ions including K^+, Mg^{2+} and PO_4^{3-} from older senescing to young growing tissues.

5. Salt tolerance was assessed in sunflower, maize, guar, and hexaploid wheat at different growth stages. Growth analysis using different models was carried out to determine the effect of salinity on maize and sunflower. In these two crops none of the growth parameters like NAR, PGR and LAR exhibited any relationship with the crop yield. In guar there was considerable magnitude of variation can be of considerable importance to economically utilize in salt affected soils.

6. Comparison of a wheat accession 234/2 collected from salt range with a commercial cultivar lshahkara-95 in relation to salinity tolerance showed that the primitive variety was highly tolerant compared with the cultivated one in all the growth attributes.

7. *Gossypium hirsutum* and *Gassypium arboreum* were exposed to increased levels of Cl^- and $(SO_2)_4^{-2}$ arraigns, with Na^+ as cation. The determination made for growth, ion accumulation and photosynthetic parameters rewarded that Cl^- was more inhibitory to majority of the above parameters than $(SO_2)_4^{-2}$. *G. hirsutum* was more tolerant of both the anions than *G. arboreum*. Both the species exhibited a differential accumulation of Na^+, Cl^- and $(S0_2)_4^{-2}$. *G. hirsutum* indicated a greater accumulation of ions in stem followed by leaves and root. Whereas, *G. arboreum* accumulated most of the ions in the leaves, followed by root and stem. The results revealed that better Cl^- and $(SO_2)_4^{-2}$ tolerance ability of *G. hirsutum* was due to exclusion of excess ions to the stem, thus protecting leaves from their adverse effects.

8. The effect of increased salinity, drought and hypoxia on the growth, ion accumulation and changes in chlorophyll, carotenoids and anthocyanins in *Gosspium hirsutum* and *G. arbaretim* was determined. Both the species displayed differentiation tolerance under stress. *G. hirsutum* had greater content of carotenoid and anthocyanins in the leaves, which were closely related to stress tolerance of this species. Such relationships were, however, not evident in case of *G. arboreum*. Both the species indicated an accumulation of Na^+ and Cl^- in the shoot and root under salinity, but the extent of accumulation was very low under drought or hypoxia. However, *G. arboreum* indicated greater accumulation of both Na^+ and Cl^- in the shoot than root. Recovery from stresses showed a diminishment of the accumulated Na^+ and Cr, and chlorophyll, carotenins and anthocyanins also appeared to approach the values in control plants, due to resumed growth of both the species. Results revealed that better growth of *G. hirsutum* was due to low accumulation of Na^+} and Cl^- in the shoot together with accumulation of cartenoids and anthocyanins which help it to tolerate increased level of salinity, drought and hypoxia.

9. An experiment was conducted to assess whether gibberellic acid (GA_3 could alleviate the adverse effects of salt stress on the growth, ion accumulation and photosynthetic capacity of two spring wheat cultivars, Barani-83 (salt sensitive) and SARC-I (salt tolerant). Three week-old plants of both the cultivars were exposed to 0, 100 and 200 mol m^{-3} NaCl in Hoagland's nutrient solution. After three weeks of initiation of salt treatments, half of the plants of each cultivar were sprayed fully with 100 mg L^{-1} GA_3 solution. Plants were harvested 3 weeks after the application of GA_3. Fresh and dry weights of shoots and roots, plant height and leaf area were decreased with increasing supply of salt, but gibberellic acid treatment caused a significant ameliorative effect on both the cultivars with respect to these growth attributes. However, GA_3 caused no significant change in grain yield but increased grain size in both the cultivars. Saline growth medium caused a marked increase in the concentrations of Na^+ and Cl^- in shoots and roots of both the lines. However, with the application of GA_3, accumulation

of Na^+ and Cl^- was enhanced in both shoots and roots of both wheat lines, but more ions accumulated in salt sensitive Barani-83 than in salt tolerant SARC-I. Net CO_2 assimilation rate (*A*) of both wheat lines decreased consistently with increasing supply of NaCl, but application of GA_3 was found to be effective in alleviating the effect of salt stress on this variable in both the cultivars. However, the ameliorative effect of the hormone was more pronounced in Barani-83 than in SARC-1. Overall, GA_3 treatment stimulated the vegetative growth of both cultivars of wheat under salt stress, but it caused a slight reduction in grain yield. GA_3 treatment enhanced the accumulation of Na^+ and Cl^- in both shoots and roots of wheat plants under salt stress. It also caused a significant increase in photosynthetic capacity in both lines at the vegetative stage under both saline and non-saline media.

10. A study was conducted on the salinity tolerance of 25 semi-dwarf CIMMYT wheat genotypes, including Tobari-66 and Sonora-64 (known salt tolerants). Such materials are of great value in breeding program for enhancing salinity tolerance. Two NaCl levels (0 and 150 mmol L^{-1}) were used, and the pattern of Na' and CI- accumulation was examined. Results revealed that rate of photosynthesis, stomatal conductance and water relations parameters had no positive association with the wheat genotypes differing in degree of salt tolerance. Analysis of data further revealed that it was not easy to draw relationships between degree of salt tolerance and pattern of toxic ions uptake due to polygenic and very complex nature of salinity tolerance phenomenon.

11. To cope with adverse environmental conditions, plants produce some organic compounds like sugar, proline and glycinebetaine (GB). These organic compounds improve growth and development and yield of crop plants under stress. In a study, exogenous application of GB was carried out to induce salt tolerance in wheat. Two wheat genotypes, MH-97 and S-24 were subjected to salt stress. Three levels of GB (0, 50, 100 mM) were applied at vegetative and booting stages of plant growth and the data were recorded after 20 days of GB spray. Under control condition, salt stress had a significant adverse effect on fresh and dry biomass production, shoot length, number of spikes, 100 grain weight and yield per plant. The plants applied with GB indicated improved content of total soluble proteins, free proline and soluble sugars. Gas exchange parameters such as CO_2 assimilation rate, transpiration rate, sub-stomatal CO_2 concentration and stomatal conductance were all improved with GB application. The effect of salt stress was more pronounced at booting stage than at the vegetative stage. The wheat genotype S-24 proved better than MH-97 under salt stress condition.

12. The effect of foliar application of indole-3 acetic acid (IAA) and gibberellic acid (GA_3) to wheat and maize, exposed to saline conditions, was studied. Both the growth regulators at 100 ppm concentration were slightly effective on mitigating the effect of salinity in both the crops. Similarly effect of cytokinin, benzyl aminopyrine (BAP), was also assessed on the growth and yield of wheat. Two levels of this PGR i.e. 10 and 20 ppm; as foliar spray, considerably enhanced the growth of wheat. In a separate study, effect of varying concentrations of GA was determined on the growth, yield and anatomical characteristics of canola, GA application resulted in reduction of most of the growth parameters. Moreover, induction of numerous anatomical changes at root and leaf levels were also apparent due to GA application.

Drought Resistance in Legumes

1. The morpho-anatomical changes in some mung bean (*Vigna radiate* L.) Wilczek) and mash (*Vigna mungo* (L.) cultivars under different water stress conditions were recorded. Stress imposed at different stages decreased the relative growth rate and yield parameters of all the cultivars tested. Among the local/approved mung bean cultivars Niab 92 proved very susceptible and NCM 98 slightly resistant to the stress imposed. The morphogenetic resistance of seven genotypes of mung bean, collected from different a zones of Pakistan to water stress was also similar. However, accession 285/1 (Turbet) proved comparatively more tolerant to water stress. Among the mash (*Vigna mango* L.)~cultivars mash 88 proved comparatively1drought tolerant. Under stress conditions it not only showed better growth but also an improvement in the water conducting and storing tissues.

2. Exposure of *Triticum aestivum*, *T. durum*, *Zee mays*, *Hordeum vulgare* and *Lens culinaris* to soil drought was investigated at different stages of growth. Water tress induced a significant reduction in growth and yield of all the species but a greater effect was noted at the flowering stage. *T. durum* emerged as the most tolerant species to soil moisture stress. Supplementation of nitrogen to moderately water stresses plants proved beneficial in enhancing the growth sad yield to some degree.
3. Responses of different genotypes/lines wheat chickpea, mungbean and sunflower to drought were assessed different growth stages of the crops. In addition a large amount of inter-cultivar/inter-genotype variation species examined. Physiological mechanism varied at different stages of' crop life cycle.
4. Some organic compounds like sugars, proline and glycinebetaine improve growth, development and yield of crop plants under environmental stresses. In the present study glycinebetaine was used to induce drought tolerance in sunflower. Two sunflower lines, Gulshan-98 and Suncross were subjected to water stress at the vegetative and reproductive stages of plant growth. Three levels of glycinebetaine (0, 50, 100 m*M*) were applied, before sowing (seed treatment), and at the vegetative and reproductive stages. Carboxymethylcellulose (CMC) solution (5%) was used as sticking agent for seed treatment, whereas 1% solution of Tween-20 was used along with glycinebetaine for spray at the vegetative and reproductive stages. Data were recorded after 20 days of water stress and glycinebetaine treatments. Water stress had a significant adverse effect on fresh and dry biomass production, capitulum diameter, number of achenns/plant, 100 achene weights and yield/plant. In contrast total soluble proteins, proline and glycinegbetaine contents were increased due to water stress. Gas exchange parameters such as CO_2 assimilation rate, transpiration rate, sub-stomatal CO_2 concentration and stomatal conductance were also reduced due to water stress. The effect of water stress was more pronounced at the vegetative stage than at reproductive stage. Stress induced reductions in biomass production and yield components were significantly reversed by glycinebetaine application. Leaf glycinebetaine contents in water stressed plants were also increased due to foliar application of glycinebetaine in both sunflower lines. The sunflower line Suncross proved better than Gulshan-98 under water deficit conditions.
5. Twelve bread wheat and twelve durum wheat genotypes were tested for their response to soil moisture stress. Based on yield parameters four genotypes i.e. two tolerant and two sensitive from each species were selected for further study. Data revealed that Chakwal- 86 and Inqlab-91were tolerant to adverse soil moisture condition among bread wheat genotypes and D-88678 and D-91641 among durum wheat genotypes.

Seed Priming

1. Seed pre-sowing treatment for a sustainable enhancement in crop production on salt affected soils is not well established. Keeping this in mind, an extensive study was carried out during the years 2000-2004 to find out some effective priming agents out of a large number of tested, e.g., different inorganic salts, plant growth regulators and extremes of temperature etc. Of these, GA_3, polyamines and kinetin and low temperature treatments were found to be very effective in alleviating the adverse effects of salt stress on wheat and other potential crops. This was indeed confirmed.
2. A study was conducted to determine whether salt tolerance could be induced in maize at the germination stage by soaking of seeds for 8 h in distilled water or in 200 meq L^{-1} of NaCl, KCI, $CaC1_2$, $2H_20$. Both primed and un-primed seeds were subjected for 14 days to 0, 100 or 200 mol M^{-3} NaCl under controlled conditions. Although all priming agents were e ffective in alleviating the adverse effects of salt stress on maize at the germination stage, $CaC1_2$. $2H_20$ proved to be more effective since the seeds primed with this salt had significantly higher final germination, rate of germination and fresh and dry weights of plumules and radicles than those treated with other salts or distilled water. Concentration of Na^+ K^+ and Ca^{2+} increased significantly in all the parts of germinating seeds of

maize primed with NaCl, KCl, or $CaC1_2$ $2H_20$, respectively. In addition, seeds primed with $CaC1_2$. $2H_20$ were the highest in Cl^- in all parts of the germinating seeds, followed by the seeds treated with NaCl and KCl. Most of the Ca^{2+} was retained in the seeds and mesocotyl, because of which, transport of this ion to plumules and radicles was low.

3. A study was carried out to assess whether salt tolerance could be improved in pearl millet at the germination stage and vegetative stage by soaking the seeds of two cultivars, IC-8206 and 18-BY, for 8 h in distilled water, 150 mol m^{-3} NaCl, or polyethylene glycol (PEG-8000, -0.72 Mpa), or by subjecting the seeds to chilling (5°C) or heating (60°C) for two days. Germination of both treated and a non-treated seed of both the cultivars was assessed for 8 days in Hoagland solution amended with 0 or 150 mol m^{-3} NaCl. Chilling and to a lesser extent PEG increased the final germination percentage but not the germination rate of both the cultivars under both saline and non-saline conditions. Chilling alleviated the adverse effect of salt stress on IC 8206 in terms of fresh and dry weights of shoots and roots following 42 d in sand culture received 150 mol NaCl M^{-3}. Chilling also reduced Cl^- accumulation and to a lesser extent that Na^+ and enhanced K^+ and Ca^{+2} accumulation in the shoots and roots of both cultivars under biosaline and non-saline substrates. The reverse was true in plants raised from seeds treated with NaCl or PEG.

4. Per-sowing seed treatment with different inorganic salts or organic chemicals including plant growth regulators is an efficient and economic means of improving salt tolerance in potential crops. Seeds of two wheat varieties i.e. MH-97 and Inqlab-91 were treated with varying concentrations of different hormones or inorganic salts and sown in a salinized field (15 dS m^{-1}). Data for fresh and dry biomass, seed yield and gaseous exchange parameters were recorded and concentration of different polyamines (Put, Spd and Spm) determined. The anatomical features of primed seeds were also determined to compare the effectiveness of various treatments on germinating seeds. Salinity decreased dry biomass, grain yield and gaseous exchange parameters like net CO_2 assimilation, transpiration rate and stomatal conductance but pre-sowing seed treatments with kinetin, GA_3 and inorganic salts ($CaC1_2$ and KCl) alleviated the adverse effect of salt stress.

Cellular level salt tolerance mechanisms

1. *In vitro* NaCl salt tolerance mechanism was studied in two wheat genotypes (S-24 and Potohar) differing in salt tolerance. There were three treatment of NaCl (0, 100, 200 mol M^{-3}) and each treatment was replicated thrice. The studies showed, reduction in callus fresh weight, Ca^{2+}, Cl^- and water status were increased, with the increase in NaCl concentrations in the medium in bath the genotypes. It was concluded that more the salt tolerant genotype, more the accumulation of salts and retention of S-24 showed better mechanism of compartmentation than Potohar.

2. *Comparative* salt tolerance at whole plant and its corresponding cellular level of two wheat genotypes (LU-26S and Potohar) differing in salt tolerance was studied. There were three treatments of NaCl (control, 100 and 200 mol M^{-3}) and each treatment was replicated thrice. Data showed that Na^+ and Cl^- of leaf and its corresponding callus increased with increased in salt stress in both the genotypes. The rate of accumulation of these ions was lower in leaf than that in its corresponding callus. Low turgor was noted in leaf compared to its callus. These results indicate that Na^+ and Cl^- exclusion mechanism was operative in whole plant, was not evident in callus. Low turgor in leaf and high in callus is one of the prominent adaptive components of salt tolerance.

3. In vitro salt tolerance in two cereal crops barley (Jue-87, B-00047) and durum wheat (D-97, D-98627) were studied. There were three levels of NaCl (control, 100 and 200 mol m^{-3}) and each treatment was replicated thrice. Dry weight, Na^+ and Cl^- contents of callus tissue, increased with increased NaCl concentration in the growth medium. The extent of increase was greater is barley than durum wheat. This indicated that barley tissues exhibit better compartmention of ions than durum wheat.

4. Studies were conducted for the assessment of NaCl tolerance in various genotypes of Barley (*Hordeum vulgare* L.) at seedling stage in vivo and in vitro. All the genotypes showed variations in the

NaCl tolerance under both the conditions. Data showed a decrease in all the parameters, except that carbohydrates Na, K, and Ca contents. On other hand, fresh weight was the most declined of all the parameter. Seedlings of all the genotypes showed indicated better seedling growth and compartmentation of ions in vitro than in vivo. It is concluded that better NaCl tolerance in vitro may be due to simple nature of growth medium than soil which is a complex interacting factors for salinity tolerance.

5. MS (Murashige and Skoog, 1962) basal medium was used with different concentrations of 2,4-D alone and in combination with BA for callus induction and proliferation of rice (Cv DM-25). For embryogenic callus 2,4-D alone at the concentration of 4 mg L^{-1} was found to be best, high concentration, and in combination with BA showed declining effect in induction percentage. For regeneration calli which were initiated on low conc. of auxin (2 mg L^{-1} 2,4-D) alone showed best result as compared to the high conc. Among the different combination MS with 4 mg L^{-1}IAA and 2 mg L^{-1} KIN found to be best (80%) for regeneration. LS (Linsmaier and Skoog, 1965) basal medium was used with different concentration of auxins (IAA, NAA and 2, 4-D) alone or in combination with cytokinin (BAP and KIN) and amino acids (Proline and Glycine) plus different levels of sucrose. In maize, (Cv. UM-6) root apical region was found to be the origin of callus. For induction of embryogenic callus 5 mg L^{-1} 2, 4-D alone with 40 g L^{-1} of sucrose was found to be best. The rate of regeneration of 5.03% and 14.28% vas observed with the addition of proline and glycine to the medium containing LS basic medium plus 0.2 mg L^{-1} 2, 4-D and 0.5 mg L^{-1} BAP respectively. When embryogenic calli wore cultured on hormones free medium, the regeneration rate was found to. Be greater (19.13% than that with hormones).
6. Somatic embryogenesis technique has the potential for crop improvement due to the production of bipolar embryoid. In addition, this technique enables the rapid production of complete plants within short span of time. This method was used for the induction of somatic embryogenesis in callus cultures of durum and bread wheat. Different combinations of auxins and cytokinin were employed. Of all, type I callus with single added hormone (2, 4-D) at 1.0 to 2.0 mg/L proved effective in the induction of somatic embryogenesis in both the wheat species.

Plant Genetic Resources:

Research work on plant genetic resources continued and crop germplasm of different crops was evaluated against salinity and drought. The results achieved so far on salinity are highly encouraging as a result of this primitive wheat strains resisting 15.0 EC of NaC1 have been identified. Similarly, the germplasm of sugarcane resisting very highly salinity levels have also been selected and some additional germplasm is being tested against this malaise. Two strains which tolerated high levels of salinity now have been planted at Salinity Research Institute, Pindi Bhatian for further tests and trials. Drought resistant strains of wheat and Mungbean have also been selected for further research. Distribution of the germplasm to the interested plant scientists is being carried out of the benefit of agricultural research.

Mineral Nutrition:

1. The relative efficacy of foliar and soil applied urea was compared for growth and yield in barley Cv. Jau-87 under field condition. Foliar applicstion (mainly 55.5 Kg ha^{-1}, urea at tillering stage) enhanced maturity, stem-length, spike length, number of fertile tillers (m^{-2}) and grains ($spike^{-1}$), grain weight per spike,1000-grain weight, grain yield, dry matter yield (m^{-2}) and nitrogen percentage (booting stage).
2. A comparative evaluation of effects of foliar feeding and soil application of urea and growth and yield of barley showed that method of urea application had significant effect on Baring and maturity period. Maturity period was enhanced by foliar application of urea especially when applied at later stages of development. Stem length was significantly affected by foliar application of nitrogen and tillering stage was found to be more responsive to foliar application. Higher dosages of foliar applied urea increased the spike length significantly when given at tillering stage. Number of fertile tillers/m^2 was significantly

increased by foliar application of urea especially when applied at earlier developmental stages; lower doses of urea sprayed at later stages of growth produced even less number of fertile tillers than control. Maximum number of non-productive tillers was recorded when higher dose of urea was sprinkled at booting stage; whereas control plants produced minimum number of non-fertile tillers. Significant variation was shown by number of grains per spike as affected by the methods of urea application. Minimum number of grains per spike was recorded in plants receiving minimum dose of liquid urea at earlier growth stages and maximum number was noted in plants sprayed with highest dose of nitrogen at tillering stage.

Higher dose at earlier developmental stages resulted significantly in higher grain weight per spike. Minimum grain weight per spike was recorded in control plants, however, foliar spray of nitrogen significantly affected 1000-grain weight which increased progressively with the increasing concentration of urea, particularly at tillering stage. However, the lowest 1000-grain weight was recorded in control plants. Grain yield was significantly increased by urea only when its higher dose was sprayed at earlier stage. However, the lowest 1000-grain weight was recorded in control plants. Grain yield was significantly. increased by urea only when its, higher dose was sprayed at earlier stages of development, but when given its lowest concentration at booting stag, the yield was less than control. Straw yield was not affected significantly by the methods of urea application, however, earlier developmental stages were found to be more responsive to foliar application than later stages. Dry matter yield/m^2 was significantly increased by the foliar application of urea and the plants receiving highest concentration at earlier developmental stages produced higher dry matter/m^2. Control plants, however, produced minimum dry matter/m^2. Minimum harvest index was shown by plants, treated with minimum dose of nitrogen at tillering stage and highest harvest index was recorded in plot receiving maximum urea at booting stage. Significantly more nitrogen percentage in plant material was recorded in plants receiving nitrogen to their aerial parts. Nitrogen percentage in plant material progressively increased by increasing nitrogen concentration and advancing stage of development. Higher percentage was recorded in plants having maximum dose of foliar nitrogen at booting stage.

The effect of Cu and Zn in the presence of NPK on yield and growth of *Oryza saliva* L. was studied in pots. Some agronomic features like leaf area, number of tillers, biomass, length of panicles, total number of spikelets, 1000-grain weight, grain and. straw yield, and harvest index were enhanced. Nitrogen content of grain and straw increased but phosphorus contents were inhibited. K and Zn content of grain and straw increased when Cu and Zn were added to soil. The antagonistic effect of Zn on Cu contents was also obtained.

3. A comparison between the full N dose at the time of sowing and 6 split nitrogen applications at three stages of barley (*Hordeum vulgare* L.) was made. Full nitrogen application at the time of sowing and its split application at 3 stages proved an efficient technique of fertilizer application for obtaining the maximum grain yield.

4. Effect of full or split application of nitrogen (0, 80 and 120 kg/ha) and phosphorus (0, 8, 32 and 56 kg/ha) fertilizers on maize indicated a significant increase in overall growth and economic yield parameters. Split half-doze application of both the fertilizers, each at sowing and silking was the most effective in increasing grain yield. Combined application of N and P fertilizers indicated that split application of half doze, each at sowing and booting to wheat, enhanced the fertile tillers per plant, number of spikelets per ear and 100 grain weight, as compared to their solo application. This indicated a synergistic interaction of both the fertilizers in giving higher economic yield.

5. Effect of different doses of nitrogen on the growth and yield of wheat (*Triticum aestivum* L.) and canola (Brassica *napus* L.) was studied in glasshouse conditions. Application of nitrogen @ 240 kg/ha to wheat and 120 kg/ha. to maize proved to be most effective in enhancing growth and yield. Similarly, interactive effect of calcium and ino on wheat was assessed, and it was found that combined application of both these fertilizers, up to certain limits, proved beneficial in enhancing

overall growth and yield parameters. In another study, the interactive effects of nitrogen and phosphatic fertilizers with soil salinity was investigated on tetraploid and hexaploid wheat species. Hexaploid varieties proved better and efficient to use N and P under mild salinity levels, as reflected by different growth and yield parameters.

6. 6. Nutrient utilization efficiency of two wheat cultivars was determined. Yield potential revealed that fresh and dry weights of shoots, leaf area per plant and relative growth rates were higher in low yielding Barani-83 than those in Inqlab-91 at the vegetative stage. Inqlab-91 had higher amounts of N, P, K and S in the shoot. The relatively low biomass production and relative growth rate of Inqlab-91 seem to have played a significant role towards its higher grain yield. The low yielding Barani-83 maintained higher N in the first and K^+ in second leaf as compared to Inqlab-91, thus possibly not having supplied sufficient amounts of these nutrients to the developing grains. Relationship between rate of photosynthesis and growth rate of the above two spring whet cultivars revealed a decrease in photosynthetic rate, stomatal conductance and transpiration rate in both the varieties with time, but Inqlab-91 was superior to Barani-83 with respect to these attributes.

7. 7. A field study was carried out to unravel the inter-specific difference in cotton for the partitioning of important nutrients from the subtending leaves to the respective reproductive parts of *Gossypium hirsutum*, *G. barbadense* and *G. arboreum* at various stages of reproductive growth.

   Results revealed significant differences among the species for the various parameters studied. Overall there was a greater fresh and dry mater yield of various reproductive parts and subtending leaves of *G. hirsutum* and *G. barbadense* than the *G. arboreum*, although the rate of leaf photosynthesis was similar. Age-dependent increase in leaf area/leaf mass indicated a greater portioning of earlier acquired assimilates to the growth of reproductive parts. Results indicated greater partitioning of N, P, S and Ca during later reproductive growth (from boll production to its opening) in *G. hirsutum* and *G. barbadense*, but during earlier reproductive growth in *G. arboreum* (from bud up to flower formation) as was evident by decreased subtending leaf/reproductive parts ratio. It is concluded that better N, P, S and Ca partitioning ability of *G. hirsutum* and *G. barbadense* at the onset of boll development played a major role in the better yield and good quality fiber characteristics. This is because the greater partitioning of these nutrients at this stage helped the bolls to growth bigger in size, followed by greater origination of lint from the testa.

8. A study was undertaken on the growth response of *Cyamopsis tetragonoloba* to various ammonium fertilizers. Three levels (5, 10 and 15 kg per acre) of ammonium fertilizer i.e. ammonium sulphate (AS), ammonium nitrate (AN), diammonium hydrogen phosphate (DHP) and urea were applied. Various growth parameters were enhanced with 10 kg per acre. Among the nitrogen sources, DHP gave maximum dry matter yield. Nitrate reductase activity and chlorophyll contents also showed increase in fertilizer level up to 10 kg per acre.

9. The present study was conducted to investigate the influence of different doses of nitrogen on growth and yield attributes of Isbagol and Kalonji. Four nitrogen (N) levels, i.e.; 0, 30, 60, and 90 kg per acre were applied at vegetative stage. Growth parameters i.e. fresh and dry weights of shoots and roots were the maximum at 60 kg N per acre, whereas N, P and K concentrations were maximum at 90 kg N per acre. Yield parameters including 100 seed weight, seed yield per plant, number of tillers and spikes and seed yield per acre increased consistently with increasing N levels. Seed oil content in Kalonji was the maximum at 30 kg N per acre. Among the saturated and unsaturated fatty acids myrestic acid, linoleic acid and dihomolenoleic acid remained unchanged at varying soil N levels.

Water Pollution and Aquatic plants

It was observed that low sodium salinity acted as growth stimulant for *Eichhornia crassipes* and *Pistia stratioties*. *P. stratioties* was more tolerant to HCO^{-3} and Na^+ but not to NH_4, NO_3 and *E. crassipes* more tolerant to HCO^{-3} but tolerant to NH_4, NO_3 induced eutrophication while their response to NaOH, Na_2CO_3,

NH_4Cl and $CaOC1_2$ was found to be similar. Chemical analysis showed that Na^+ concentration was more crucial in aquous medium and it interfered with the Ca^{2+}, Mg^{2+}- and K^+ percentage of the plant white there was a positive correlation of concentration in the aquous medium and their accumulation in case of Na^+ and Cl^-. Nitrogen in aquous medium increased the crude protein level at lower levels while higher nitrogen concentrations suppressed protein percentage as well as growth in general.

Growth regulation

1. Response of two barley (*Hordeum vulgare* L.) cultivars Jow 83 and Jow 87 to single and split (double and triple) sprays of 1200 ppm chlormequat was tested. The double and triple sprays of 1200 ppm chlormequat proved better than single spray and split applications, and cv. Jow 87 gave higher yield than Cv. Jow 83.
2. Foliar application of GA_3 and NAA at the concentration of 10 and 20 ppm to chickpea and wheat at the flowering gave higher economic yield in both the species as compared to their application at vegetative stage. 20 ppm concentration of both the PGRs proved to be the most effective. In another study, seed-soaking of Chloromequat was effective in reducing internodal length but enhanced grain yield of barley. However supplementation of N-fertilizer to chloromequat treated plants at the onset of earing, counteracted inhibitory effect of Chloromequat with a significant increase in grain yield over those receiving no supplement nitrogen.
3. The experiment was conducted in pots and IAA was applied as foliar spray (15 and 30 mg L^{-1}). Thirty days after germination water was withheld to half the lot of pots after hormones application. Significant effects of IAA and low water treatment were observed for plant height, leaf area, number of tillers per plant and grain yield. In another study, morpho-physiological response of mungbean (*Vigna radiata* (L.) Wilczek) to IAA and NAA was investigated. Data revealed an increase in various parameters with increasing concentration of both IAA and NAA. NAA exhibited an increase up to 86% in grain yield while IAA showed 122% increase in yield over control.
4. A study was performed to determine the adverse effect of Ni-polluted soil on the growth of mungbean [*Vigna radiata* (L.) Wilczek]. Mungbean seeds treated (with 20 and 40 mg kg^{-1} of Prostart) or untreated were sown in Ni-polluted soil. Results revealed that Ni-polluted soil although adversely affected the growth, dry biomass and yield contributing characters, treatment with the Prostart was effective in counteracting Ni-toxicity.

Radiation studies

Mutagenesis studies performed on eight diverse genotypes comprising five microsperma and three macrosperma types revealed that gamma radiation was detrimental to various morphological traits in Mr plants. In most of the genotypeschlorophyll mutations showed a positive association with the frequency of morphological mutations. For inducing mutations in lentil a dose of 20 KR was considered a threshold dose the microspermra group showed relatively higher mutation rate than macrosperma.

Enzyme production

Fungi were isolated from soil by Warcups (1950) isolation technique and screened for the production of amylases and pectinases. Among the amylolytic fungi six strains and among the pectinolytic fungi dour strains were selected for enzyme production.

The screened fungi were identified and enzyme production techniques were refined which proved surface fermentation technique better than the one through submerged fermentation.

Floristic composition of national forest reserves

1. Survey of National Forest Reserves Chingi (Talagang) and Lalsohanra (Cholistan) was conducted for the analysis of prevailing flora and central of species erosion to combat desertification. Both sites showed very poor species richness and varied slightly during the two year period. At Chingi site, over exploitation of plant resources and at Lalsonhara extensive herbivory as well as extreme dry were mainly attributed to poor species richness.
2. To explore the leguminous diversity endemic to Soon valley in the salt range of the Punjab, five sites viz. Khabeki, Uchhali, Anga, Sodhi and Knotty garden were visited. With a slight variation at all sites, *Acacia modesta*, and *Acacia fernigiana* among the leguminous, *Olea cuspidata*, *Adhatodh vasica*, *Dodoneah viscose* and *Zizyphuis numulhric* among the non-leguminous species and *Saccharum spontaneum* among the grasses were examined as the dominant species. Extensive grazing by cattle, shortage of rainfall and lopping of woods for fuel purpose were examined the major threats to plant diversity in the region.

Herbicidal Weed Control

1. Pro-emergence (Machete) and post-emergence (Logran, Tolkan, Buctril-M and Karmax) herbicides controlled the different narrow and broad leaved weeds which significantly enhanced the growth and yield of wheat and barley. A higher increase was noted in fresh and dry weight of shoots number of leaves, number of spikelets per ear, 100 grain weight and total grain yield per plant.
2. Effect of application of different post-emergence herbicides, i.e., Buctril-M, Panther, Arelan and Logran to control weeds in wheat fields was investigated. Although post-emergence application of all herbicides brought about a reduction in weed population, BuctriI-M emerged as the most effective. As the consequence of low weed density, the wheat yield increase by about 10 to 15%.

Phytoremidiation of Heavy Metals

1. *Azolla pinnata* was used for the removal of Ch (VI) from synthetic solutions. It showed maximum growth at lower concentration (up to 8ppm) for both Ch (VI) and Ch (III) that acted as nutrients. However, above 8 ppm, Ch (III) proved toxic. At pH 2.00, up to 98.99% chromium was removed by *Azolla pinnata*.
2. Under natural conditions synthetic solutions were used. *Azola pinnata* showed maximum growth at low concentration of chromium (VI) and chromium (III). Maximum growth also proved a food nutrient at lower concentrations (lppm, 2ppm, 3ppm and 4ppm) but at 8ppm it proved to be toxic.
3. In a study, effect of heavy metal toxicity was investigated on some leguminous species. Zinc (Zn), chromium (Cr), nickel (Ni) were applied as heavy metals @ 100 & 200 ppm, 50 & 100 ppm and 50 & 100 ppm respectively alone or in combination. Cr registered maximum deleterious effects on growth as compared to Ni and Zn. Combined application of these metals resulted in a greater decrease in growth and yield of plants, together with a decrease in potassium, calcium and chlorophyll contents. In a similar study, effluents from textile and leather tanning industries were applied to 30 days old plants at various concentrations (25%, 50% and 75% of the effluents). Results revealed that growth and yield parameters showed gradual decrease with increasing concentration of effluents.

Use of Biofertilizers

1. Phosphate solubilizing bacterial strains were isolated from the rhizosphere, root and nodules of chickpea. They greatly varied in their Indole Acetic Acid (IAA) production and ARA (acetylene reeducatase assay) activity. Some of the phosphate solubilizing bacterial (PSB) strains isolated from chickpea rhizosphere showed maximum positive effect on shoot length, shoot dry weight and on number, size and ARA activity of nodules in the inoculated chickpea plants.
2. In a resembling study phosphate solubilizing bacterial (PSB) strains were isolated from the roots and rhizosphere of lentil (*Lens culinaris*) plants. Effect of these isolates on lentil plants was determined in

a pot experiment. The results revealed that applied PSB strains considerably enhanced seedling emergence. The enhanced plant growth in the inoculated lentil plants was attributed to improved phosphate availability.

3. The study was conducted to observe the effect of plant growth promoting rhizobacteria on the growth of maize. Plants of maize variety FYH 433 were grown in sterilized sand filled in plastic pots. Seeds were inoculated with ten different PGPR strains. Plants were also given N fertilizer in recommended doses at first watering. In growth room studies, seeds were inoculated with same PGPR strains and plants were given half strength N-free Hoagland solution after every three days. Results pertaining to various growth parameters showed a significant increase in presence of ½ NPK and N-free Hoagland solution application in both the experiments. Application without inoculation also showed good result. However, inoculation in the presence NPK showed highly significant results. Nitrogenase activity of inoculates maize roots also showed positive response inoculation of PGPR strains increased root area and total root length. Plants inoculated with PGPR strains also increased Na^{+}, K^{+}, Ca^{2+} and P content and total nitrogen compared to controls in both the experiments.
4. Phosphate solubilizing bacterial (PSB) strains enhanced phosphate availability to plants and promoted their growth. Various PSB had maximum positive effect on vegetative growth parameters and considerably improved the total plant N and P content. The number of nodules was also significantly increased which indicated the dual importance of PSB strain improving the crop yield.
5. Phosphorus solubilizing bacterial (PSB) strains considerably enhanced seedling emergence, establishment and phosphate availability to plants that consequently promoted growth of chickpea plants. PSB inoculation caused on increase in total N, P and other cations such as Na, K and Ca. Bacterial strains exerted a positive influence on shoot dry weight, root dry weight and ARA activity of nodules of chickpea plants.
6. Growth response off our rhizobial strains (PS-1, PS-2, LC-12 and LC-31) to low temperature (0°C to 30°C) was determined. All the 4 bacterial strains showed a tendency to survive even at 5°C but their number remained the same. At 10°C there was a little increase in the number of LC-31 from 106 to 108 but the other strains did not show any increase in the number of cells. However, at temperature from 20°C to 30°C all the bacterial aspect PS-2 strains showed a well detective growth.

CHEMISTRY

Different research groups of the department have been working in their areas of specialization. Salient achievements of these research groups have been described under the following headings

1. DRUG METABOLISM

Drug metabolism studies are important in revealing alteration in the activity of the drug molecule following biotransformation. Such studies not only help in developing the rationale for optimal therapeutic approach but also provide species characteristics at the biochemical levels. Several studies dealing with drug metabolism have been conducted by using commonly employed drugs as models in different species of domestic animals. These studies have revealed that in buffalo, cow, sheep and goat intravenously injected dose of sulphadimidine is excreted as unchanged drug, acetyl and hydroxymetabolite and as conjugated metabolites. Nearly one fourth of the dose is excreted as unchanged drug while the remaining, is metabolized. However, in dog, unchanged drug constituted the major urinary excretion. *In vitro* metabolism of sulphadimidine by ruminal microflora from the 4 species of ruminants indicated a similar rate of decline of unchanged drug concentration with time in the incubated samples. Similar studies with sulphadiazine revealed that nearly one third of the intravenously injected dose in sheep and goat is excreted as unchanged drug while rest of the drug is excreted as metabolites.

Contrary to the information given in literature, the local species show both qualitative and quantitative differences in the rate and extent of metabolism, which indicates the need for further investigations on these lines in order to describe the drug metabolism under indigenous conditions and on local species. The studies dealing with the renal handling of sulphadiazine revealed the involvement of glomular filtration, back diffusion and active tubular secretion of the drug. It is of interest to study the biochemical factors, which affect the biodisposition of the drugs in different species because each species has got its own biochemical characters and secondly certain metabolic disorders have a profound influence on the hematochemistry. The studies involving sulphadiazine and ampicillin have shown that blood pH and total proteins in blood can affect the plasma levels and response to drugs.

The kidney plays a vital role in the maintenance of homeostasis through the regulation of acid-base and water electrolyte balance and excretion of endogenous and exogenous substances. Therefore, understanding the role of kidney in the maintenance of biochemical melieu interim is of practical importance. Urea is commonly used as non-protein nitrogen source in the ration of ruminants. Thus, renal handling of urea in sheep has revealed the involvement of active tubular secretion, which has not been documented earlier. The metabolic disorders of diabetes have been found to significantly change the disposition and fate of sulphadimidine in dogs apprising the need of dosage adjustment under such conditions. These studies have generated such a useful data, which necessitates that these studies be continued to find out the physiological and biochemical factors affecting the biodisposition and fate of drugs in the indigenous conditions to rationalize the therapy.

2. PHYTOCHEMICAL/PHARMACOLOGICAL SCREENING OF INDIGENOUS MEDICINAL PLANTS

The importance of plants as sources of medicinal agents has always been recognized by the people working in this field. Many plants grow all over the country and have not been investigated by modern phytochemical and pharmacological procedures. However, some preliminary investigations have revealed that indigenous plants contain medicinal agents, which are presently being, imported to meet the needs of the local pharmaceutical industry. A systematic phytochemical screening of medicinal plants of Faisalabad suburbs was carried out and a total of 52 plants belonging of twelve families have been analyzed so far. The families investigated included Acanthaceae, Amaranthaceae, Amaryllidaceae, Apocynaceae, Asclepidaceae, Bignoniaceae, Boraginaceae, Chenopodiaceae, Compositae,

Convolvulaceae, Crucifareae and Cucurbitaceae. Out of the total of 52 plants, 33 were found to contain glycosides, 25 contained alkaloids, and 20 contained flavonoids, while saponins were detected in 16 plants. Studies leading to the isolation and identification of individual components are in progress. Moreover it is planned to study the isolated components pharmacologically. In addition to those studies, in two separate studies positive antidiabatic effect of 'Karela' extract and antihypertensive effect of 'Ghee Kawar' were investigated. Phenolic constituents of 'Neem' plant were also determined.

3. UTILIZATION OF AGRICULTURAL/INDUSTRIAL WASTES

Waste utilization is both a necessity and challenge. It not only adds to the revenues but also minimizes the problem of pollution and waste treatment. Pakistan produces quite large quantities of agricultural and industrial wastes. These wastes include rice husk, oat, wheat straw, corncobs, bagasse, cotton sticks, molasses, mango stones etc. Besides these wastes, some naturally growing plants/weeds like Sarkanda, Kai, Dhabb, Khabal grass, Pahari kikar etc. are also available in exuberance. In recent years attention has been focused on the utilization of these materials as a potential source of commercial chemicals, notably furfural, active carbon and car boxy methyl cellulose (CMC).

Furfural (a five membered heterocyclic aldehyde) and its derivative have multitudinous applications in industries like pharmaceuticals, fungicide, insecticide, herbicides etc., as an intermediate in nylon, dihydropyran and lysine production and as a selective solvent in wood resin purification, refining of petroleum and corrosion resistant cements. Successful experiments have been conducted for the production of furfural from various raw materials like corn cobs, bagasse, rice hulls, cotton sticks, pericarp, sarkanda, dhabb, kai, khabal grass and pahari kikar, by acid hydrolysis under optimum conditions of temperature, acid concentration and time periods. The percentage yields obtained ranged from 3.24 to 12.99. Further experiments indicated 100% increase in yield by using chlorides of sodium, calcium, barium, aluminium and iron.

Active carbon is used in a wide range of processing industries including vegetable ghee, sugar, fertilizer, pharmaceutical, and beverages. It also finds application in the purification of water and organic acids. Efforts have been made to use various agricultural wastes as raw material for the preparation of active carbon. Activating agents like zinc chloride and sulphuric acid at different concentrating and at various carbonization temperatures have been employed for obtaining maximum yields of active carbon, which ranged from 28.4 to 68.3%. The physicochemical properties of the active carbon obtained were found to be comparable to those of imported material.

Sodium cellulose glycolate commonly known as sodium salt of carboxymethyl cellulose (CMC) also referred to as cellulose gum in food industry is an important constituent of detergents, pharmaceuticals, ceramics and ceramic glazes. It also finds extensive application in many industries such as textile, paper and cosmetics. Agricultural waste products like bagasse, cotton linters, corncobs, rice hulls and rice straw have been used for the production of CMC, which, could be safely substituted for the imported material. The yields obtained ranged from 43.8 percent from rice straw to 48.9 percent from corncobs. Efforts are being made to improve the quality and the yield of CMC.

4. EXPLOITATION OF INDEGENOUS RESOURCES

The main task of researchers working in this area of research is to characterize and exploit indigenous bioresources and introduces various methodological and analytical protocols for their viable industrial applications. The research is mainly focused on the investigation, extraction and characterization of some conventional and non-conventional oil seeds, legumes and lentils, natural antioxidants and essential oils from indigenous botanical sources. Different in-vitro assays like antibacterial, antifungal and antioxidant activity are employed to evaluate the activity of plant extracts and bioactive compounds. Quality assessment of raw and end-use vegetable oil and fat products is being carried. Analysis of omerga-3,

omega-6, cist/trans fatty acids. Industrial wastewater treatment protocols are developed and analysis of trace and heavy metal contaminants, organic pollutants e.g., PCBs, POPs and pesticide residues in food and feedstuff is going on. Very cheaper biosorbants are being developed to remove heavy metals from industrial effluents.

Evaluation of natural antioxidants from plant material and agricultural wastes was carried out. The methanolic and acetone extracts of rice bran, wheat bran, oat goats and hull, strawberry and *Moringa oleifera* leaves were found to exhibit very good antioxidant efficacy. Keeping in view the acute shortage of edible/industrial oils in the country efforts were made to characterize and exploit some indigenous non-conventional sources of oils like *Moringa oleifera,* rice bran*, Cannabis sativa,* mango kernels, kachanar seeds and Ipil Ipil seeds with oil yields of 35.0, 16.0, 27.5, 12.3, 16.0 and 5.0% respectively. The investigated oils were found to show adequate edible and industrial potential, which could help meet the domestic needs of our country. Mineral composition of some medicinally important plants was also explored which revealed these might be used in our native medicine and folk remedies.

Pakistan produced 0.55 million metric tons of molasses during 1985-86. Inspite of the fact that very valuable materials are being obtained from molasses in the western countries, a major portion of the local molasses is exported at very low prices. Research work has been carried out on demineralization, decolourization and deodourization of molasses by various physical and chemical methods including active cation/anion exchange resins and solvent extraction. Edible syrup suitable for use in beverages and backing has been successfully prepared and evaluated.

5. SYNTHESIS OF DYES, DYE INTERMEDIATES AND TEXTILE AUXILIARIES

The department of chemistry has developed collaboration with Sandal Dyestuff Industries, Faisalabad (Pakistan's largest colour manufacturing industry) to initiate the Colour Chemistry research. We have improved the yield of Reactive Blue 13, Reactive Red C4BL, Pigment yellow 12 and Black B5 textile dyes. Furthermore we developed technology for Pigment Red 170, which was not locally manufactured previously. Now we are capable to produce this product locally with international quality and standards. The technology for the production of Syntan (Tanning agent) has also been developed. This product is used for the strengthening, softening and bleaching of leather (Skin). This chemical is equivalent to Baysyntan of BASF Germany. Furthermore this product is totally imported from abroad now a days. Sandal Dyestuff will start the production of this chemical in 2006 due to arrangements of glass lined production plants. These achievements have been successfully employed in industry. In response of above achievements and good collaborative work, the industry has agreed to renovate the Colour Chemistry Laboratory for the research on colours in the department. Furthermore, they also agreed to do project with 80% share of HEC. These achievements will not only boost our economy in present scenario but also prove that our technologists/researchers can develop the technologies of international standards in our own country. Efforts are underway for the production and improvements of imported chemicals in Pakistan.

6. BIOSORPTION OF HEAVY METALS BY DIFFERENT BIOMATERIALS

A basic investigation into the removal of Lead ions from aqueous solution by different biosorbents including fish scales, cotton seed cake, rice bran, Neem leaves and bark and distillery sludge biomass was conducted in batch conditions. The influence of different experimental parameters such as pH, biosorbent dose, biosorbent size, initial concentrations of Lead and sorption time was evaluated at 100 rpm and 30 °C for 24h. Results indicated that different biosorbents have different efficiency for uptake of Lead in all batch experiments. Data obtained was fitted using Langmuir and Freundlich models. Distillary sludge, a waste byproduct of sugar industry was found to be excellent adsorbent when preheated for 30 minutes showing 99% removal of Lead at optimum conditions while its efficacy reduced to 84% when chemically pretreated. Investigation of lead uptake by Neem leaves and bark revealed 88% and 72%

Lead uptake from synthetic solutions. In another investigation 92% removal of Lead was attributed to $Al(OH)_3$ pretreated fish scales at optimal conditions while efficacy of rice bran was found to bound 55% of Lead which was enhanced upto 86% by pretreated rice bran.

Nickel removal was checked by acid pretreated rice bran and *Cassia fistula* biomass which revealed 65% and 100% nickel uptake respectively. Due to excellent Lead and Nickel uptake capacity all biosorbents proved to be efficient biomaterials for accumulating and recovering Lead and Nickel from aqueous as well as industrial effluents in continuous flow water treatment columns. Evaluation of physico-chemical parameters of different industries were carried out using standard methods. For improvement of physico-chemical parameters internal mass of pods of *Cassia fistula* was used, which considerably reduced almost all pollution parameters to acceptable limits. All these achievements proved to be successfully implemented in the treatment plants of all industries situated in our country for safe and prosperous environment.

7. INSECTICIDE RESIDUES IN FOODS

The residues of insecticides in food materials are of concern to everyone everwhere. Because of the inherent toxicity and ubiquity, the residues of these chemicals have received a good deal of attention throughout the world. Consequently many countries have introduced legislation for protecting the consumers health from the hazards of insecticides. Unfortunately no law has been enforced in Pakistan, which may arouse the public awareness and hence protect the people and the livestock. The possible reason seems to be of the non-availability of scientific data in this country. The present work was, therefore, started for the creation of sufficient scientific data to form the basis for making suggestions for the remedial measures to be adopted against the use of insecticides.

Insecticides such as BHC, DDVP, DDT, dieldrin, endrin, and malathion, were tested on various vegetable crops namely spinach *(Spinacea oleracoae),* methi *(Menthaviradis),* turnip *(Brassica rapa),* carrots *(Daucus carota),* radish *(Raphanus sativus),* cucumber *(Cacumis sativus*) brinjal *(Solatium melonegena),* pea *(Pisum sativum)* and okra *(Ablemoschus osculentus).* The experiments were conducted under two distinct phases concerning the plant materials and animals respectively. Various vegetables were grown and sprayed with the insecticide to be tested. Samples of the vegetable were collected daily and analyzed for the residues. The results indicated the persistence of melathion to be the least (8 days) and that of BHC to be the highest (16 days). Samples of various vegetables were also collected randomly from various markets and fields in and around Faisalabad. The analsysis revealed that endrin was being used indiscriminately and injudiciously. The highest amount was found in cucumber (669.4ug/100g). The maximum consumption of the insecticide calculated from this result came out to be 28.69 ug per kg body weight per person per day. This amount is very high and much alarming as compared to 0.2 ug per kg body weight as recommended by FAO.

The experiments on animals (albino rats) revealed that all the insecticides adversely affected the growth rates and accumulated in the livers of the animals. Other body organs like adrenals, heart, kidneys, liver, lungs and spleen were adversely affected by the administration of the insecticides. Outcome of the studies has established the need for the enforcement of basic pesticide legislation, as the official control procedures at the national level are essential first step in promoting the safe and effective use of these chemicals. Based on the results of the present study, two main recommendations are being suggested:

Sufficient number of pesticide research laboratories should be established in government institutions. Universities and industrial concerns for maintaining a safe food supply.

The government to control importation, sale, labeling, packing and availability of pesticides vital to ensure both effective use and safety of the people should constitute a committee or organization.

8. QUALITY EVALUATION OF FOOD STUFF AND DRINKING WATER

Residual nickel contents of ten different brands of vegetable ghee were determined spectrophotometrically. Out of these, three brands were found to contain nickel in amounts greater than the permissible limit of 2 micro g/l0gm recommended by WHO. Moreover, other quality parameters like acid value, iodine value, saponification value, peroxide value and melting points of most of the brands were found to be not in accordance with the approved quality control standards of Ghee Corporation of Pakistan.

Nine newly evolved wheat varieties obtained from Ayub Agricultural Research Institute, Faisalabad were analyzed for moisture, protein, carbohydrates, ash and mineral contents to assess their nutritive value. Food value with respect to the said constituents was in following order in the various varieties: V-81608, V-81612, V-79436, D-79736, V-81068, V-79353, V-1262, V-79388, Pak-81, D-79717; Pak-81 was used as a standard variety. In order to evaluate the quality of drinking water of Faisalabad city area with respect to the toxicity of Na, K, Ca, *Mg,* Cu and Zn, water samples from some localities were analyzed quantitatively. High sodium toxicity was observed in Behari Colony, Noorpur and Akbarabad, while mild sodium and magnesium toxicities were found in all over Faisalabad city area. High zinc and high copper contents were noticed in D-Type and Khalidabad residential areas respectively. Nitrate and nitrite contents were determined from 150 samples of drinking water from different localities of Faisalabad city. Nitrates were in the range 0 - 73.07 g/ml and nitrites from 0 - 3.94 g/ml. About 14% of the samples crossed the safe limits for nitrates while none of the samples crossed the safe limits for nitrites.

9. CLINICO-MEDICAL BIOCHEMISTRY & DEVELOPMENT OF DIAGNOSTIC KITS

The research group working in this area has developed and standardized indigenous enzyme conjugates for ELISA based diagnosis, diagnostic kits for study of protein glycation in diabetics and glucose estimation kit. This group has completed studies for the isolation, production and characterization of enzymes for ultimate use in these diagnostic kits. The kits for protein glycation, ELISA based diagnosis and glucose estimation are ready to be commercialized after investigating their economic feasibilities. The work is now focused on hyperproduction of enzymes, through chemical mutagenesis and fermentation. The enzymes thus produced will be used in the development of immunological/ enzyme based diagnostic kits for diagnosis of human and animal diseases on commercial scale.

The studies have also been carried out on diabetic complications, protein glycation in diabetics and relationship between diabetes and infectious diseases like hepatitis B and C. Investigations have also been carried out on biochemistry, hematology and enzyme profiles of chronic hepatitis B and C patients. Molecular and serological epidemiological studies were conducted to study the prevalence of Hepatitis and blood cancer in Faisalabad Region. An alarming high prevalence of Hepatitis C was observed in otherwise healthy individuals and blood donors. Success of combination therapy with ribavirin and interferon–α for chronic hepatitis C was investigated. The results revealed that the treatment has a reasonably good success rate with lapses in a few cases. Antifungal and antimicrobial activities of gemotherapeutically treated Fennel and Neem were determined and it was found that gemmofennel and gemmoneem were more potent as compared to native Fennel and Neem.

10. INDUSTRIAL BIOTECHNOLOGY AND MICROBIAL ENZYMES

The optimum conditions to culture *Trichoderma harzianum* on rice husk, rice straw and rice polishing were determined for the production of fungal mycelial biomass protein in Liquid state fermentation (LSF) of rice straw, rice husk and rice polishing. Under optimum conditions, the fungal organism resulted increase in protein level of the biomass 3.5 to 12.5, 7.3 to 12.00 and 11.25 to 19.05 g/100, respectively. The mycelial protein obtained from rice polishing was found to be reasonably good quality limiting only in lysine and methionine amino acids. The mycelial protein when supplemented with lysine (0.5%) and

methionine (0.1%) was found to be superior to casein diet. Based upon these observations the fungal biomass protein obtained from rice polishing fermentation supplemented with 0.5% lysine and 0.1% methionine amino acids is recommended as a suitable protein concentrate for poultry and livestock. Production process was developed and standardized for the production of mycotoxin and Single cell protein (SCP) through fermentation of rice polishing and corn stover with *Arachniotus* sp. The mycotoxins have shown antagonistic behavior against pathogen fungus *Fusarium oxysporium.* Mycotoxins were isolated and characterized for use on agricultural crops to replace the use of insecticides. The SCP was used in poultry rations in place of conventional protein concentrates and was found to be of good quality as compared to costly plant concentrates and animal protein sources used in poultry rations. A solid state fermentation (SSF) process has also been developed for SCP production by *Neurospora sitophila* using banana fruit wastes. The SCP product was found to be of high quality with pleasant almond like smell, flavour and taste and it was free of toxins.

Fermentation processes for lysine in the broth during fermentation of rice polishing and distillery sludge from sugarcane industry with *Trichoderma harzianum, Brevibacterium flavum* and *Arachniotus* sp. were optimized. L-Glutomic acid was produced in molasses medium by *Brevibacterium flavum.* It was then converted to sodium glutamate, the flavouring agent extensively used in food industry. Edible acid including citric acid and lactic acid are very important tools in food and many other industries. Lactic acid was produced by growing *Lactobacillus acidophilus* in milk whey based fermentation medium. The L-lactic acid thus produced was fed to broiler chicks to study its effect on their immune system. Very exciting results in terms of improved immunity were observed.

Microbial enzymes have extensive application in different biotechnological and industrial processes. The industrial biotechnology group has developed fermentation processes for the production of cellulases, amylases, pectinases, xylanases and ligninases. Cellulases have been produced through LSF and SSF of rice straw corn stover, citrus peel and banana wastes by *Arachniotus sp*. and *Neurospora sitophila*. The enzymes have been purified and characterized for their application in industrial processes. Cellulase produced by *Arachniotus sp.* was used for stone washing of denim jeans and its efficiency favourably compared to commercially available imported cellulases. Alpha-amylase and glucoamylase were produced by *Aspergillus niger* and *Bacillus subtilis* using waste breed, waste potato and other agro-industrial wastes. The enzymes have been purified and characterized through kinetic and thermodynamic studies to access their potential as industrial biocatalysts in starch processing and desizing of cotton fabrics.

Production processes for pectinase and xylanase by *Trichodema harzianum* and *Chaetomium thermophile* have also been developed and optimized respectively. The xylanase was purified to elctrophoretic homogeneity, characterized and applied for biopulping of commercial pulps. The xylanase showed an excellent biopulping potential for application in paper and pulp industry. In another study ligninases like lignin peroxidase and laccase were produced by *Phanerochaete chrysoporium* and *Pleurotus ostreatus*. The *P. chrysosporium* lignin peroxidase was purified, characterized and immobilized on hydrophobic sol gels. The immobilized lignin peroxidase showed activity and thermostability characteristics suggesting its application for biodegradation of toxic chemical pollutants and textile dyestuffs. Studies are underway for development of an economic indigenous technology for biodegradation of textile dyestuff and bioremediation of industrial effluents.

11. IMMOBILIZATION OF ENZYMES

The term "immobilized enzymes" indicates enzymes, which are physically or chemically attached to solid supports. Enzymes are highly efficient catalysts, commonly accelerating chemical reactions one million to one trillion times the speed they would occur in the absence of the enzymes. They accomplish this under mild physiological or life supporting conditions (room temperature, atmospheric pressure, mild acidity or alkalinity, etc.), thus avoiding large energy wastes and operating hazards frequently associated with the

use of presently popular industrial catalysts. Enzymes are highly specific catalysts. They are involved in all the chemical reactions necessary to sustain the living cell and hence control a variety of reactions. In spite of all these advantages, enzymes are not chosen as catalysts for many household or industrial processes. The main problems are: (i) their high costs of production; (ii) difficulties in their recovery from reaction products for eventual recycling; (iii) unstability toward temperature, pH, storage, etc., and (iv) biodegradability. The preparation of synthetic enzymes and improved separation technique of affinity chromatography may lower their costs of production. The enzymes can be reused if they are firmly fixed on suitable supports. The immobilization may improve their stability toward storage, temperature, pH, as well as resistance to microbial attack and autolysis.

Cellulase was immobilized by physical method using activated charcoal and glass as support. Various agricultural wastes like bagasse, rice husk, saw dust and waste paper were employed as substrate for the production of glucose using immobilized cellulase. Maximum yield of glucose up to 10% on dry weight basis was obtained from bagasse. Delignification of the substrate was affected by treatment with 4% sodium hydroxide before hydrolysis. Cellulase was also immobilized on glass chemically by using bifunctional reagent. When compared with physically immobilized cellulase, the chemically immobilized cellulase was found to be more active in converting CMC to glucose. Nitrophenylazide derivatives of glass and cellulase have also been prepared. These activated matrix materials are stable for months when stored at room temperature in the dark. Other industrially important enzymes like ligninases have also been immobilized in hydrophobic xerogels and immobilization enhanced activity and thermostability of lignin peroxidase.

L-Asnase (antilcukemic agent) has been immobilized with the matrix materials by a simple photochemical method under very mild reaction conditions. This new photo-chemical technology has a wide range of application in agriculture, industry, medicine, environmental control and analytical work. The immobilized L-Asnase has a high specific activity. Various parameters were studied to see the effect of temperature, drying, salt concentration, proteolytic enzymes and plasma to see if it can be used for *in vivo* experiments. The immobilized L-Asparaginase has been found to be quite stable and active to the above-mentioned parameters as compared with the free enzyme.

12. MOLECULAR BIOCHEMISTRY AND GENE COLONING

Xylanases and cellulases are industrially important enzymes obtained from different microbial strains. Molecular cloning techniques have advantages over traditional technologies for enhanced production of these enzymes. The genes for cellulases and xylanases have been isolated from *Trichoderma harzianum* and *Chaetomium thermophile.* The genes were successfully expressed in heterologus hosts. A regulatory gene *crel* has also been isolated and cloned for gene regulation studies in future.

13. PURIFICATION AND CHARACTERIZATION OF BIOACTIVE PEPTIDES

Antifungal proteins and peptides have important place in research. About three quarters of the world population rely mainly on plants and plant extracts for health care. We have investigated some medicinal plants (*Hygrophila auriculata, Abrus precatorius, Moringa oleifera, Withania somnifera, Croton tiglium, Solanum nigrum* and *Psoralae corylifolia*) against pathogenic fungal strains *Aspergillus tamarii, Rhizopus solani, Mucor mucedo* and *Aspergillus niger* and bacterial stains of *Streptococcus, Bacillus megaterium, Escherichia coli* and *Pasturella multocida*. The leaves and seeds of the plants were extracted in different buffers followed by ammonium sulphate precipitation, dialysis, gel filtration chromatography and SDS. Antimicrobial activities of the extracts were determined by disc diffusion assay method, before and after the gel filtration. Significant results were obtained against physiologically important fungal and bacterial strains. The positive activity reveals the importance of these medicinal plants used in the traditional medicine for further analysis.

ZOOLOGY & FISHERIES

1. FRESH WATER FISHERIES

1.1. Fish taxonomy

Work on the collection and study of fish fauna of the Punjab was initiated in 1976. The principal purpose of this research was to collect and identify the fishes of the Punjab and to have the collected specimens in the Museum's cellars of the Zoology Department for reference by future workers for confirming their identification. The collection period extended from July 1976 to July 1979. The fishes were collected from landing centres situated along the various river sides running through Punjab. During the period of study 72 species of fresh water fish were collected and described. Further this study also purported to record the morphometric data in respect of each of the fish collected from various water bodies in Punjab and to subject the taxonomic characters to numerical treatment with a view of assessing the soundness of the existing classification system at the specific level. The morphometric measurements in respect of 27 parameters of the fish body have been induced under each species and these, being quite stable and permanent for a species, are being proposed for the first time as useful taxonomic characters.

Tables of comparison of characters have been prepared to compute percentage similarity among various species of each genus and, there from, phonograms have been constructed to show the level of morphological relationship among them. The work has confirmed the status of various species taxa established by previous taxonomists. However, the desirability of splitting the genus *Labeo* into two sub-genera has been indicated.

1.2. Formulation of fish feed and its effect on fish growth.

Twenty four pelleted formulae consisting of meat meal, blood meal, fish meal, bone meal, cotton seed cake, rice husk, rice polishing, salts, multivitamins, wheat bran, wheat flour and guar gum were prepared with a hand machine. The pellets which were 5 mm in size were dried at 50°C and stored in plastic bags. Physical tests were performed to determine the stability of pellets in still water, running water and by dip method. The wheat flour and other ingredients in the formalao improved the stability to the extent that all the pellets produced could be easily fed to *Lubeo rohita* which is a slow feeder. There was no loss of nutrients before they could be consumed by the fish.

Proximate analysis of 24 formulae of pelleted feed for carps were performed to determine the moisture content, total ash, protein, fat, crude fibre and carbohydrates. The gross calorific value/100 gms of each feed was calculated. The biological experiments showed that supplementary food rich in protein (about 3%) was effective to increase the growth rate of *Labeo rohita.* The increase per fortnight in body weight and fork length was statistically significant. The conversion ratio for *Labeo rohita* for the food given (30% protein) was 1:2.66.

1.3. Effect of artificial feed, fertilizer and manure on the growth of carps.

The growth of three species of fish viz; Cat/a cat/a, *Labeo rohita* and *Cirrhina mrigala* in three ponds (1. with no additives i.e., control, 2. with artificial feeding and fertilizing; and 3. with artificial feeding, fertilizing and manuring) has been studied by taking into consideration 3 body parameters i.e., body weight, fork length and total length. The study revealed that artificial feeding-cum-fertilizing was quite effective in increasing the weight of fishes, whereas the addition of manure caused further increase in their weight. The increase in fork length of the three fish species was significant in fertilized pond while manuring caused further increase in the fork length of these species. It was also noted that changes in fork length has no significant relation with variation in body weight especially in case of *Cirrhina mrigala.* It was

further noted that all the three species gained more body length in fertilized as well as manured ponds.

The condition factor for all three fish species in different ponds was computed and did not show much variation between control and treated ponds, though, of course, the value of K in respect of *l,ahco rohita* did not show more variation within its various ponds. It has also boon noted that both the treated ponds showed higher values of K as compared to control pond during the first 9 months of study and afterwards the trend was almost similar.

1.4. Pond fertilization with N.P.K.

The growth performance; of major carps viz., *Catia catia, Laboo rohita, Cirrhina mriffala* and common carp, *Cyprinus carpio* has boon described. The fishes were kept for a period of 7 months in two katcha ponds, one was fertilized with N.P.K. (20 : 20 : 5) and the other served as a control without additives. Length-weight relationship and analysis of variance was also computed. Initial stocking for the control and treated ponds were 7.55 Kg and 8.43 Kg, respectively. At the termination of the experiment the total production per acre per year of control and treated ponds remained 585.74 Kg and 1400.00 Kg, respectively.

1.5. Artificial feeding of the fish

The experiment to study the effect of artificial feed on the growth of major carps viz., *Catia catia, Labeo rohita* and *Cirrhina mrigala* was conducted for one year. Two ponds were selected (treated and control). Both these ponds were stocked with 56 fishes in each pond in the ratio of 25:60:15 (14 *Catia catia,* 34 *Labeo rohita* and 8 *Cirrhina mrigala).* Ration (30.73X protein) was supplied to the treated fish at the rate of 2% wet body weight and reduced to IX daily. Every month, the increase in body weight, fork length and total length of fish were recorded. After one year the data was computed, which showed that the feed given had significant effect on weight gain, increase in fork length and total length. The total production per year per acre was computed to be 431.21 Kg and 1167.28 Kg for the control and treated ponds, respectively. It was also noted that the growth of fishes was directly related to the temperature and maximum growth was observed at 30 °C to 32 °C.

1.6. Effect of fertilizer (S.S.P.) plus artificial feed on the growth of major carps.

The experiment was conducted for the period of nine months to study the effect of fertilizer (single super phosphate) plus artificial feed on the growth rate of three major carps, viz., *Catia catia, Labeo rohita* and *Cirrhina mrigala.*

The computations pertaining to biomass revealed that in case of *Catia catia* there was 2.82 fold, in case of *Labeo rohita* 2.70 fold, and in *Cirrhina mrigala* 2.08 fold increase of biomass in treated pond as compared to that of to control on termination of the experiment. The total production per acre per year was computed to be 624.14 Kg and 1573.66 Kg for the control and treated ponds, respectively.

2. BIOLOGY AND CONTROL OF VERTEBRATE PESTS

2.1. Rats and mice

In Pakistan, rats and mice exert a serious limitation on agricultural production by causing chronic losses to all major food crops. Bulk of the plant protection measures in Pakistan are being practised in the absence of adequate data on the biology and behaviour of these pests. Neither the cropping pattern of the areas to be ridden of rats nor the environmental hazards inherent in unguided use of dangerous toxicants are being given due consideration. The major objective of the studies on rats and mice during the last decade had been to know the pests in their actual ecological cultural setting and to develop

control methods through integerating biological information about the pests with the cultural and ecological peculiarities of a given place.

This report briefly reviews some aspects of the biology, behaviour, ecology and control of four major rodent pests of the irrigated farmlands of the Punjab.

The females of *Tatera indica, Bandicota bengalensis* and *Rattus moltada* remained reproductively quiescent during December-January, whereas the females of *Mus musculus* bred almost round the year. The annual prevalence of pregnancy in *T. indica* and *B. bengalensis* varied widely. The average annual prevalence of pregnancy in T. *indica, B. bengalensis, R. meltada* and *M. musculus* was 33.60%, 47.36%, 54.12% and 51.06%, respectively. Pregnancy peaks were recorded in April-May for all the four species. A second pregnancy peak was preceptible in October-November for *T. indica* and *M. musculus,* and in August-September for *R. meltada.*

The embryonic litter size in *T. indica* was 6.76 f .344(39) and for *If. bcngnlcnsis, li. mclL'ida* and A7. *musculus* it was 7.40 *j_* .512(27), 5.33 ± .287(17), respectively. *M.musculus* tended to produce larger litters during December through May, whereas the other throe species gone-rally produced larger litters in February-May. The malorn?-il body weight and the number of embryos were significantly related in *T. indica, II. mclL.idn* and *H.muKculuR.*

The annual rate of production i.e. the number of young produced por female per year varied greatly in *T. indica* and *B. bvngalcnsis* as compared to that of *R. meltada* and *M. musculus.* The average annual rate of production for T. *indica, B. bengalensis, li. moltada* and *M.musculus* was 47.32, 75.18, 65.78 and 76.63, respectively.

The average annual trap success (relative density) in sugarcane crop was 11.2%. The trap success showed two peaks, one in December-January and the other in August-September. In the combined annual samples the order of dominance was *R.. meltadu, M. musculus, B. bengalesis* and T. *indica.* The average trap success for the wheat crop was 9.1%. Peak abundance was recorded in February-March. The order of dominance of the various species in this crop was *B. bengalensis, T. indica, M.musculus* and *li. meltada.* In leguminous fodder crops the average trap success was 8.4%. Trap success peak occurred in June-July. The order of dominance was *R. meltada, B. bengalesis* and *M.musculus, T. indica* was not recorded from these crops. In fodder crops belonging to the family Gramineae, the average trap success was 12.3%. Highest abundance was recorded in June-July. The order of dominance was *R. meltada, B. bengalensis, M.musculus* and *T. indica.* In miscellaneous subhabitats (minor crops and alkaline wastes) the average trap success was 6.3%. Peak abundance possibly occurred in August-September and the order of dominance was *T. indica, M. musculus, B. bengalensis and*

R. meltada. The seasonal and subhabitat-wise variations in the trap success were not only related to the rates of recruitment of these rodent populations but also to the temporal changes in the area of various subhabitats.

Rat and mice infestation of the wheat crop indicated low rodent density in the wheat fields during sowing and early tillering stages. During the late tillering and booting stages their populations increased by several folds. But, density peak was not recorded earlier than the flowering stage. Past this peak, the population declined rapidly and by the harvesting season rodent density was very low. During the sowing and tillering stages only *T. indica* and *M. musculus* were present during the booting, flowering *and* early maturation periods all the four species including *It. meltada* and *B. bongnlcnsis* were present; and during the late maturation and pro-harvesting period only *I), bongalonsis* was present.

Apart from providing ample shade and space, the wheat fields have a surfiet of nutritious food. The rodents exploit these resources intensively and channelize the acquired energy for attaining accelerated

rates of reproduction. Efforts should, therefore, be made to deny these resources to the rats and mice and they must be annihilated before they get a chance to establish themselves in the wheatlands. For this they must be intercepted in these cropped or even non-cropped areas from where they emigrate.

Sugarcane plays an important role in providing proper microenvironment and shelter to rodents in late fall and early winter. The rodent populations of the cane crop had a density peak in October. Past October, their populations began declining and T. *indica* was not recorded after this month in this crop. By March two more species, namely, *R, meltada* and *M. musculus* also vanished; *B. bengalensis,* being the only species left in the cane fields.

The rodents damaged the cane crop mainly during and before October. Sustained baiting of the cane crop from October through March had not favourable effect on the canes of the treatment fields. This indicated that to inhibit rodent depredations on the cane crop, plant protection measures should be taken earlier than October.

Sustained baiting of the wheat crop alone failed to provide sufficient protection against rodent depredations. But, sustained baiting of sugarcane fields for three weeks in December, leguminous fodder crops for six weeks in January-February, and the wheat crop for eleven weeks in February-April in conjunction with intermittent treatment of the rat burrows with zinc phosphide bait provided complete protection to the wheat crop from rodent attack. Inhibition of rodent populations through sustained baiting is a promising strategy for small farmlands provided the protection measures are not confined to a single crop.

Studies on reproduction, infestation and damage patterns of the rodent pests, response of these pest populations to poison baiting and the information about the ecological niche of the pests in the agro-ecosystem lead to the development of a strategy for inhibiting their populations in the central Punjab. The salient features of this strategy are:-

a. For sustained baiting chronic poisons such as fumarin, racumin etc. should be used. The various crop should be treated with this poison according to this schedule sugarcane from September to November, leguminous fodder crop (lucern, shaftal and berseem) and minor crops (pulses, vognl.-iblos ct.a) in April nnd May. b. For baiting Lho rodent burrows zinc phosphide may bo used. Kodont burrows of nearly alkaline and sandy tracts should be treated in October, of the cane fields soon after the crop is harvested, of the wheat field once during the tillering-booting stage and again during the flowering stage. c. Control measures should cover large areas. Larger the protected area more permanent shall be the effect of control efforts. Preferably, the area to be protected should be bounded by such physical barriers as irrigated canals, highways, railroads, alkaline tracts etc.

2.2. House sparrow

The House Sparrow is a hangeron of man in Pakistan. It infests his buildings for nesting and breeding and obtains its nourishment from the cereal and other food crops produced by man. On account of its flock feeding behaviour and formation of large communal roosts, it often concentrates in large numbers in small areas for feeding and foraging. It is then the sparrow causes heavy damage to the cereal and other food crops of a particular area. The situation is further exasperated by the migratory forms of the sparrows who join the local population in inflicting heavy damage to the ripening crops falling in their migratory path. To a luckless farmer this loss may be a real catastrophe, but on a regional or national scale it may prove to be very small in relation to the overall production of a region or country. So impressed by the local depredations of the sparrow one must not make a headlong rush into a costly and massive control. Rather the actual impact of the sparrow depredation should be assessed from the overall loss figures rather than making unjustified extrapolations from the data of those areas which traditionally receive heavy sparrow damage.

The House Sparrow *{Passer domesticiis)* spends the night in communal roosts which are mostly located in trees and shrubs with dense and thorny crowns. The sparrows can easily be killed in these nocturnal assemblages. The sparrows began entering the roost 35 to 85 minutes before the sunset. The rate of arrival at the roosts generally peaked 5 to 40 minutes before sunset and terminated 1 to 18 minutes before sunset. The number of sparrows in the roosts varied in space and time; the range being 106 to 8278. The duration of arrival to the roosts was generally longer (luring the brooding season,

The sparrows began leaving the roosts a few minutes before •sunrise except during the winter season when they departed from the roosts a couple of minutes after sunrise. The process of departure was completed in 15 to 50 minutes time. Peak departure was recorded within 10 to 15 minutes of the first departure.

During the colder months of the winter at least some of the roosts were entirely abandoned. The roost size was the largest in July.

It was estimated that an average village house had 7.22 and an average village room had 1.54 sparrow nests in them, while per house and per room nest density in urban situations was respectively 3.23 and 0.37. Thatched and beamed roofs tended to harbour large number of sparrow nests, only 10% of the nests were located outside building roofs. The bird nested in outdoor situation only after available nesting niches in indoor situation had been filled.

Eggs and nestlings were recorded from March through September. The average clutch size was 3.0 and the average brood size was 2.80. The fledglings began to be recruited to the population by April.

For the nestlings, both plant and animal food were consumed with almost equal frequency. Insects among the animal foods and wheat among the plant foods were the staple of the diet of the nestlints. As compared to the nestling, the older sparrows depended for their nutriment mainly on plant seeds in which wheat grains, seeds of fodder crops, and weed plants were prominent.

The rythm of the foraging activities of the House Sparrow in the cultivations was studied. During the ripening season of the rice crops, the sparrows attacked the crop with the greatest intensity between 7:30 a.m. and 10 a.m., and 12 noon and 4:30 p.m. Outside these periods the sparrows were scarce in the fields. They attacked ripening wheat in late March and early April. Intensive attacked were observed between 6:15 a.m. and 10:30 a.m., 'and 4 .p.m. and 6:45 p.m. The sparrows also foraged in large numbers in the recently harvested wheat fields, on and around the piles of the harvested plants, and in leguminous fodder crops.

Beside the House Sparrow (Passer *domesticus indicus),* two more species of sparrows were present in the study area. These were *Passer pyrrhonotus* and *Passer hispeniolensis.* The former joined the House Sparrow's feeding flocks in the vicinity of riverine and marshy habitats, whereas the individuals of the latter species were found mixed in House Sparrow flocks in April and September.

2.3. Rose-ringed parakeet

The Rose-ringed Parakeet *(Psittacula krameri)* is widely distributed and is one of the most destructive birds of agricultural and horticulture in Pakistan. During the day time it raids and depredates ripening crops of millet, maize, sunflower, wheat and orchard crops and for the nocturnal rest it assembles in communal roosts comprising of grooves of tall trees found in canal forest plantations, cantonments, civil lines and in similar well wooded areas.

A series of studies aimed at knowing the roosting habits, nesting niche, breeding habits, food, and

general behaviour of the Rose-ringed Parakeet *(Psittacula krameri)* in the cutivations of the central Punjab were carried out to know its ecological niche and weak links in its life so that the same could be exploited to inhibit its population.

The parakeet spent the night in groves of tall trees found in civil lines and cantonment areas, along irrigation canals, and in forest populations. The parakeet started leveling the roosts a little before sunrise for foraging and feeding in flocks of varying sizes. The rate of departure generally peaked at sunrise or a little earlier. After two or three hours the departure rate was minimal. The parakeet began to return to the roost shortly after the morning departures and arrival peaks were recorded 1 to 1.5 hours after sunrise. A second departure peak was recorded in the afternoon and a second arrival peak 15 to 50 minutes before sunset.

The size of the departing flocks ranged from 1 to 17 with a mean of 2.325. The departing flocks in January and October tended to be larger than those of the other months. The arriving flocks comprised of 1 to 40 birds and the mean flock size was 2.075; the flock size being the largest in January and October.

A variety of the subhabitats in the cultivations were surveyed to know the nesting density of the parakeet. The survey revealed that .40, 17.32, 18.95, 15.48, 5.90, and 0.72 parakeet nest cavities were present in each acre of the cropland, road-side plantation, canal-side plantation, city-road avenues, city gardens and parks, and village trees and groves, respectively. The older trees tended to offer more nesting sites than the younger ones. *Acacia arabica, Albizzia, Tamarix Terminalia, Salmalia,* and *Erythrina* carried larger number of nests cavities than other kinds of trees.

The parakeet showed interest in nest cavities as early as in December. A lot of agonistic behaviour was elicited by the breeding pairs for the occupation and defence of the nest cavities. The female played a leading role in the selection, occupation and defence of the nest. A number of cavity nesting birds and squirrel competed with the parakeet for the nesting cavities.

The parakeet copulated and laid eggs in March. Hatching was observed in April. Fledglings were recorded in late April and May. The females were the chief actors in defending the nests during the incubation and breeding periods. The male were busy in procuring food for the brooding females and the nestlings. They fed the female through regurgitation. The females fed the young in turn. The females also participated in defending the nests against intruders, provided they happended to be around.

The parakeets utilized a large variety of plant food. But, they heavily depended on maize, guava, sunflower during the fall, maize, *Brassica,* guava, *Zizyphus,* and *Albizzia* during the spring and maize, guava, and sunflower during the summer season.

Of the various suhabitats, the croplands offered the greatest variety and abundance of food to the parakeet. The proximity of the canal-side and road-side plantations to the croplands and the presence of trees in the croplands in the croplands helped the parakeet in exploiting the rich food resources of the croplands. During the spring season the parakeet ate fruits and seeds of plants which were of no economic value to man. During other seasons, however they heavily depended on cultivated crops and orchard fruits.

The parakeet attacked maize and sunflower crops severely. Crops of the plants located near their nocturnal roosts received severe damage.

From the above studies it was concluded that nesting cavities played an important role in keeping the parakeet population below the carrying capacity of the cultivations. The parakeet population could be managed by manuplating the nesting silo.

3. ENEMIES OF FARMLAND PESTS

3.1. Owls

The owls arc the most perfect known rat-catching devices. Their superb hearing enables them to mark down a mouse rusting leaves in a total darkness. Several species of owls hunt over the cultivations of the central Punjab in fairly good numbers. Predilection of the owls for rats and mice is well known. As such they play an important role in controlling the population of these important pests of agriculture. Consequent upon this a number of studies have been devoted to the food habits of the owls.

Pellets of four species of owls, collected from different districts of the Punjab were analysed to know their food habits. Eighty-eight to 100% of the pellets contained remanents of small mammals, particularly those of the rats and mice which degrade and destroy agricultural crops. Insects were consumed intensively; their frequency of occurrence in the pellets varied from 73% to 80%. Birds and frogs were also consumed but much less frequently. It was concluded that rats and mice were the main items of the diet of owls.

An examination of the culticular patterns of the scales of the hairs found in the pellets of the Spotted owlet revealed the presence of 10 species of small mammals of which rats and mice were the staple items. Remanents of insects in the pellets indicated consumption of members of eight orders of insects among which coleoptrans and lepidopterans were predominant. The insects predominated in the spring and summer diet and small mammals in the fall and winter diet.

3.2. Mammalian predators

Scats of the Asiatic jackal, desert fox, and jungal cat collected from cultivated areas of the Punjab, were examined for the remanents of vertebrates preys only. The diet of the jackal comprised mainly of rodents (81%) and birds (16%). The average number of rodents per scat was 1.75 f.129 (N=110). *R. bongalensis* was the most intensively utilized rat species among the rodents. Remanents of juveniles and old specimens of the rodents were predominant in the scats of the jackal. About 81% of the scats of the fox had remains of small mammals in them, whereas amphibians and reptiles were represented in about 22% of them. Seventy percent of the scats of the jungle cat contained body remanents of small mammals. Birds, amphibians and reptiles wore represented in 10% of the scats.

3.3. Toads and frogs

Toads and frogs are well known for their predilection for insects. Because of their predation on insects they have been regarded as allies of the farmers. Their role as the inhibitors of insects populations in the paddy fields of India and Bangladesh has been recently proved. Large scale removal of frogs from the croplands of these countries for export purposes upset the ecological balance in favour of the insects. This caused an upsurge in the populations of the pesitiferous insects.

An examination of the stomach contents of the common toads, *Rufo stomaticus,* revealed that ants (57%) and beetles (24%) were the main constituents of the diet of the toad. Other constituents were, in order of importance, the armyworms and caterpillers (10%), bugs (4.9%), snails (2.6%), termites (1.1%), spiders (0.6%) crickets and grashoppers (0.6%), millipedes (0.3%) and houseflies (0.10%). A few grains of wheat (0.5%) were also present. Ants and beetles were eaten throughout the study period, whereas consumption of other food items was restricted to particular months or seasons.

Other studies revealed that occurrence of different animals n the stomachs of *Rana tigerina* was insects 67.57%, snails 16.62%, and earthworms 2.47%, while in case of *R. cyanophlyctis* it was: insects 86.38%, snails 9.19% and earthworms 0.47%. These data indicated that both the frog species were overwhelmingly insectivorous in their food habits. Another study on the food habits of the common toad

revealed that percent occurrence of various items in its stomachs was: insects 82.28%, arachnids 14.85% and earthworms 8.0%.

3.4. Snakes

Snakes belong to class Reptilia and order Ophidia. Studies have revealed that only a few species of snakes are poisonous and harmful for man while the majority of them are non-poisonous, rather they are useful as they devour rats and mice which could play havoc with our crops. That is why, those creatures have been called "the friends of the farmers." Field studies have revealed the presence of 17 snake species belonging to 13 genera in Kaiwilabad.

Significant Research Achievements since 1987-2005

The Department has made certain breakthroughs in the field of research since the time of its coming into being in 1961. A brief resume of its salient achievements is given as under:

1. All the major vertebrate pests of the croplands of Punjab have been described in detail in terms of their ecology, behaviour and demography. A strategy has been developed to inhibit rodent populations with minimum use ofrodenticides.
2. The growth patterns and food habits of all freshwater commercial fishes of the Punjab have been thoroughly investigated and described. The effect of artificial feeding, manuring, and fertilization of ponds on the growth and meat quality of fish has been studied under mono-culture and polyculture conditions.
3. Terrestrial snakes from all over Pakistan have been collected, measured and described. The ecology of these serpents is also being worked out.
4. Metals eco-toxicity of river ravi has been studied with a view to assess the ill effects of different heavy metals on the water, plankton and fish.
5. The taxonomy and ecology of spiders of farm crops and orchards have been studied. The ultimate aim of this project is to assess the effect of predatory activities of these animals on insect pests.

MATHEMATICS AND STATISTICS

1. ESTIMATION AND INFERENCE

If x and y can be observed as X = x + e and Y = y + f where e and f are errors of observations, then estimation of parameters alpha and beta in the functional relation y = alpha + beta X has been studied by many statisticians. This aspect of statistics has been reviewed in detail in an article.

A procedure to estimate mean in the presence of a single spurious observation was developed by Veale. A method was developed for more than one such observations to estimate mean value and suggest an estimator based on the whole information. In this work the estimator has been also critically studied.

A property of spearmans Rank correlation coefficient has been etuidied. If, instead of taking D i = Yi -Xi the values are *(*given + 1 or -1 according to the sign of differences, it becomes Kendall's Bank corrrelation coefficient.

2. REGRESSION ANALYSIS

A number of papers have been published on the applied side including milk yield production functions, crop production functions, econometric models, linearization of multiplicative model, selection of the best regressors by all possible regression methods with special reference to rice data in Punjab. Forward selection produre has also been used to estimate the effect of different environmental factors on first lactation yield of Sahiwal Cows.

3. EDUCATION STATISTICS

Studies were conducted to investigate the relationship of (selected factors e.g. family income, family size, educational level of family, students* age and height etc. with educational achievements viz. marks obtained in matriculation, F.Sc. and B.Sc. examinations. The relationships were mostly significant at matric level and decreased with the advancement of education. In another study the wastage of education was studied by considering the number of repeaters, and number of deserters in various classes at primarily stage level. The data were obtained through survey Humpling by personal interviews.

In another study a method of finding the reliability of n score measurement for knowing the educational achievement was developed.

Realizing the need for improvement in statistical education in Pakistan various aspects of undergraduate and postgraduate curricula in statistics have been critically reviewed and suggestions were made to improve them by including new subjects and deleting some of the existing ones. Our postgraduate students are deficient in many ways in their knowledge about mathematics, applicable in statistical learning. Suggestions for improvement and removal of deficiency in mathematics at postgraduate level have been made.

4. EXPERIMENTAL DESIGN

A procedure for estimating variance-covariance matrix in change over trial has been discussed and an application to data for animal experiment has been given. Some papers on plot/block sizes and shapes have been written using data on unformity trials as well as on experimental data. Two crops i.e. wheat

and sugarcane are covered in this work.

5. SURVEY SAMPLING

Sample size (n) for estimating proportions has been discussed and statistical tables for finding the sample sizes are given for various values of P, C.V (P), d and alpha values.

Two surveys, one studying the marriage statistics of Faisalabad District and the other providing statistics about smokers at the University of Agriculture were carried out. Also the population projections for Pakistan were made for the period 1972-2000.

6. COMPUTER AND COMPUTER PROGRAMMING

A number of articles on computer education, programming and applications in agricultural development emphasizing the needs of developing countries were written. Some computer programmes have also been developed.

PHYSICS

1. GENERATION OF HIGH INTENSITY MAGNETIC FIELD AND ITS USE IN SEED STIMULATOR

High intensity magnetic field was generated in three steps:

(1) fabricating a multilayered coil with soft iron core, (2) standardizing the air-cored coil of 3400 turns and (3) calculating the field strength of multilayered coil by using null method.

The air-cored coil was standardized by measuring the field intensities at distances of 0.01 m to 0.18 m from the centre of the coil at intervals of 0.01 m and for different current values i.e., 0.03, 0.04 and 0.08 amp. The field generated at different points on the concave pole of multilayered electromagnet was measured. The values of field at a distance of 0.01 m from different points i.e., 1, 2, 3, 4, and 5 were calculated. This magnetic field was of sufficiently high intensity and was produced without heating the coil. Such a strong field will yield better results when used in the magnetic seed treater.

2. DESIGN AND FABRICATION OF ELECTRONIC PRECISION TIMER

An electronic precision timer has been developed. It is a device used for automatic starting or stopping a machine or device at predetermined time. It is a combination of counter, detector, display, driver and crystal oscillator. A quartz crystal has been used for generating precise time control. It acts as a remote control device to operate system conveniently and with precision, which is otherwise awkward and hazardous to handle. It is very economical and most reliable regarding accuracy upto nano seconds. It could be used as a stop watch in games or to control traffic signals.

3. GENERATION OF ELECTRIC POWER FROM DIFFERENT FALLS OP FAISALABAD DISTRICT

A study was conducted to estimate the electric power that can be generated by different falls that exist in the canals of Faisalabad district. Faisalabad district has four major irrigation canals (Jhang branch, Rukh branch, Burala branch and Lower

Gugera branch) from Lower Chenab, in which there exist, some falls. The necessary information about the falls had been collected from the Canal Office, Faisalabad. By the available potential at different falls, the power by the water-power equation has been estimated, which can be used to drive the turbine and generate the electricity. In the present study the falls from which electricity can be directly generated are four, two in Rukh branch, one in Burala and one in Lower Gugera branch.

4. THE EFFECTS OF GAMMA RADIATION ON THE DEOXYRIBONUCLEIC ACID (DNA) IN THE PRESENCE AND ABSENCE OP OXYGEN

E. Coli strain has been used for the preparation of 0 x 174 phage. DNA was isolated from 0 x 174 phage by centrifugation and gamma-irradiated by Co^{60} source in 10 x citrate broth in the presence and absence of oxygen at a dose rate of 1000 rad/min. DNA was analysed by neutral succrose gradient, alkaline succrose gradient and agarose gel electrophoresis techniques. Tri. carb scintillation counter has been used for radioactive counting.

In the present study two types of base damages, alkali labile sites and thymine ring saturation products, were quantified in DNA irradiated in the phage capsid under oxic and anoxic condition. The extent of

formation of these base damages was compared with the number of single and double strand breaks produced under the same conditons. The individual inactivation efficiencies of alkali labile sites and thymine ring saturation products were determined by selectively inducing each of these damages in isolated 0 x 174 DNA by chemical means *in vitro* and determining the rate of biological inactivation of treated DNA by transfixion. Alkali labile sites and thymine ring products together are 15% to 20% of the biological inactivation of gamma-irradiated bacteriophage 0 x 174. The presence or absence of oxygen does not affect the contribution to inactivation made by alkali labile sites, but inactivation is about 2-fold higher in oxic compared with anoxic conditions. Alkali Habile site's are produced in gamma irradiated 0 x 174 at 2 to 5 fold higher rates than thymine ring products in either oxic or anoxic conditions. These observations are particularly interesting because saturation of the 5-6 double bond of the thymine ring is a relatively minor base modification compared with the complete loss of a base which occurs at an alkali labile sites.

5. DESIGN AND FABRICATION OP LEAF AREA METER WITH PHOTOCELL

Leaf Area Meter is a type of photo electric transducer. It works on the principle of transforming optical changes into electrical changes with the help of a photocell. The electrical change due to leaf or specimen under study is so calibrated that the digital read out of the Leaf Area Meter represents the area of the specimen. The resolution of the instrument is 1 cm^2. It measures the area with less than + 1% error. The rate of observtions (i.e. the no. of observation per hour) lies in the range 332 to 371. It measures the area about ten times faster than planimeter with more precision and accuracy. It is also a reliable method of measuring the area of compound, damaged and diseased leaves.

6. DESIGNING A TURBIDIMETER USING A PHOTOCELL

The light transmittance of a fluid is influenced not only by the amount of light absorbing material present in solution but also by the presence of light obstructng material such as insoluble substances in suspension, Turbidimeter is a type of phto-electric transducer. It works on the principle of transforming optical changes into electrical changes with the help of photcell. The elecltrical change due to any turbid solution or specimen under study has been so calibrated that the readout' of the digital multimeter shows the percentage transmittance. The absorbance is calculated by the formula

Absorbance =log (1/transmittance)

The statistical results have shown that the fabricated instrument (Turbidimeter) gives transmittance values as efficiently as a photometer.

7. SPECTRUM ANALYSIS OP TEMPERATURE DATA OF FAISALABAD

A search was made for knowing periodicities in the temperature data of Faisalabad for the years from 1941 to 1982 with the help of different techniques followed by T.G.J.Dyre (1976). The data was treated to test the homogeneity by calculating the coefficient of variance, i.e. 2.33% which showed that the data was homogeneous therefore, further analysis was carried out. After filtering the data using binomial filter, rank correlation coefficients were calculated to plot the correlograms for 14 lag years. To plot the spectrum, the spectral ordinates were calculated using the Parzen'B window. The correlogram did not show the shorter periods whereas the better resolution of the spectrum indicated the oscillations of shorter periods of 2.33 years and 5.6 years.

The significant peaks were selected by drawing a horizontal line at the height of 1/m from the frequency axis. Three significant peaks were obtained at frequencies 0.035714, 0.17857 and 0.42857 respectively and the time periods were calculated as 28 years, 5.6 years and 2.33 years.

The spectrum for annual means has a major portion of its variance in a relatively short frequency interval at the low frequency end, together with a peak at frequency 0.42857 cycle/year (2.33 years).

8. A TECHNIQUE FOR DESCRIBING CROP AND WEATHER RELATIONSHIPS

The crop weather relationships are essential tools for checking the effect of the weather elements on the production of the crop. This study was an attempt to see the effect of only two variables, temperature and rainfall through spectrum analysis for Faisalabad district.

The model fitted was of the linear form
Y = a+bXl +cX2
The values of a, b, c, thus found were
a = 2.093, b = 0.00012, c = - 0.0372
The equation of expected yield was
Yo = 2.093 + 0.00013 xl + 0.0372 X2

The expected yield has been found by using the values of XI and X2. The coefficient of determination has been found to be .2331 which shows that the contribution of rainfall and temperature is 23.32%.

9. DESIGN AND FABRICATION OF SOME SOLAR GADGETS

9.1. Parabolic solar concentrator

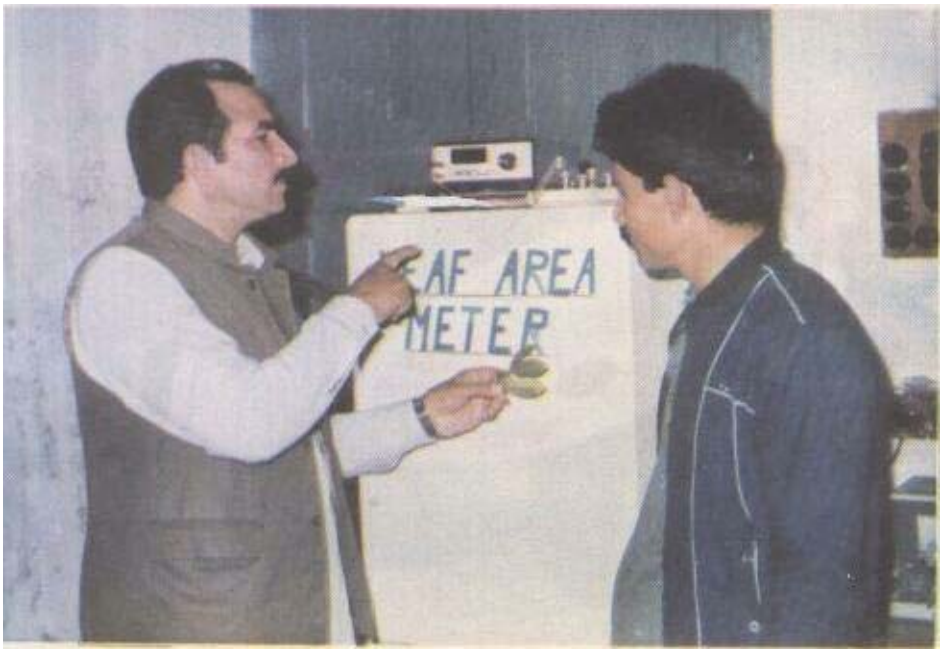
One promising device for capturing solar radiations and converting it to thermal power is parabolic solar concentrator. The parabolic reflectors focus the parallel incident radiations from the sun on to a small area and thus high temperature is produced. The solar concentrator fabricated at Department of Physics, University of Agriculture, Paisalabad was parabolic one. The indigenous material was used in its fabrication. The concentrator was tested for cooking and boiling different food items comprising mutton, beat, chicken, vegetables, daals, rice etc. *Good* results were obtained. The focussed sun radiations with this collector served as source of energy for cooking and boiling. Cooking with pressure cooker and by kettle using prevailing conventional method was found equally good.

9.2 Parabolic step reflector-type solar cooker

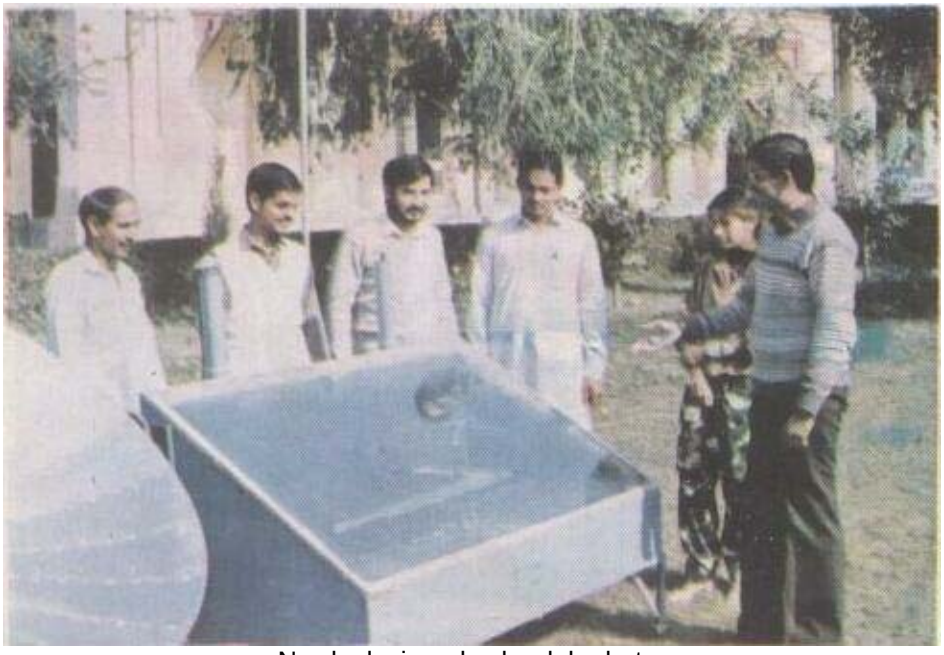
This reflector consisted of six highly polished metal strips. Each strip was 7.5 cms wide and its surface had been made reflective by nickle elelctroplating. These strips were fixed on a wooden batten frame with the help of screws in such a way that the whole asembly was in the form of a parabolic concentrator. The diameter of reflector was 0.8654 m. This concentrator was then mounted on a stand. Its working principle was quite simple. The solar radiations parallel to the axis of the concentrator were focussed at a point after reflection. Therefore heat was generated at that point. A utensil, painted with mat black paint was placed at the focus point. Pood items such as milk, potatoes, meat, vegetables, daals, etc. were cooked. The step reflector cooker has several advantages. It is lower in cost, lighter in weight and can easily be fabricated with indigenous material. Further as this reflector is made in steps with the strips of metal, it can definitely withstand more wind pressure.

Solar engine and solar concentrator developed by the Department of Physics

Solar engine and solar concentrator developed by the Department of Physics



Leaf area meter designed by the Deportment of-Physics



Newly designed solar dehydrator

9.3 Solar steam cooker

This cooker consisted of two main parts: flat plate collector and a cooking vessel. When this cooker was placed facing the sun, the steam was produced within an hour and continuously produced till it received sunshine. Cooking was done by the steam generated by this flat plate collector. The food cooked in this cooker was as delicious as cooked by the conventional ways. The hygienic conditions were fully

maintained in this cooker.

9.4. Effect of seasonal and angular variations on the performance of a flat-plate solar collector

Flat plate collector is the heart of all solar collectors. The efficiency of a flat plate collector also depends on the seasonal and angular variation. The fabricated collector was studied for two months (Jan. and July 1985). The ambient air temperature and the plate temperature both were recorded. The data so collected was statistically analysed by the analysis of variance. It was concluded that the summer season and the inclinations of 34 degree with vertex at Faisslabad were the best for getting maximum efficiency from this collector. Statistical analysis indicated that plate temperature depended 45% on ambient temperature for winter season and 76% for summer season.

9.5. Solar water heater

This Solar Water Heater consisted of two main parts; (i) a flat-plate collector and (ii) a storage drum. The flat-plate collector was connected in a closed cycle to the storage drum with flexible plastic pipes. The heater was placed facing the sun. The data was recorded for thirty days from August 10 to September 18, 1985. The collector plate temperature, ambient air temperature and the water temperature in the storage drum at two locations i.e. at the bottom and at the top were recorded during this period. The data so collected was statistically analysed with respect to time. Standard error and 95% confidence limits were calculated for the values recorded after every 15 minutes. The average maximum temperature acquired by the absorber plate, hot water in the storage drum and ambient air were 95.6°C, 50.1°C sand 38.6°C respectively during 30 days of observations.

9.6. Solar dryer

The dryer was made with indigenous material and consisted of a rectangular container insulated at its base and sides, covered with double layered transparent roof. Material to be dried was placed on perforated trays in the enclosure, which was painted with mat black paint. Solar radiations were transmitted through the roof and the heat was generated by the absorption of solar radiation on the product itself as well as on the blackened interior surfaces of the chamber. Moisture was removed from the product by maintaining the circulation of air. Different types of fruits and vegetables were dried in this dryer and its performance was found to be quite satisfactory. This dryer produces a good quality of dried products as compared to open sun drying techniques which results in inferior quality because of contamination by dirt and insects. Further this dryer reduces the drying time in comparison with conventional sun drying.

9.7. Solar water lift pump

A number of attempts have been made by scientists to utilize solar energy for water pumping. Solar pumps are based on direct conversion of solar energy to electrical energy or the utilization of the thermal energy. Solar cells are very expensive and their use for agricultural pumping purposes is probably a distant possibility.

AGRICULTURAL METEOROLOGY

ANALYSIS OF WEATHER, DATA OF FAISALABAD

The analysis of weather records of Faisalabad for twenty five years revealed that since 1962 the early winter season has been getting warmer and late winter colder with greater amount of rainfall. Maximum temperature has fallen during the winter season, whereas the spring season is getting warmer. The minimum temperature has decreased during June - October period because of increased rainfall,

whereas it has gone up during November -January. The average amount of rainfall has increased from January to November over the past twenty five years.

To establish the quantitative relationships between the weather factors and the crop performance models are also being developed in the Department.

This research report describes the research carried out in the department of Physics since 1987 to onward. The research activities in the department of Physics mainly pertain to the following fields:

1.	Solar Energy	Mainly concerned with the development of various types of Solar gadgets
2.	Electronics	Electronics for practical Purposes.
3.	Spectroscopic XRD studies	Consultancy in material analysis.
4.	Environmental pollution	Studies on Environmental Pollution

1. Solar Energy

Various types of solar gadgets such as concentrators, solar ovens, cookers, dehydrators, heaters, etc were developed and tested for domestic and industrial use. A brief over view of some of these devices are as follows:

1.1 Concentrators

Solar concentrator have great practical utility. These can be used for boiling, cooking and heating purposes. The solar concentrators focuses the solar radiation at a particular point where high temperature is achieved and can be used for desired purpose. Study about the tilt angle and the angle of rotation of the sun was also made to determine the specific orientation at which maximum in coming solar radiations can be absorbed to get high temperature.

1.2 Solar Ovens

Like concentrators, solar ovens is another useful device for boiling and cooking purposes. Department of Physics developed various types of solar ovens such as hexagonal solar oven, solar stove .etc. In solar oven solar radiations are absorbed and trapped inside the oven which increase the internal temperature of the cabinet of oven. This high heat energy accumulated in the overi is used for boiling and cooking.

1.3 Solar Cookers

A comparison study of the solar cookers developed in the department was carried. The spherical concentrator achieved maximum temperature (350°C) where as all other cookers had temperatures sufficient enough for cooking/baking/boiling. Seasonal study of these cookers revealed that these cookers were very effective and efficient in summer. With these cookers almost all sorts of commonly used edibles can be cooked at one time, in a quantity sufficient enough for a family upto eight members.

1.4 Solar Stills:

Solar stills of various designs (namely single cone solar still, double glass solar still, tent type solar still) were designed, fabricated and tested under the local climatic conditions of Faisalabad, The results obtained were very encouraging. The comparative performance study showed that the tent-type solar still was the most efficient. Seasonal study of these stills was also carried out and their performance was found to be satisfactory in all the four seasons. By utilizing the solar still, brackish water of any locality can be changed into a potable water especially in far flung areas where canal water is not available and the

underground water is saline.

1.5 Solar Dryer

A modified design of a box-type solar dryer was made. An appropriate temperature for dehydration lies in the range 70-80°C. which was maintained in the chamber of the dryer by regulated air circulation. It has me capability of dehydrating 5-10 kg food stuff. Its seasonal study showed that it could be used for dehydration round the year.

1.6 Solar Barbecue

This unit consisted of a hot-plate (griddle) situated at a suitable height heated through solar radiation reflected from a number of reflectors oriented at a particular inclination and fitted beneath the hot plate such that the reflected radiations from each reflector fall at the base of the hot plate. During the performance study of the unit, the hot plate (griddle) was filled with 01 liter water that gained a temperature upto 870°C (above ambient temperature) during the month of December 1990. It is a good device, mostly suitable for picnic spots.

2. Electronics

2.1 Digital Tachometer

This digital tachometer consists of three stages, a sensor processing unit and a display. It uses BP104 photodiode as RPM sensor; A number of holes were bored in a disc behind which a bulb was lit in such a way that the light coming out of the holes serve as a light source for photo-diode. At one time during the revolution of the disc, only one hole faces the photo diode. The light fallen on the photodiode produces an electronic pulse and is implied upto a required level by passing it through an 1C CA 3240 whose output is then fed to a voltage limiter. After this the signal was again amplified, and its frequency was compared with mono stable 555 timer and finally after integration the signal was fed to a digital display voltmeter where read out was ^'*y* token. The reading of this meter was obtained in 10's.

2.2 Digital Thermometer

In research laboratories, some critical temperature have to be measured with great I precision in several experiments. In this regard digital thermometer is a good tool for measuring the temperature. The instrument designed and fabricated in the department, proved itself a reliable tool in this regard, because it gave quick response in temperature measurements than conventionally employed mercury in glass thermometer. The digital thermometer can measure temperature with resolution of0.1°C and has a range from 1°C to 1000°C.

2.3 Digital Function Generator

The test[1] instruments are the most useful tools a technician must have in his workshop-dealing with electronic circuits, m laboratory work function generator is an essential tool, the signals generated by which are used for receiver performance testing, receiver alignment and receiver serving. For this purpose a function generator with digital readout was fabricated.

2.4 Experimental Microcomputer

Most of the earlier machines developed by man were manually controlled. The control was quite slow and many persons were required to monitor and control the industrial processes. With advancement in digital electronics, it has become possible to control the industrial processes automatically with the aid of

microprocessor. An experimental microcomputer was fabricated using z-80 microprocessor. The performance of the device was tested and the results were found satisfactory.

2.5 Digital Lux Meter

The Lux meter is suitable for many applications, especially those associated with photography and lighting systems. Proper lighting is important to prevent eye strain. A digital lux meter was fabricated which can measure the intensity of light intwo ranges, i.e. 1-2000 lux and 100-20,000 lux. Various other electronic projects such optical filters, transmission hologram are in progress.

3. Environmental Pollution

3.1 Noise Pollution

Environmental pollutions are of global concern. Noise pollution is becoming more and more serious problem day by day with the tremendous increase in traffic and rapid expansion of industries especially in big cities. The survey was conducted at various locations of Faisalabad. A computer programme was developed to analyze the recorded noise level, traffic density and temperature and correlation of noise levels with traffic density was calculated. The computer programme can estimate noise level if traffic density or time is known. It is found that the average noise level is very close to the upper permissible limit. It is imperative to adopt a comprehensive policy to control the noise and protect the general public from its harmful effects.

3.2 Pollution Particulate

Faisalabad is the one of the cities of Pakistan where situation is aggravating day by day. Rapid urbanization and industrial expansion accompanying in the population growth are the major factors responsible for environmental pollution in general and air polluting in particular. The vehicles on city roads have been increased many folds and there are a great number of industries in Faisalabad which are contributing heavily to the environmental pollution. During this study 14 samples were collected at six selected sites by using high volume air sampler. Concentration of suspended particulate matter are in the range of 72-99. ug/m^2 concentration of suspended particulate was recorded within the range 72.99 to 504.31 ug/m^2. Higher values of suspended particulates are mainly due to fugitive dust and unpaved roads.

3.3 A Qualitative Assessment of Inhaleable Particulate Matter

The constituents of suspended particulate matter (SPM) was studied. The SPM samples were collected from various regions of Jhang. The qualitative phase analysis of SPM samples showed that calcite, chimichlore Gypsum lillite quartz and tale were presented as constituents. The presence of carbonaceous material was also observed. Phase analysis of SPM was carried out by employing an automated powder x-ray diffrectometer which was equipped with a scintillation counter and pulse height analyzer.

4. XRD Studies

4.1 Identification and Quantification Of Ca-Minerals In Salt-Affected Soils

The salt affected soil samples were taken from different fields of 'Pacca Anna'' at longitude 72°-49$^{/}$ -28 $^{//}$ latitude. 31^{0}-15$^{/}$ -01$^{//}$ at 190 m height from sea level. Sample collection was made at 0-30 cm. and 30-60 cm depths from the ground surface. Organic matters were removed by using H_2O_2. The treatment included the Bicarbonate-Dithionate-Citrate procedure. Samples were centrifuged at 4000 RPM to get the supernatant.

Qualitative phase analysis of treated and untreated samples was accomplished by employing powder X-Ray diffractometer. Quantitative analysis of soil samples was performed by matrix -flushing method. The percentage of minerals were Wollastonite 19.99%, Polyhalite 15.71%, Diopside 18.50%, Ferrobustamine 6.27% Dolomite 8.22% and calcite 1.78%.

4.2 Radioactive Analysis of Wheat And Wheat Products

The object of study was the radioactive analysis of Wheat and Wheat products grown on the different soil particle and its comparison with the wheat of normal cultivated area of NIAB.

Wheat's samples was grand into flour form and made chapatti and bread. ^j^ll-1^^ radios was measured for each flour, chapatti and bread samples by using the radiation monitor type (335). Then after two days, again readings were taken and it was concluded that readings of the samples emit different radioactive gases to the environment.

4.3 Elemental Constituents of Virgin Soil of Bio Saline Research Station-N (Pakka Anna) In Different Depths

Present study was conducted to investigate the radioactive minerals in virgin soil samples. After preparation, these samples were sealed for 40 days. Concentration of 'Na' was determined by a flame photometer, while the concentration of Ca+ Mg was determined by titration method. Then soil PH & electrical conductivity (EC) were measured for each sample. The qualitative analysis was done by using X-rays diffraction techniques and radioactive compounds were identified i.e. THR; Th $(Si0_4)$ $(OH)_4$, URN; $(UO_2)_6$ $SO_4(OH)_{10}$ 12 H_2O, HAUT; $H_2(UO_2)_2$ $(PO_4)_2$ 8 H_2O etc.

EC varied from (1.70-9.13) ds/m. PH varied from (7.46-8.52). The results showed that radioactive minerals present in NIAB soil were less than the virgin soil samples. The excess quantity of radioactive minerals in soil was very toxic & dangerous for plant growth & human life.

4.4 Identification and Comparison of Industrial Clay Minerals in Chiniot and Sargodha

Study was carried out to find out the important industrial clay minerals in Sargodha and Chiniot by using X-ray diffraction. Comparative studies of different clay samples were helpful for industrial mineral research progress. The XRD criteria used to determine the purity of our samples were based on the number and intensity of diagnostic peaks. The impurities were identified in a sample; a semi quantitative estimate of their abundance was made by XRD. Samples of shale present in the Chiniot and Sargodha were collected from the field and three samples were selected from analytical work, comprising whole rock and clay mineralogy by XRD. The results show that Chiniot and Sargodha are rich in clay minerals comprising illite-smectite, illite, and chlorite along with appreciable amount of quarts, albite and some samples contained minor to moderate quantity of calcite.

The department is constantly endeavoring to strengthen its laboratories for various research activities. In this connection, laboratories were established under "JICA" and “Strengtheningof Lab. and Library Science departments" schemes. The laboratories are now well equipped with latest and sophisticated equipments. The department is also running collaborating research with various institutions like NIAB, NBGE, PINUM, PIEAS etc.

FACULTY OF ANIMAL HUSBANDRY

ANIMAL BREEDING AND GENETICS

1. Dairy Cattle Breeding

Dairy cattle breeding work has focused both on purebreds such as Sahiwal, Thari and Cholistani breeds apart from crossbreds of Holstein and Jersey with Sahiwal. The extracts from various studies are presented separately for purebred and crossbreds.

1.1. Purebreeding

1.1.1. Performance

Sahiwal breed has been the most commonly studied breed. It is more productive than other breeds in the country in terms of milk production and has been exported to other countries for upgradtaion and for development of milk and beef synthetics. Productivity has been quite variable across different farms as most of the studies were based on longitudinal data from any single herd. Earlier reported average milk yield of 2385 ±13 kg may be erroneous as later studies could not testify it. Farms vary in average lactation yield but generalization for the breed for lactation milk yield may be 1525 liters per lactation with lactation length of about 235 days. Sahiwals calve more frequently in January to March (37%) and have a calving interval of 440 days on the average. Seasonality of calving has been established in some of the studies and calving pattern is different from that of buffaloes. Severe temperatures affect the productivity. For example, one degree (F) rise in maximum temperature was associated with half a litre decline in milk production, similar decline was observed for decline in minimum temperature. Reduction in feed consumption being the major factor for the decline. Age at first calving vary across herds but population average may be around 45 months while dry period (220 days) and service period 150 days also are much higher than commercial breeds. Also, first calvers have been found to have poor reproductive performance than the cows in later parities. They are however, more persistent in producing milk than later parity cows. Milk produced in the first three months of lactation is about 42%. Seasonality of caving in Sahiwal has been explored. About 50% of cows calve in the first four months of the years (December to April) while July to October has about 20% of calvings which is clearly different from calving season of buffaloes. Commercial dairying thus needs to have combined cattle/buffalo herds to supply milk year around.

Milk recording, both for morning and evening milkings under field conditions, is difficult especially, the morning milking. Severe weather conditions making it even worse. A study explored the feasibility of estimation of lactation milk yield from once a month, morning or evening, records only. Using complete lactation records of Sahiwal cows various test plans for predicting lactation yield from partial records were compared. Recording morning and evening milkings at a monthly interval was used as a standard (AM-PM plan) for comparison. Cows on an average produced 8.6 % more milk in the morning as compared to the evening milking. Based on correlation between actual and predicted milk yield, AM plan was generally better than PM plan while correlations for alternate AM-PM plan were also comparable. Standard deviations of biases (difference between actual and predicted milk yield) were lowest for the standard AM-PM plan while highest values were observed for the alternate PM-AM plan. Proportions of predicted lactations falling within a range of ± 10 % of the actual lactations were around 70% for the four plans as compared to 78% for the standard plan. Lactation milk yield could be fairly accurately predicted from alternate AM-PM plan

as well as PM plan for use under the field conditions.

Lactation length adjustment has also been an important research area. About 70% of lactations have been found shorter than 44 weeks. Lactation curves for different lactation length classes behaved differently. About 28% were atypical (either they decreased after the initial yield or rate of increase after peak was positive). Lactation milk yield averaged 1475±651 kg for an average lactation length of 248±67 days (n=2039). Very short lactations (8-11 weeks) had average milk yield of 322±139 kg as compared to lactations with 44 weeks duration where average milk yield was 1990±474 kg. Year of calving and season of calving both significantly ($P<0.01$) affected milk yield and lactation length. Age within parity also significantly affected the two traits. Winter calvers produced more milk (1546 kg) as compared to summer calvers (1362 kg). Milk yield gradually increased towards 4^{th} and 5^{th} parity and declined thereafter while highest lactation length was for first parity cows (263 days). Phenotypic trend in milk yield was negative while lactation length showed upward trend over the years which was suggested to get attention for further research. Lactation length had heritability of 0.15±0.035 with repeatability estimate of 0.28±0.033.

Among the three adjustment procedure, based on correlation between actual and predicted milk yield and standard deviation of bias (difference between actual and predicted lactation yield), adjustments using linear regression procedure were the worst with phenomenal predictions for shorter lactations. The adjustments were most precise when last test day and average daily yield of the recorded duration was used. Predictions were more accurate towards the end of the lactation where more information because available and less information was to be predicted. Unadjusted and adjusted lactation milk yield under three adjustment procedures had heritability estimates of between 0.15±0.042 and 0.20±0.041 with repeatability estimates between 0.32±0.035 and 0.52±0.041. Improved estimates of genetic parameters and more accurate predictions by the procedure that utilized last test day and average daily milk yield information of the recorded duration suggested that it be used for lactation length adjustment of Sahiwal cows in future.

Cholistani is another important dairy cattle breed in the country. A study has focused on its performance indicating that first lactation milk yield was 1220 kg with about 225 days of lactation length and a very long dry period of 275 days. Age at first calving may be as high as 50 months and a calving interval of 18 months. Breeding efficiency was 85% and herd life of about 1000 days.

1.1.2. Genetic Variation

Most commonly studied trait of economic importance using state of the art computer software and theoretically good models has been lactation milk yield. It has a medium degree of repeatability meaning that first few lactations are enough to judge lifetime production. Genetic control among various herds has been quite variable but inter-herd analyses indicate that environmental variations mask genetic variation to an appreciable extent and relative importance of genetic variation in 15-20%. This leads to conclude that not only animals performance be recorded, information on animal's relatives would also be very important in determining genetic worth of an animal. A recent study on comparison of pedigree selection and progeny testing further supports this finding. It was found out that current A, B, C and D categories of bull dams for selecting young bulls for Artificial Insemination program are not correct in indicating how a bulls daughters will perform. They rather had no association with bulls's genetic worth to transfer traits like milk yield. Reproductive traits such as service period and calving interval have generally been claimed to have low genetic control and this is true for cattle breeds such as Sahiwal. Age at first calving on the other hand can be improved as the same pace as lactation milk yield due mainly to its similar genetic control. Lactation length may have a low to medium genetic control but selection for better milk yield is likely to improve this as a correlated response.

A hidden factor, inbreeding, has also been topic of at least few studies at the Department. Its drastic effects were established on productive and reproductive traits in various Sahiwal herds. Reduction in

lactation and life time milk yield, as well as productive life was established in a recent study in Sahiwal. Genetic progress in Sahiwal has been a very debatable issue in studies conducted at the Department and even studies utilization Sahiwal data from Pakistan. Not just phenotypic deterioration has been highlighted, genetic deterioration in most of the performance traits has been documented with strategies to revive the situation. Some of these suggestions has been accepted by the line Departments and efforts have started in this direction.

Genetic association of milk yield and other traits has also been subject of research in some of the studies at the Department. They are likely to help establish selection indices for selecting Sahiwal for overall productivity. Studies on performance recording at farmer level and international evaluation and establishing beauty standards in Sahiwal are underway.

The Cholistani Government farm has also been evaluated. Data were limited for genetic parameter estimation but a medium control of most productive traits and a weak control of reproductive traits was reported. Breeding values for first lactation milk yield has a very wide range from (–1325 to 1255 kg) indicating scope of selection genetically superior animals The genetic trend for milk yield and other traits was however, close to zero in the evaluated herd indicating that the breeding program in the past was ineffective and selection needed to be practised to improve genetic ability of the animals.

1.2. Crossbreeding

Realizing the possible role that crossbreeding can play in the improvement of dairy cattle productivity in Pakistan, a research project was initiated in 1973 with the financial assistance of US DA out of PL-480 funds. The objective was to develop a high yielding and better adapted strain of dairy cattle through crossing local Sahiwal cows with the semen of exotic breeds namely, Jersey and Holstein. The insemination work was carried out in the 7 villages of Shergarh area of District Okara. The resulting female progeny was obtained at the age of weaning and brought to the University of Agriculture, Faisalabad. The breeding work was continued at the University and the data on (i) maturity age (ii) ago at first calving, (iii) breeding regularity, (iv) milk production, (v) fat percentage, (vi) heat tolerance and (vii) disease resistance of the two-breed and three-breed crossbreds were collected and analyzed for comparison.

1.2.1. Growth rate and efficiency of feed conversion in heifers

Seventeen heifers (throe purebred Sahiwal, five Jersey x Sahiwal and nine Holstein Friesian x Sahiwal) between the age of 9 to 13 months were kept under feeding trial for a period of 16 weeks from February to May. The animals were fed ad libitum a mixture of balanced ration during the experimental period. The average daily weight gain was the highest (914 ± 45 gm) among Friesian crossbreds, while it was 833 + 4 8 gm and 634 ± 59 gm in Jersey crossbreds and purebred Sahiwal heifers, respectively. The feed consumption was also the highest among Friesian crossbreds and the lowest amongst the Sahiwal purebreds. The Friesian crossbreds were the most efficient animals as they required 5.58 kg of TDN per kg of 'gain in weight. The pure Sahiwal and Jersey crossbreds consumed 6.55 and 6.86 kg of TDN per kg gain in weight, respectively. Feed efficiency did not differ in various genetic groups but weight gain was significantly better in the crossbreds. During the month of May when it was hot and dry, the feed efficiency was better in Jersey crossbreds than the other two groups. This justifies the incorporation of Jersey inheritance for better adaptability and performance.

1.2.2. Digestibility of various feed nutrients in heifers

Three animals each of purebred Sahiwal, Jersey x Sahiwal and Friesian x Sahiwal of comparable ages were fed ad libitum a mixed balanced ration that contained 14.3X crude protein and 66.7% of the total digestible nutrients (TDN) along with 10 kg of green chopped maize per animal. The digestibility trial of five days duration indicated that there was no difference in the digestibility of various feed nutrients by the different

types of animals. The digestion coefficients were slightly higher among the crossbreds than pure Sahiwals during hot dry summer months, indicating the superiority of halfbreds. The digestibility coefficient for crude protein and crude fibre were: 72.2 and 66.8 for Sahiwals; 76.3 and 68.9 for Friesian x Sahiwal; 78.4 and 70.5 for Jersey x Sahiwal, respectively.

1.2.3. Adaptability of crossbred heifers to summer season

Five heifers of each of the three genetic groups were studied for various physiological parameters with response to summer stress. The rectal temperature did not differ much among the three genetic groups and it ranged from 38.8 to 39.2°C in Sahiwal, 38.6 to 39.0°C in Friesian x Sahiwal and 38.8 to 39.0°C in Jersey x Sahiwal. The pulse rate was higher in Friesian crossbreds (91.0 ± 0.52 per minute) while it was 90.0 ± 0.46 in Jersey x Sahiwal and 89.0 ± 0.55 in the Sahiwal in the month of August. Average respiration rate per minute was 32±0.5 in Sahiwal, which increased to 37 ± 0.8 in July. In Jersey crossbreds respiration rate was 35.0 ± 0.42 which increased to 61 ± 1.5 during July. A further increase was noticed (80 ± I.6) during August in Friesian crossbreds. This indicated that Jersey crosses were adaptable to the environments than Friesian crossbreds. This justifies the inclusion of Jersey breed in three way crosses.

1.2.4. Performance traits

The age at first calving was greatly reduced amongst the crossbreds compared with the purebred Sahiwal cows. In two-way crosses, it was 36 ±1.5 and 38 ±1.8 months for Friesian and Jersey crosses, respectively. In three-way crosses it increased to 44 ±2.1 months in cows having 1/2 J:1/4 F:1/4 S inheritance. The crossbreds had relatively shorter calving interval than the pure Sahiwal cows. Average calving interval was the shortest (15.0 + 1.5 months) amongst the three-breed crossbred cows having 50% Jersey inheritance. The percentage of cows calving in a year was also higher (78.2%) in this genetic group. The breeding efficiency was the highest in the three-way crosses. The Friesian x (Jersey x Sahiwal) group was slightly better than the Jersey x (Friesian x Sahiwal) group. Two-way crosses were inferior in this respect. Non-return rate at 90 days was the poorest among the purebred Sahiwal cows. Peak daily yield and initial milk yield in first 60 days wore the highest among the Friesian x Sahiwal crossbred cows. The maximum peak daily yield was 34.0 kg in this genetic group. The average peak production was slightly lower in three-breed cross but was definitely higher than the Sahiwal cows. Three-breed crossbreds were more persistent than the other genetic groups. The persistency index in three-breed cross was 95%.

The average 305-day milk yield was the highest (3114 ± 100.6 kg) among the Friesian x Sahiwal cows. This group yielded 100% more milk than the contemporary Sahiwal cows. The Jersey-halfbreds yielded 2467 ± 195.8 kg of milk in 305-day lactation period. Three-breed crossbreds produced 2457 ± 185.2 kg of milk as against 1554 ± 233.3 kg of milk in contemporary Sahiwal cows. The comparison of various genetic groups for milk yield on 4% fat corrected milk (FCM) basis indicated that superiority of Friesian-halfbreds, Jersey-halfbreds and three-breed crossbreds over the Sahiwal cows was 91.3, 69.0 and 60.9% respectively. The butterfat percentage was the highest among the F1 Jersey x Sahiwal cows (5.10 ± 0.77%). This group also had the highest total solids in the milk. The cows having 1/2 Friesian and 1/2 Sahiwal inheritance had the lowest butterfat (4.30 ± 0.81%) and solid-not-fat (8.72 ± 0.41%) contents. The butterfat" percentage was higher among the three-breed crossbreds than the Sahiwal and Friesian halfbred cows.

1.2.5. Feed consumption and utilization

The cows of the various genetic groups were fed the available green fodder and wheat straw to meet their maintenance requirements worked out according to NRC standards on the basis of their body weight. The production requirements were mot through concentrate. The total digetible nutrients (TDN) intake was the highest (7.69 kg) in Friesian-halfbreds. The Sahiwal and three-breed crossbreds consumed 5.56 and 5.59 kg TDN per day which is very similar. Generally, the feed consumption was higher in winter than in the summer season. The average daily energy intake was the highest in the Holstein Friesian x Sahiwal cows

and they consumed on an average 34.46 Kcal/cow/day. The 3/4-Friesian cows consumed 28.6/KcaI/cow/day as against 26.67 Kcal/cow/day in the three-breed crossbred cows. The Sahiwal cows consumed 24.6 Kcal/cow/day which was the lowest in all genetic groups.

The 4% fat corrected milk (FCM) was the highest (10.95 kg/day) among the Friesian halfbreds. The milk yield was the lowest (6.64 kg/day) among the Sahiwal cows. The production was about 30% higher in winter than in the summer season. The total energy consumed by the cows of each genetic group was divided into maintenance and production requirements. The quantity of the energy secreted in milk was calculated so as to work out the gross and net efficiencies.

The gross efficiency which was expressed as the percentage of Kcal in the milk produced out of the total Kcal in the TDN consumed was the highest in the 3/4-Friesian crossbred cows. It was the lowest amongst the Sahiwal cows. Three-breed crossbreds were better than the Sahiwal and the Friesian halfbreds. The net efficiency was expressed as the percentage of Kcal in the milk produced out of the Kcal utilized for milk production. The three/breed crossbreds had 48.9% net efficiency value and the three-quarter-bred Friesian cows ranked next with net efficiency of 48.7%. The Friesian-halfbreds had 42.6% efficiency, whereas such an estimate was 37.0% for the Sahiwal cows. The three-breed crossbreds had better energetic efficiency of milk production than the other genetic groups. The three-way crosses too had better breeding efficiency compared to two-breed crosses and the Sahiwal cows. Keeping in view the past experience, the future breeding plan has been modified and attempts are being made to produce animals having 3/8-Holstein Friesian: 1/4-Jersey: 3/8-Sahiwal inheritance. This group will be compared with the half-bred Holstein Friesian -Sahiwal genetic group.

2. Beef Cattle breeding

The project to develop a synthetic beef breed using Bhagnari and Droughtmaster is underway since 1969 at Beef Production Research Center (BPRC), Sibi, Balochistan. The breed was developed from crossing Bhagnari females with Droughtmaster males gifted by Australia. The F1 were back crossed with Narimaster and offsprings crossed with Droughtmaster to get 5/8 Droughtmaster and 3/8 Bhagnari inheritance. The data being generated as a result of crossbreeding was analyzed to draw meaningful inferences about the performance and adaptability of the pure and crossbred animals. The performance records of animals being maintained at Beef Production Research Center, Sibi, from 1969 to 1994 were used for three M.Sc. studies.

Data on 1534 performance records of Bhagnari, Droughtmaster and different genetics groups of crossbred animals kept during 1969-1994 were used. The overall birth weight averaged 24.2 $\pm$ 4.5 kg with a coefficient of variation of 18.35 percent. The weaning weight averaged 110.9 $\pm$ 23.1 kg and ranged from 49 to 212 kg with a coefficient of variation of 20.82 percent. The preweaning average daily gain was 0.41 $\pm$ 0.10 kg and it ranged from 0.14 to 0.84 kg. The postweaning average daily gain was 0.26 + 0.2 kg with a coefficient of variation of 63.17 percent. The mean body weight at 8 and 16 weeks of age was 45.0 $\pm$ 8.3 and 66.3 $\pm$ 13.5 kg, respectively. The weight at 24 and 28 weeks of age averaged 89.1 $\pm$ 18.9 and 102.0 $\pm$ 22.2 kg, respectively. The yearling weight averaged 159.9 $\pm$ 44.8 kg and ranged from 91 to 357 kg with a coefficient of variation of 28.85 percent. The influence of year, season, sex and genetic group on most of these traits was significant.

Birth weight was moderately heritable (30%) when data were analyzed from all the genetic groups. When birth weight was analyzed separately for the six breed groups (Bhagnari (BN), Droughtmaster (DM), BN x DM (the F_1), F_1 x BN (the F_2), F_2 x Droughtmaster (the F_3), and F_3 x F_3 (Narimaster), heritability of birth weight was higher in the Droughtmaster and Narimaster breed groups as compared to the crossbreds (F_1, F_2, F_3). Maximum heritability was observed for Droughtmaster (h^2 = 0.75) while minimum value (0.08) was estimated for F_1 animals. In the Narimaster population, birth weight was 66% heritable and modeling this trait by an animal model revealed heritability to be 0.60. In Bhagnari, birth weight was 13% heritable and

improper recording of birth weight, and other environmental factors such as feed and fodder availability could be some of the reasons for such an estimate. Calves having higher percentage of Droughtmaster inheritance exhibited better performance. Birth weight had a positive genetic correlation with weaning weight (0.80) and preweaning growth rate (0.35). Weaning weight was only 4% heritable indicating that variation in the trait was environmental and genetics had little role to play. Although, data on the postweaning traits (yearling weight and postweaning growth rate) were limited, yet yearling weight was 19% heritable while postweaning growth rate was mostly controlled by environment (h^2 = 0.03). Standard errors of these estimates were high due to availability of such records on 136 calves only. Most of the Narimaster animals (90%) were inbred with an average level of inbreeding being 6.61%. Effect of inbreeding on birth and weaning weight was negative but non-significant statistically. Pedigrees of Droughtmaster and Bhagnari animals were also traced back to the base population but inbreeding could not be calculated due to incomplete pedigrees.

Among life time production traits, the least squares means for cumulative number of calves weaned and cumulative weight of the calves weaned were 2.23±2.00 and 305.66±235.21 kg, respectively. The least squares mean for longevity was 3765.95±1549.45 days. The herd life averaged 2076.32±1385.08 days with age at first service was found to be 1108.89±390.0 days. The age at first calving and calving interval averaged 1307±402.8 and 554±220.9, respectively. The least squares means for service period, number of services per conception and breeding efficiency were found to be 198.14±155.02 days, 1.18±0.36 and 65.39±18.84%, respectively. Cumulative number of calves weaned by a cow and cumulative weight of calves weaned by a cow had heritability estimates of 0.13±0.16 and 0.17±0.17, respectively. The heritabilities for longevity and herd life were estimated to be 0.04±0.18 and 0.02±0.18, respectively. Estimates of heritability for age at first service, age at first calving, calving interval, service period, number of services per conception, and breeding efficiency as obtained in the present study were 0.15±0.19, 0.09±0.16, 0.11±0.02, 0.01±0.06, 0.0 and 0.10±0.05, respectively. The repeatability estimates of calving interval, service period and number of services per conception as obtained from the restricted maximum likelihood individual animal model analysis were found to be 0.05, 0.24 and 0.13, respectively.

The genetic trends for birth weight, cumulative number of calves weaned, cumulative weight of calves weaned, longevity, herd life, age at first service, age at first calving, and breeding efficiency were all negative. The genetic trend for weaning weight and calving interval were, however, slightly positive. All phenotypic trends were negative with the exception of the ones for weaning weight, calving interval and breeding efficiency, which were slightly positive. Due to poor performance of Narimaster, more studies were suggested on beef quality and performance testing with the farmers. Revision of the breeding program was also suggested.

3. Buffalo Breeding

3.1. Seasonal effects on economic traits

The season of calving had a significant effect on milk yield and the buffaloes calving in winter season had the maximum lactation milk yield than those calving in other seasons. Most frequent calving season in the buffaloes was July to September. The maximum number of services occurred during the fall season (51.0%), followed by winter (22.2%), summer (15.2%) and spring (11.6%). The conception rate was found to be the poorest during spring and summer and was the highest during winter (82%) and fall (77%) seasons. The mean gestation length was 305.3 days. The male calves were carried on for slightly longer period than female calves. The birth weight of buffalo calves born during different years, months and seasons differed significantly, the calves born during spring were heavier (34.6 kg) than those born during other seasons.

3.2. Biological factors affecting dairy traits

The milk yield in buffaloes was not significantly affected by the age at first calving. The total lifetime yield was found to be negatively correlated with the age at first calving. The calving interval also did not significantly influence 305-day milk yield as the correlation coefficient between the two traits was 0.187. The calving interval was found to be negatively and significantly correlated with wet average. A non-significant correlation coefficient of 0.432 was observed between age at first calving and length of calving interval. It was concluded that efforts should be made to reduce the age at first calving and calving interval in buffaloes so as to make it an economically feasible animal.

3.3. Genetic variation

The analysis of the data on Nili-Ravi buffalo calves born at Common Wealth Livestock Farm Rakh Ghulaman, District Bhakkar, revealed that the heritability estimate of birth weight of calves was 0,572 + 0.043 by halfsib analysis and 0.250 + 0.114 by the method of intra-sire regression of offspring on dam. These fairly high estimates of heritability suggested that the selection based on high birth weights would be very effective in improving the trait. The average ago at first calving in the Nili-Ravi buffalo herd maintained under Thal conditions was 1669.40 ± 16.76 days. The estimates of heritability for this trait were 0.215 ± 0.183 and 0.514 ± 0.243 by the methods of paternal halfeib correlation and intra-sire regression of daughters on dam, respectively. These estimates suggested that the age at first calving can reasonably be reduced by selection from and amongst the buffaloes which calve at an early age. The average first and second calving interval in Nili-Ravi buffaloes was 548.30 ± 11.82 and 477.30 ± 11.13 days, respectively. The estimates of heritability for these parameters were low suggesting that the greatest improvement in the trait will be through better feeding and management of the buffaloes.

Data on 1880 lactations of 433 buffaloes were analysed to estimate the repeatability, of 305-day milk production. The estimate of repeatability obtained by the method of intra-class correlation for 305-days milk yield was 0.323. The regression coefficient of milk yield of subsequent lactation on the proceeding lactation ranged from 0.410 to 0.587. The heritability estimates for the first and second lactation milk yield were 0.113 ± 0.152 and 0.132 ± 0.216, respectively by the method of half-sib correlation. The corresponding estimates by the method of intra-sire regression of daughter on dam were 0.127 ± 0.150 and 0.180 ± 0.274, respectively. Higher estimates of heritability by daughter dam regression method were assumed to be due to the inclusion of dominance component in the estimates. It may be concluded that no appreciable loss in the efficiency of selection will occur if the selection of buffaloes is made on the basis of first lactation yield alone.

3.4. Inbreeding

The coefficient of inbreeding among 212 inbred Nili-Ravi buffaloes kept at Livestock Production Research Institute, Bahadurnagar (Okara) ranged from 0.25 to 22.60% with an average of 7.64 ± 0.37%. The inbreeding was found to significantly depress the first lactation milk yield. The first lactation milk yield averaged 1545.97 ± 43.46 kg and it declined at the rate of 21.89 ± 7.68 kg for each one per cent increase in the inbreeding. The inbreeding accounted for 2.0% of the total variation in lactation length. The liveweight at first calving averaged 557.72 ± 4.84 kg and the regression of liveweight on inbreeding was -1712 ± 0.96 kg. However, this regression in liveweight due to inbreeding was non-significant. The age at first calving and first calving interval increased by 7.25 ± 2.86 and 2.56 ± 2.32 days, respectively for each one per cent increase in inbreeding. The regression analysis showed a significant effect of inbreeding on age at first calving but variation in calving interval was non-significant. The breeding efficiency averaged 62.75 ± 1.09% and it was not significantly affected by inbreeding. The inbreeding contributed 0.63% of the total variation in this trait. The regression of breeding efficiency on inbreeding was -0.19 ± 0.20%.

3.5. Frequency of testing for milk production

Milk production records on Nili-Ravi buffaloes kept at the University were used to evaluate the frequency of

testing for milk production. The average 305-day milk yield by monthly recording was 2281.8 kg compared to 2254.5 kg by daily recording. The correlation coefficient between actual milk yield and yield calculated by monthly recording was 0.963 with very close confidence intervals. Milk recording once in two months or once in three months was not as accurate as monthly recording and hence it was suggested that these testing intervals could be applied where monthly recording is not feasible. For the purpose of surveys where recording can only be done once in lactation, it was suggested that representative yield in the fifth month of lactation will provide fairly accurate information.

Another study compared different recording plans for finding compromise between accuracy and feasibility. Comparison of different recording plans The alternate AM-PM or PM-AM plans were comparable in terms of accuracy in the present study. Number of milkings to be recorded were however, similar to that of AM or PM plans. Any plan that includes morning milking would however be difficult to implement due to its feasibility under field conditions where farm size is very low and communication facilities, meager. The best choice in terms of feasibility is then the evening recording (PM plan). The loss of accuracy is not substantial as compared with the alternate AM-PM or PM-AM plans and quite comparable with the AM plan, the most unfeasible.

4. Sheep breeding

4.1. Factors influencing growth rate and body weight

4.1.1. Environmental factors

The birth weight and the weaning weight were found to be significantly influenced by the year of birth, breed, sex of the lamb and age of the dam in Harnai and Bibrik breeds of Pakistani sheep. There was positive and significant correlation between body weight of ewes and birth/weaning weight of lambs.

The data of Awassi sheep which were imported in Pakistan in 1965 from Lebanon were studied for various environmental factors influencing productive and reproductive traits. The differences in birth weight and adjusted weaning weight due to bith type, sex and year of lambing were significant. The correlation coefficient between weaning age and weaning weight ranged from 0.485 to 0.618 in two sexes and birth types. The correction factors based on the prediction equation were developed for each birth type and sex separately for adjusting records of weaning weight to a comparable 120-day basis.

The analysis of the production records of Rambouillet sheep kept at the Livestock Experiment Station, Jaba, District Mansehra (NWFP) indicated that year and month of birth had significant effect on the birth weight and weaning weight. The males were generally heavier at birth and weaning and the age at weaning significantly affected weaning weights of the lambs.

4.1.2. Genetic variation

Heritability estimates for birth weight and weaning weight in Awassi sheep by intra-sire regression analysis were 0.221 ± 0.087 and 0.432 ± 0.142, respectively. This suggested that a significant improvement in weaning weight may be made through mass selection. The inbreeding had no significant influence on birth weight and weaning weight in Awassi sheep. The inbreeding in the closed Awassi flock averaged 10.69 ± 0.56% and depressed the birth weight and weaning weight at the rate of 0.002 ± 0.009 kg and 0.082 ± 0.052 kg, respectively for each one per cent increase in inbreeding.

The heritability estimates for birth weight and weaning weight by halfsib analysis in Rambouillet sheep were 0.692 ± 0.187 and 0.492 ± 0.155, respectively. The inbreeding coefficient in the Rambouillet flock ranged from 0.39 to 37.27% with a mean of 8.75 ± 0.25%. The birth weight and weaning weight decreased at the rate of 0.008 and 0.010 kg, respectively, for each one per cent increase in inbreeding. The decline in

the two traits due to inbreeding' was non-significant.

4.2. Factors affecting wool yield and quality

4.2.1. Environmental factors

The wool yield at first shearing was negatively but non-significantly correlated with body weight in Awassi sheep. The wool yield was higher amongst the single born ewes than the twin born ewes.

4.2.2. Genetic variation

A general decline in wool yield with increased level of inbreeding was observed in Awassi sheep. This decline in wool yield due to inbreeding was, however, non-significant. The wool yield amongst the inbred Rambouillet ewes averaged 2.78 ± 0.03 kg and was significantly affected by inbreeding. The intra-sire regression of wool yield on inbreeding was 0.014 ± 0.075 kg. The study of inheritance of wool quality in relation to heterotypical fibres in Lohi sheep indicated that major part for the expression of heterotypical fibre is played by the genetic make up of the individual and that the environment caused minor difference. The percentage of kemp fibre is also controlled by heredity but major part of expression for these fibres is influenced by the environments.

4.3. Factors influencing reproduction traits

4.3.1. Environmental factors

The number of services per conception did not differ significantly amongst the single and twin born Awassi ewes. The correlation between age at first lambing and number of services per conception was significant. The conception rate was slightly better in single born ewes than the twin born ewes. The fertility rate was higher in twin born ewes than single born ewes.

4.3.2. Genetic variation

The prolificacy expressed as the number of lambs per ewe per lambing averaged 1.12 ± 0.02 in Awassi sheep. The prolificacy was not significantly affected by inbreeding.

4.4. Crossbreeding

The analysis of the data on 1319 lambs of Kachhi, Awassi, and their crosses kept at the Livestock Production Research Institute, Bahadurnagar (Okara) revealed that twinning percentage was depressed with crossbreeding. The birth weight in Awassi, Kachhi and Awassi x Kachhi was 4.17 ± 0.03, 3.24 ± 0.04 and 3.75 ± 0.09 kg, respectively. The adjusted 120-day weaning weight records of single born lambs showed significant difference due to breed and sex. The crossbreds were midway between the Awassi and Kachhi breeds and had 23.97 ± 0.60 kg weaning weight. The crossbreds excelled both the parental breeds in wool yield. The survival rate was slightly depressed amongst the crossbred lambs but was still fairly high (85.2%).

Relative performance of three breeds of Pakistani thin-tailed sheep namely, Lohi, Kajli and Kachhi and their crosses for high gaining ability was compared. The average birth weight ranged from 2.18 to 3.92 kg. There was no significant difference between the birth weight of lambs born during various years or between sexes. However, significant difference was noticed when, the data were classified according to the sire breeding groups and dam breeding groups. The average birth weight of lambs sired by Kachhi rams was the highest (3.20 kg); in Lohi it was 3.07 kg and in Kajli 3.04 kg Lohi and Kachhi ewes produced lambs weighing 3.17 kg and 2.86 kg, respectively. Only 474 lambs could be reared upto weaning age of 110

days. The average weaning weight ranged from 8.86 to 12.87 kg and 8.64 to 11.98 kg in males and females, respectively. The highest weaning weight was observed in Kajli x Lohi crossbreds (15.54 kg). Next in order were Lohi x Kachhi (14.85 kg); Kachhi x Kajli (14.63 kg); Lohi x Kajli (12.00 kg). When the data were pooled according to the breed of sire, the average weaning weights were 14.41, 13.88 and 13.83 kg among the lambs sired by Lohi, Kachhi and Kajli rams. The average weaning weights according to the breed of dam groups were 14.31, 14.04 and 13.25 kg among Kajli, Lohi and Kachhi dams. The mortality rate was much higher in the early period of the experiment but later on it was reasonably controlled. The mortality was mainly due to change in feeding regime (limited grazing and stall feeding), overcrowding and poor housing facilities. Those health problems adversely affected the fertility of ewes and the percentage of lambs born alive. The lambing percentage varied greatly during different years and ranged from 30.5 to 91.5%.

5. Goat Breeding

Most of the work on goat breeding pertains to Teddy goat. Data recorded on 777 progenies from 38 bucks (for heritability estimation) and 946 progenies from 301 does (for repeatability estimation) for period from 1975 to 1990 were used to estimate the genetic parameters (heritability, repeatability and correlations) of some productive traits like birth weight and weaning weight. The overall average birth weight and weaning weight of kids ignoring sex and type were 1.67 ± 0.31 and 8.50 ± 2.18 kg, respectively. The estimates of heritability of birth weight and weaning weight by halfsib correlation method were 0.448 ± 0.022 and 0.101 ± 0.012, respectively. Repeatability estimates of birth weight and weaning weight were found to be 0.2089 ± 0.035 and 0.1381 ± 0.0315, respectively. The phenotypic, genotypic and environmental correlations between birth weight and weaning weight were 0.08, 0.212 and 0.49, respectively.

Data comprising of breeding and performance records of teddy goats maintained at Livestock Production Research Institute Bahadurnagar, Okara during the period from 1975-1990 were used to study some of the environmental factors affectively birth and weaning weights. To study birth weight, 1241 births were recorded from 1976-1990, showing the mean birth weight of 1.66 ± 0.033 and 1.65 ± 0.033 kg respectively. The results of analysis indicate that season of birth had a non-significant affect on birth weight. For type of birth, singly 538, twins 587 and triplets 116 births with an average birth weight of 1.86, 1.63 and 1.49 kg respectively were recorded. It was found that type of birth had a significant effect on birth weight. It was also concluded that single born kids were significantly heavier than twins and triplets and similarly twins were significantly heavier than triplets. Out of the total recorded births 50.7% were males and 49.3% were females. The mean birth weight was 1.70 and 1.62 kg in males and females respectively. It was concluded that sex had a significant effect on birth weight. The males were significantly heavier than females. The age of dam also had a significant effect on birth weight. A total of 937 weaning weight records with an average weaning weight of 8.61±0.71 kg were available. The results of analysis revealed that year of birth had a significant effect on weaning weight. Out of the total records 518 and 419 with an average weaning weight of 9.08 and 8.13 kg were recorded during winter and summer respectively. The kids weaned during winter were significantly heavier than the summer weaned kids. The weaning weight recorded in 381 singly, 465 twin and 91 triplet births 8.72, 8.45 and 8.65 kg, respectively. The type of birth had a non-significant effect on weaning weight. Accordingly the weaned kids 52.19 and 47.81% were males and females with an average meaning weight of 8.78 ± 0.71 and 8.42 ± 0.71 kg, respectively. The results indicate that sex had a significant effect on weaning weight and the males were significantly heavier then females kids. The age of dam and birth weight of the kid had a non-significant effect on weaning weight.

Data on 1664 kidding records of 485 Teddy does sired by 31 bucks, maintained at Livestock Production Research Institute, Bahadurnagar (Okara) from 1975-1999 were used to study the growth and reproductive traits. Birth, weaning and yearling weights averaged 1.65±0.34, 10.36±2.05, 19.89±3.68 kg while pre-weaning and post-weaning growth rates averaged 113.69±20.02 and 41.02±12.16 gm,

respectively. The number of kids weaned averaged 3.06±2.43 and age at 1st kidding averaged 343.09±164.55 days. The single born kids were heavier (1.74±0.05 kg) as compared to twins (1.55±0.05 kg), triplets (1.46±0.06 kg) and quadruplets (1.03±0.13 kg). Year and season of kidding generally influenced most of the traits. The Restricted Maximum Likelihood heritability estimates for birth weight, weaning weight, yearling weight, pre-weaning average daily gain, post-weaning daily gain and age at first kidding were 0.52±0.31, 0.29±0.12, 0.22±0.19, 0.19±0.13, 0.11±0.05, 0.15±0.11 and 0.12±0.09, respectively. The genetic correlation among various traits were generally very low except between birth weight and weaning weight (0.69) and between weaning weight and yearling weight (0.31). Phenotypic and genetic trends of various traits were generally negative suggesting that definition of traits, selection criteria and improvement in the managemental aspects need concerted efforts in future.

6. Poultry Breeding

6.1. Chick hybridization

Several experiments were initiated at the University to develop a strain of poultry, best suited to the rural conditions. Such a strain was supposed to be dual purpose, i.e., for eggs and meat. A comparison between chicks of Desi, White Cornish and their reciprocal crosses indicated that the crossbreds had better body weight than the Desi purebred and in no way they were inferior to White Cornish purebreds. The crossbreds yielded significantly higher eviscerated meat than the Desi purebreds. There was no significant difference in the palatability of meat from all the four breeds/crosses. Desi birds had, however, better viability and hatchability percentage.

A comparison of the broiler quality of Lyallpur Silver Black, Desi and New Hampshire revealed that there was no significant difference in the viabilities of these breeds. The palatability of the meat of the three breeds did not reveal any significant difference. The birds of the newly evolved Lyallpur Silver Black strain were better in weight gain than the New Hampshire and Desi breeds. The shank length had a positive correlation of 0.784 with gain in weight and was considered to be a good indicator of weight gain and weight of dressed meat. The estimate of heritability for body weight at 16 weeks of age was moderate in Lyallpur Silver Black breed. The heritability estimate for age at maturity in this breed was 0.79 which suggested that considerable improvement in the trait could be accomplished through mass selection.

6.2. Performance of commercial strains

The efficiency of 4 commercial strains of White Leghorn layers was compared. The differences for weight gain in various strains studied were non-significant. However, feed efficiency significantly differed between strains and the Hy-Line strain was the best for this parameter. Mortality rate was the highest (8.32%) in Arbor Acros strain. The number of eggs laid per hen in a period of 200 days was maximum (142 eggs) for the PIA-Shaver strain. The feed efficiency amongst the layers expressed as the amount of feed required to produce one dozen of eggs was better in PIA-Shaver (1.56 kg) compared with other strains studied. The survival rate was the best in the Babcock strain. The influence of egg weight on hatchability in five commercial strains of Broilers was studied. It was found that the egg weight and strain did not exert any significant effect on the hatchability over all eggs set or over fertile eggs. However, the egg weight and the strain had significant effect on day-old chick weight. The day-old chick weight increased with increase in the egg weight.

7. Animal Reproduction studies

7.1. Hormonal treatment for anoestrus and ovulation

The Pregnant Mare Serum (PMS) and progesterone were administered in cows and buffaloes during breeding season and off-breeding season for the treatment of anoestrus and to induce ovulation. All cow-

heifers and 90% buffalo-heifers came in heat during breeding season with a single dose of 500 IU of PMS. The response was recorded in 50% of the animals in both species during the off-breeding season with a similar dose. The response of cows and buffaloes to 1000 IU of PMS was poor in breeding as well as off-breeding season. However, about 83% of cows and 63% of buffaloes came in heat when a dose of 1550 IU of PMS was injected during breeding season. The response was shown by 80% cows and 42% buffaloes during the off-breeding season. This showed that in cows, single dose of 1500 IU of PMS was effective to induce oestrus. Amongst the buffaloes, a higher single dose of PMS (2000. IU) was needed to induce oestrus because of 100% buffaloes came in heat during breeding season, while the response was 80% during off-breeding season. There was no appreciable effect of progesterone treatment in adult animals of both species. However, the administration of PMS after progesterone treatment increased the occurrence of heat. The conception rate was 100% of those that came in heat with all treatments except with progesterone treatment alone when the conception rate was 66%. There was no marked effect of PMS treatment on daily milk yield of cows as well as buffaloes.

7.2. Semen preservation at room temperature

The usefulness of egg-yolk and the interaction between glucose and sodium bicarbonate in CO_2 -saturated diluters for storage of semen of Sahiwal and buffalo bulls at room temperature (68 - 82°F) was studied. It was found that egg-yolk is not necessary for the carbonated diluents used for storing semen at room temperature. Sodium bicarbonate beyond 2% level in the carbonated diluters was not beneficial. Increased glucose levels in the diluters (upto 1.5%) appeared to have favourable effect on maintaining motility in storage. There was no interaction between sodium bicarbonate and glucose at high levels of these ingredients. Greater amount of CC>2 was needed for the increased amount of bicarbonate in diluters to bring the initial pH of the diluter at the required pH value of 6.4 for preserving semen at room temperature. A new diluter (A.U. modified IVT diluter) was developed and named for reference purposes after the name of Agriculture University for use and storage of semen at room temperature under local conditions. The diluter was essentially a CC>2 saturated diluter containing 1.5% glucose plus 0.4% bicarbonate.

The sperm motility and livability of semen for a Sahiwal cow bull and a Nili-Ravi buffalo bull diluted in CC>2 saturated diluents for semen preservation at room temperature (21 to 31°C) was studied. The diluents containing sodium bicarbonate and glucose at 0.2 and 1.0% levels respectively, maintained better sperm motility for four days than other diluents used. The evidence gathered in the study showed that the atmospheric temperature was an important factor that affects the carbonation of diluents. For room temperature of 30°C or above, it did not seem possible to attain proper saturation of the diluents with CC>2 and to store the diluted semen so as to maintain sperm livability for longer periods. The use of carbonated diluents would not prove successful under high temperature conditions until improved techniques are available for carbonation and room storage.

7.3. Semen preservation at 40°F

The efficiency of skim milk and egg-yolk citrate with and without glycerol as semen diluents was studied in Sahiwal, Tharparkar and Buffalo bull semen stored at 40°F. Each ejaculate from these bulls was split into four fractions and diluted with the different anitbiotic treated diluents to a concentration of 15×10^6 motile spermatozoa per milliliter. The motility was estimated on days one through six, nine, eleven and fourteen. The differences in motility due to diluters and the length of storage were significant. The maximum motility was observed on the first day, and it decreased thereafter with the passage of time, being the lowest on the 14th day of storage. The diluters, rated in order of maximum effectiveness of maintaining motility over 14 days of storage were, skim milk 10% glycerol, skim milk, egg-yolk citrate and egg-yolk citrate 10% glycerol. Skim milk 10% glycerol was regarded as the diluter of choice for maximum livability for use in artificial insemination under Pakistan conditions.

The suitability of five diluents namely egg-yolk citrate (EYCG), whole milk (WMG), skim milk (SMG), whole milk-egg-yolk citrate (WMEYCG) and skim milk - egg-yolk citrate (SMEYCG), all having 10% glycerol were tested for preservation of bull semen at 40 °F for a period of 10 days under local conditions. The best results were obtained in semen samples diluted with WMG diluent. Next in the order of merit was SMG, while the rest of the three diluents did not differ significantly among each other.

The influence of extenders containing skim milk powder, glucose, fructose and glycerol on bovine semen stored at 5°C for 7 days was studied. Eight semen extenders containing skim milk powder alone or with fructose or glucose or both, all with or without glycerol were prepared and used for semen dilution and preservation under refrigeration. The sperm motility differences between extenders were significant for both cow and buffalo bull semen from 2nd 'day of storage onward. Maximum motility was observed on the first day, which decreased with the passage of time, the lowest motility being obtained on the seventh day for both cow and buffalo bull semen. The extenders containing glycerol gave better results than the corresponding extenders without glycerol. In each of these two classes of extenders, those containing both fructose and glucose gave better results of sperm motility, whereas those containing skim milk gave the poorest results. The extenders containing either fructose or glucose were intermediate in maintaining sperm motility for cow and buffalo bull semen. It was concluded that both fructose and glucose can be added to the incubated semen extenders to prolong the livability of spermatoza and that the addition of glycerol further enhanced the maintenance of sperm motility for cows as well as buffalo bull semen.

The efficiency of four semen extenders in maintaining motility of Sahiwal and Thari bull spermatozoa stored at 5 ^{0}C for seven days was compared. The four extenders were skim milk alone, skim milk with glucose (1.2% solution), skim milk with glycerol (10% solution) and skim milk with egg-yolk (20% solution). All these extenders were treated with antibiotics. Maximum sperm motility was observed on the first day of storage which progressively declined with the passage of time. The extender containing skim milk and egg-yolk gave the best results for sperm motility while the one containing skim milk and glycerol gave the poorest results. The extenders containing skim milk with glucose and skim milk alone were intermediate in maintaining the sperm motility. It was, therefore, concluded that the extenders containing skim milk and egg-yolk prolonged the livability of spermatozoa as compared to the other experimental extenders. The addition of glycerol at 10% level at 5°C decreased the motility of spermatozoa during the storage period.

7.4. Semen freezability

The efficiency of five semen diluters containing varying levels of lactose and fructose for preservation of bovine bull semen in frozen state was compared. Each of the five diluters also contained 20% egg-yolk, 5% glycerol and antibiotics. Straw method of deep freezing used hi the study involved the freezing of diluted semen samples in poly vinyl chloride straws to -196 °C in liquid nitrogen. Frozen semen was evaluated on the basis of post-thawing motility, livability in hours and absolute index of livability of spermatozoa. The results indicated that the addition of 18.75 ml fructose could successfully prolong livability but when the rate of addition of fructose was gradually increased to 37.5, 62.25 and 75.0 ml, the results were reversed. These results clearly indicated that lactose diluter (Qadirabad diluter containing 75 ml of 11% lactose) could be improved by the addition of fructose solution. The diluter containing 62.5 ml of 11% lactose with 18.75 ml of 6% fructose successfully improved the revival rate, livability and absolute index of livability of spermatozoa in bovine semen.

8. Cytogenetic Studies

Karyological analysis of various indigenous breeds of livestock i.e., cattle, buffalo, sheep, goat have been conducted in the Department to set normal karyotypes using various banding profiles.

8.1. Nili-Ravi buffalo

The normal chromosomal pattern in Nili-Ravi buffalo was studied by using micro and macro methods for culturing lymphocytes of both male and female animals. The chromosome complement at metaphase stage revealed that the 2n (diploid) number of chromosomes in female and male was 50. Similar results were revealed by using Trypsin-Giemsa banding technique. The females were 48, XX while the males were 48 XY in chromosome complement. The chromosomes were divided into 4 groups depending upon their size and form viz., group A from chromosome 1-5 were meta/submetacentric, group B from 6-12 were acrocentric and group C from 13-19 and group D having pairs 13-19 were all acrocentric. The sex chromosome was the largest amongst the acrocentric chromosomes and hence was annexured with group B. The Y-chromosome in male was the smallest acrocentric and hence placed in group D.

8.2. Sahiwal cattle

The normal chromosome complement at the metaphase stage revealed that Sahiwal male had 58 autosomes alongwith one X and one Y chromosome while female had also 58 autosomes and two X chromosomes. The chromosomes were further divided into four groups according to their size, shape and position of the centromere viz., group A from chromosome 1-10 were large sized acrocentric, group B from 11-20 consisted of medium sized acrocentric chromosomes and group C from 21-29 comprised of smallest acrocentric chromosomes. The chromosomal arrangements for male was similar to that of female except group D in which there was only one large submetacentric sex chromosome. The Y-chromosome was acrocentric and the smallest of all the chromosomes.

8.3. Dairy cattle crossbreds

In Holstein Friesian x Sahiwal F_1 cattle, lymphocytic culture using Micro method for culturing lymphocytes revealed that the 2n (diploid) number of chromosomes in female and male was 60. The female had 58 autosomes and 2 X chromosomes. The male had also 58 autosomes similar to those of female along with one X and Y chromosome. All the autosomes in the male and female animals were acrocentric. The sex chromosome (X as well as Y) in both the sexes were submetacentric.

8.4. Beetal goats

The chromosome spreads at the metaphase stage in Beetal goat (*Capra hircus*) revealed that chromosomes number in male and female was 2n = 60. The male had 58 autosomes along with one X and one Y chromosome. The female had also 58 autosomes and two X chromosomes. All the autosomes in male and female animals were acrocentric. The sex chromosomes (XX) in females was acrocentric but in male the X chromosome was acrocentric and Y was mera/submetacentric.

8.5. Lohi sheep

The chromosomal patterns of the Lohi sheep (*Ovis aries*) was studied using Trypsin-Giemsa banding technique. Micro-method for culturing lymphocytes was used for chromosomal analysis with slight modifications. The Giemsa banded spreads of chromosomes trapped at the metaphase stage revealed 2n = 54 both in male and females. The autosomal chromosomes were divided into four groups depending upon their size and shape. Group A represented chromosome pairs 1 to 3 which were metacentric. The group B had chromosome pairs 4 to 11 which were large acrocentric. The group C and D having pairs 12 to 19 and 20 to 26 were medium and small in size, respectively and were acrocentric. The X-chromosome was the largest amongst the acrocentric and was thus annexured with group B. The Y-chromosome was the smallest acrocentric and hence placed in group D. The differential Giemsa bands on chromosomes in Lohi sheep has confirmed earlier classification of chromosomes which was essentially based on the size, shape and position of centromere.

9. Molecular Genetics studies

Molecular genetic studies have been conducted in the recent past only mainly based on phylogenetic studies of indigenous breeds of livestock. A preliminary work has also been done to identify DNA markers linked with milk yield in Sahiwal cattle by using RAPD-PCR in order to establish early selection criteria. However, a large number of primers would have to be applied in order to find genetic marker(s) linked to milk yield as it is a polymorphic trait.

9.1. Phylogenetic relationship

The future improvement and development of livestock depends upon the availability of genetic variation. Development of artificial insemination technique, indiscriminate crossbreeding, extensive system of rearing and substitution policies with more productive breeds have lead to the genetic dilution of local stocks, many of which have not been characterized or evaluated. This has resulted in the loss of germplasm inherent in these populations, which have been known for adaptation to their local environments. The molecular genetic characterization of various species is being carried out using RAPD-PCR markers to study the phylogenetics among breeds and further to identify breed specific markers for their genetic characterization. The following species have been covered under this group

9.1.1. Cattle

Random amplified polymorphic DNA (RAPD) assay was carried out to evaluate phylogenetic relationship among ten cattle breeds of Pakistan viz., *Sahiwal, Red Sindhi, Cholistani, Dajal, Dhanni, Rojhan, Lohani, Hissar, Hariana and Tharparkar* by using 80 arbitrary sequence primers. The dendrogram obtained using unweighted pair group method of arithmetic means (UPGMA) revealed two main clusters as shown in figure 9.1.

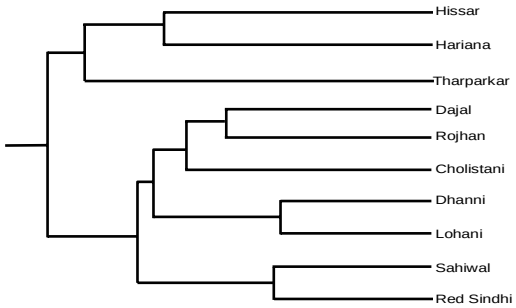


Figure 9.1. *Phylogenetic relationship among native cattle breeds of Pakistan*

9.1.2. Horse

The objective of this study was to detect DNA polymorphism among twelve horse breeds including native breeds *viz., Morna, Siean (Shiean), Anmol* and *Bralanwala Kaka* and exotic breeds *viz., Thoroughbred, Cleveland Bay, Percheron, Suffolk Punch, Noriker, Hanoverian, Arab* and *Anglo Arab*, by using 40 random decamers primers through RAPD-PCR profile. Using the unweighted pair group method of arithmetic means, dendrogram obtained from the cluster analysis revealed two major groups as shown in figure. 9.2.

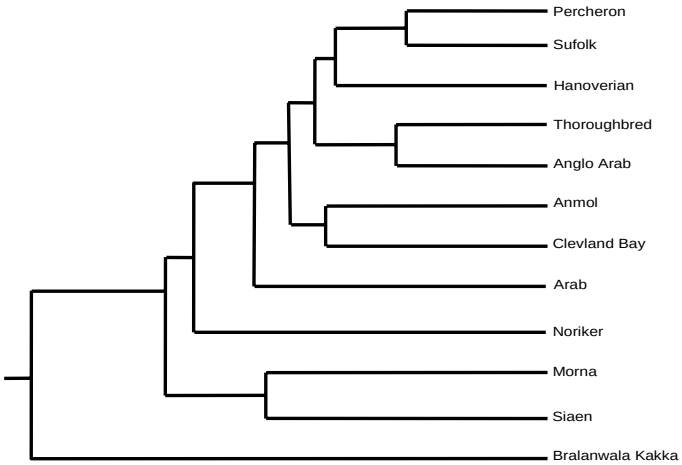


Figure 9.2. *Phylogenetic relationship among twelve horse breeds*

9.1.3. Buffalo

Random Amplified Polymorphic DNA (RAPD) analysis was carried out on three buffalo breeds (*Nili, Nili-Ravi and Ravi*) of the Punjab province by using 25 random decamer primers. These results showed that the level of DNA variation was low among buffalo breeds found in the Punjab province. A dendrogram obtained by using unweighted pair group method of arithmetic means (UPGMA) from the cluster analysis as shown in figure 9.3.

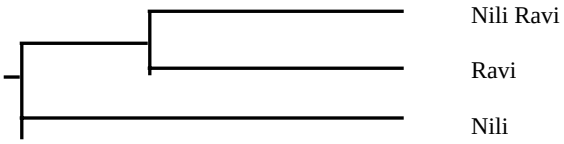


Figure 9.2. *Phylogenetic relationship among three buffalo breeds of the Punjab*

10. Future Plans.

The Department of Animal Breeding and Genetics was incepted when this University came into being in 1962. At present the department has a farm of crossbred cattle from where we provide crossbred male calves to the interested farmers and milk to the University employees. The research efforts in the past helped generate guidelines for development of cattle breeding policy of the country. Very important adaptability studies have been conducted by the department. So far, Department has produced seven PhDs and more than 90 M.Sc. students. At present 10 Ph.D and same number of M.Sc. studies are doing on various aspects of genetics and breeding. The current projects on quantitative genetics are as follows:

1. Inter-herd performance and genetic evaluation of Sahiwal Cattle.
2. Genetic and phenotypic aspects of some performance traits of Nili-Ravi.
3. Genetic evaluation of Beetal goats for performance traits.
4. Performance and Phylogenetic position of Kari sheep.
5. Characterization of Sahiwal cattle for type traits.
6. Test-day model evaluation of Sahiwal cattle.
7. Development of test-day models for genetic evaluation of Nili-Ravi.
8. Comparative efficiency of dairy cattle crossbreds.

9. Producing Sahiwal bulls-pedigree versus genetic worth.
10. Identification of Sahiwal cows without branding-some options.
11. Genetic variation in field recorded Sahiwal cows for lactation performance.

LIVESTOCK MANAGEMENT

1. BUFFALO

1.1. Yield and composition of milk

The buffaloes freshening during the winter and spring months produced more milk during the lactation period than those freshening in hot summer months. The buffaloes that freshened during the months from June to September attained their maximum yield within 60 days post-freshening. In contrast, freshening in the remaining eight months of the year required approximately 90 days to reach the peak milk production.

Higher milk production was observed in buffaloes (in 1st to 4th lactation) having longer body, wider barrel and more height at withers. However, beyond 11 years age, the relationship between milk yield and various body measurements appeared to fade away gradually.

The time spent in feeding, recumbency (lying on sternum), rumination and rest was not found correlated with milk production in buffaloes. This could be interpreted to mean that longer time spent in feeding or increased duration of recumbency/rumination should not necessarily be considered as indicators of higher milk production in buffaloes.

High environmental temperature in summer is said to adversely affect the efficiency of milk production in buffaloes. To devise a thermal relief measure so as to .alleviate the buffaloes of the stress of heat, four experimental treatments were used. Of these, the combined use of open shed, showers and ceiling fans helped in chocking the decline in daily milk yield and body weight of buffaloes. These animals also exhibited oestrus with more regularity. The use of open shed and showers alone or open shed and ceiling fans alone also showed better results than simply keeping the animals under tree shade and allowing them to wallow in water twice a day.

A significant increase was noticed in fodder consumption and milk yield due to increased frequency of feeding buffaloes, while the protein and solid s-not-fat (SNF) contents in milk were not affected significantly by changing feeding frequency. Milk fat and total solids contents did increase significantly in buffaloes fed once a day. Twice a day feeding resulted in comparatively higher milk yield.

Milk production was significantly higher in buffaloes fed 140 gm dicalcium phosphate as compared to those given 70, 210 or 280 *gm* daily in their ration. The average daily milk yield in the same order was 13.42, 10.18, 10.78 and 9.73 kg. The intake of dry matter decreased with feeding of calcium and phosphorus at levels lower than those recently recommended by NRC (USA).

Three groups of buffaloes fed a concentrate mixture containing 62, 70 or 78% TDN to meet production requirements showed that milk production increased with higher level of energy. Although differences in actual milk yield of buffaloes fed three different levels of energy were non-significant yet the ration significantly influenced the 4% fat corrected milk yield. The butter fat contents averaged 6.08, 6.14 and 6.57%, respectively. The protein and SNF percentage was not noticeably affected by changing the level of dietary energy. The green fodder and concentrate consumption did not differ significantly among the buffaloes kept on different feeding regimes.

Intramuscular injections of 10 or 20 IU of oxytocin after normal evening milking on alternate weeks did not depress the following morning milk yield. The overall mean milk production was higher for experimental weeks. The buffaloes given 10 IU oxytocin produced from 0.79 to 5.56 kg residual milk per week,

whereas those injected 20 IU oxytocin, produced 0.85 to 4.54 kg per week. The fat content was significantly higher in residual milk which, however, showed low SNF compared to that in normal milk. The number of leucocytes in normal and residual milk of eight mild mastitic buffaloes was 2,322 and 5,175 thousands per ml. These buffaloes were injected 10 IU oxytocin after each milking for 7 days. The buffaloes resumed normal production from 4th to 13th milking after initiating the treatment. The number of leucocytes in the milk at this stage ranged from 575 to 1,225 thousands per ml. The number of leucocytes and Whiteside test scores were significantly correlated.

The area ploughed by a buffalo on an average was 0.57 acre while working three hours daily in winter season. The draught work of this intensity did not affect the milk yield or milk composition. A single buffalo exerted an average draught of 155.3 pounds which was proportionate to 12.4 to 15.4% of the body weight. The average speed recorded was 40.64 meter per minute and the animal developed a horse power of 0.63.

The average SNF content in buffalo milk was not significantly different during various seasons of the year. In contrast, the fat and protein contents -were significantly higher in winter than in summer. The highest values of fat (7.80%) and protein (4.38%) contents were recorded in November and February, respectively, while the lowest contents of the corresponding constituents (6.10 and 3.89%) were observed in the months of June and July, respectively. The maximum percentage of SNF in milk was found in the 1st month post-calving, decreasing gradually to a minimum by the end of 3rd month. Thereafter, the SNF percentage started rising till the end of lactation. The percentage of butter fat in buffalo milk showed a persistent rise from sometime after calving till the end of lactation. The increase in butter fat content, however, was more marked in last few months of lactation. On average, the protein content was high during the 1st month post-calving; it declined gradually till 5th month and then steadily rose from 4.19% in 6th month to 4.67% in 10th month of lactation.

No carotene could be detected in buffalo milk; it might be that buffaloes as compared to cows are better converters of carotene to vitamin A. The vitamin A content in 100 ml of buffalo milk during the months of February, March, April, May and June was 79.37, 79.67, 77.50, 70.80 and 68.37 micrograms, respectively.

Influence of varying energy levels in the rations on the production and composition of milk showed that the milk production increased with higher level of energy. The differences in the actual milk yield were non-significant. However, the ration significantly influenced the 4 per cent fat corrected milk yield. The butter fat and total solids percentage significantly increased with an increase in the energy level of the ration. The protein percentage and SNF contents were not affected non-significantly by the change in energy level. The specific gravity and titrable acidity were not affected by the change in the energy level of the rations.

Sorghum silage was compared with routine fodder in lactating buffaloes. The analysis of variance revealed a non significant difference in milk production, milk protein, SNF, total solids and ash. While highly significant differences ($p < 0.01$) in feed intake were observed. The results suggested that feeding of silage to lactating buffaloes be considered to get results comparable to those obtained from routine fodder. Silage feeding as a substitute for green roughage to greater extent can be practiced for dairy animals during the periods of green fodder scarcity.

Feeding urea-treated and untreated wheat straw to Nili-Ravi buffaloes at approximately the same stage of lactation and with almost similar milk yield indicated that there were non-significant differences in milk composition and production of buffaloes. The feed intake (wheat straw, green fodder and concentrate) in both the groups also did not differ significantly.

Feeding value of Mott Grass and its silage in different combinations was studied in buffaloes. A significant

increase was observed in DM contents and various cell wall constituents of whole Mott grass plant and leaf and stem fractions with maturity, whereas an almost corresponding decrease occurred in crude and true protein, ether extract, ash contents and in vitro dry matter digestibility (IVDMD) with advancing maturity., A slow increase in DM contents was recorded up to 30 days age of Mott grass. Thereafter it increased rapidly. There was noticed a gradual increase in lignin contents of the plants and a consequent steady decline in IVDMD with advancing stages of plant growth. Average DM and crude protein intakes of the experimental diets were statistically the same Different dietary treatments had no effect on milk yield and its composition. Similarly, the ruminal pH remained unaffected. However, ruminal ammonia was higher in buffaloes fed Mott grass and Mott silage separately compared to those fed Mott grass and its silage in combination. Dry matter and crude fiber digestibility was significantly higher in buffaloes given Mott grass and its silage in combination than in those fed Mott grass and Mott silage separately in different groups.

1.2. Analytical techniques

The plastic bead method of Golding and Udy's Orange (G) dye binding method were evaluated as to their accuracy for estimating SNF and protein content, respectively, in buffalo milk. It was found that these methods were ' as much accurate in determining these constituents in buffalo milk as in cow milk.

1.3. Keeping quality

Buffalo milk samples did not show any change in appearance, taste or odour up to 4 hours post-milking in the months of July and August. After keeping for 8 hours, the milk showed curdling and on boiling clear whey separated from the clots. It also produced sour taste and odour. Fresh buffalo milk showed 0.15% titrable acidity which increased up to 0.76% after 12 hours storage. The viable bacterial count was about 1 million/ml which increased to 2.6×10^6 ml of milk after 4 hours storage. It was found that buffalo milk could be stored at room temperature for more than 4 hours without deterioration in its quality during the months of July and August.

Procaine penicillin persisted in infused normal quarters of the udder up to 72 and 60 hours post-infusion, when infusions were made in mineral oil and distilled water, respectively. In mastitic quarters, antibiotic infusions in mineral oil persisted up to 72 hours. Penicillin was transferred from infused to uninfused adjacent quarters when infusions were made in aqueous base but not in an oily base. The post-infusion antibiotic concentration in milk from infused quarters was inversely related to the milk yield of an animal.

1.4. Milk letdown and lactation

The letdown of milk in buffaloes was caused in the minimum time (95.44 seconds) by washing and massaging the udder, whereas the use of udder massage plus washing plus feeding of concentrate and/or green fodder took the maximum time (177.41 seconds) to bring about letdown of milk. In general, calf sucking "as a stimulus was found to be used in 68.32% of the 382 buffaloes observed, while in rural area, this stimulus alone was applied to as much as 81.40% of the animals. The effect of milk yield per day, stage of lactation and stage of pregnancy on letdown time did not show any definite trend. The overall average letdown time was 99.33 seconds.

The lactation records of Nili-Ravi buffaloes showed that the age had a significant effect on the persistency of lactation. It was the lowest (0.8033) in 1st lactation and the highest (0.9489) during the 2nd. The buffaloes calving during spring season were better in persistency than those calving in any other season. The persistency of lactation was significantly influenced by calving interval; animals with calving interval of 501-550 days showed the highest persistency.

1.5. Incidence of mastitis

It was observed that the incidence of mastitis in buffaloes was higher in urban than in rural areas. The buffaloes in 3rd, 4th and 5th lactations had the highest incidence; it was more true during peak production period of any lactation. Among various seasons, summer seemed more conducive in causing mastitis in buffaloes. Buffaloes were found to be more susceptible to mastitis when milk was used as a wetting agent both in urban and rural areas. Cleaning of floors more than once a day reduced the incidence of mastitis.

There was no adverse effect of post-milking dipping of teats in 1% Lugol's iodine solution on milk production in buffaloes; rather it was accompanied by a slight increase in the milk produced from the dipped quarters. The average leukocyte count per ml of milk was 0.491 for the control quarters and 0.311 million for the dipped quarters. New udder infections, such as mastitis, were checked appreciably.

1.6. Miscellaneous

To estimate live weight of buffaloes from certain body measurements, the average height, girth, length and weight of 2-5 years, 6-8 years and those of above 8 years old buffaloes were recorded. Highly significant correlations were observed between various body measurements and body weight. The prediction equations were derived for estimating live weight of buffaloes in three age groups, from the joint effect of body measurements, i.e., height, girth and length. The goodness of fit of the equations was tested by comparing the expected body weights with those actually observed using Chi-square test.

The young buffalo stock was found to have higher respiration and pulse rates and rectal temperature than those of older animals. The female animals exhibited higher values than males till the age of one year after which the trend reversed and the males generally showed higher respiration and pulse rates as well as rectal temperature. The values for these parameters in buffaloes of all age groups were found to be higher at evening time than those of the morning. The lactating buffaloes had higher respiration and pulse rates than the non-lactating animals. Neither pregnancy and lactation nor sex did cause any significant difference in body temperature of buffaloes.

The skim milk as a diluents preserved the buffalo spermatozoa for a longer time as compared to egg yolk-citrate, egg yolk-glycine and egg yolk-glucose-bicarbonate diluents at 37°C. All these diluents maintained the best livability of the spermatozoa at low dilution rates. Egg yolk-glycine diluent maintained greater viability of the spermatozoa which were least influenced by the high dilution effect and prolonged storage at 5°C. The motility percentage of the spermatozoa progressively declined in all the diluents when the concentrations were reduced from 20 to 2.5 million per ml of the diluent.

As compared to the controls, significantly better weight gain and feed efficiency were observed in heifers given 50 mg subcutaneous implants of progesterone. No ill-effects were observed except the development of mammary glands in the progesterone treated animals. The results suggested that the growth rate in buffalo heifers could be enhanced with progesterone implants.

The heifers fed maize fodder consumed significantly more as compared to those given sorghum fodder. The heifers on maize fodder exhibited better growth rate than those fed sorghum fodder. The protein efficiency ratio of the fodders was not significantly different from each other. These results substantiate the hesitation of farmers to feed sorghum to their animals.

By using *in vivo-vitro* method of predicting forage quality, it was observed that dry matter digestibility of various forages (shaftal, berseem, lucerne, sorghum and guar) was significantly enhanced with increasing durations (12, 24, 48 hours) of sample retention in fistulated rumen of a male buffalo.

The comparative frequency of the use of oxytocin and its influence on milk production and reproduction in buffaloes and cows in urban as well as rural area, located with in the radius of 15 km from the city. 'Clock

Tower' Faisalabad was determined. The oxytocin was being used in 18.8 per cent of the 1573 buffaloes and 9.7 per cent of the 527 cows. Natural milk ejection and reflex was adversely affected in 49 per cent buffaloes and 37.3 per cent cows. It was revealed that more than 50 per cent of the dairy animals receiving oxytocin tended to abort, mortality in earlier stages of the pregnancy. The overall health of the buffaloes and cows especially those having poor body condition were reported to be adversely affected as a result of prolonged oxytocin treatment.

A comparative study of the frequency of different types and extent of cruelties inflicted on farm animals was carried out during summer and winter season in both city and suburban areas, located within the radius of 12-15 Km from the center of the Faisalabad city. Five hundred observations, comprising sixty percent from the city and the rest from the suburban area/localities, were made using a pretested interview schedule.

Cruelties being inflicted on 10.6, 24.8, 19.8, 17.4, 45.2, 67.4, 14.4 and 33.4 percent of the 973 buffaloes, 487 cattle, 448 sheep, 539 goats, 405 donkeys, 224 mules, 144 camels, 863 horses/ponies and 406 poultry birds/locations respectively were observed in this study. Among the 4489 animals observed, 1449 animals (32.27 percent) were found being subjected to cruel practices.

The extent of cruelties like beating during milking in buffaloes and cattle was 41.8 and 24.79 percent respectively. Rough handling during transportation including loading, unloading and overcrowding in sheep, goats and poultry birds was of the order of 53.9, 39.2 and 48.5 percent, respectively. Overloading cases in draught animals such as donkeys, mules, horses and camels were 57.9, 65.5, 48.0 and 61.2 percent, respectively. Carelessness towards wounds inflamed parts and lameness in donkeys mules and horses was observed in 33.3, 21.2 and 24.8 percent animals respectively. These constituted the major types of cruelties, There were also observed other types of cruelties such as unnecessary exposure to severe weather, wandering animals, vaginal manipulation of tail, inadequate feeding/watering during transportation, use of goad (spiked stick) on draught animals as well as old, emaciated, neglected and starving animals. Teasing /beating of animals by children subjected to. Observations on aspects such as shrinkage, bruising and rough handling of animals before or during slaughtering, were also made in the slaughterhouse.

2. CATTLE

2.1. Yield and composition of milk

Sahiwal cows were fed concentrate ration at 0.3, 0.4 or 0.5 kg/litre milk produced. The highest yield was obtained in the cows fed 0.5 kg concentrate/litre milk produced. There was no significant change in the butter fat content in the milk of cows given different concentrate levels; the protein percentage also did not differ significantly. However, the SNP contents were noticeably influenced by varying levels of concentrate feeding. It was observed that concentrate feeding at 0.5 kg/litre milk did result in increased milk yield, however, comparison of feeding costs revealed that 0.3 kg concentrate/litre of milk produced, was rather an economical level for feeding Sahiwal cows.

Three levels of cytozyme (Ration*), i.e., 0.17, 0.25 or 0.34 kg/ton of feed were used as a supplement in Sahiwal cows which were fed a ration containing green fodder plus a concentrate mixture at the rate of 2 kg at each milking. .The milk yield of cows fed cytozyme at different levels did not improve compared with that of control group. The fat content in milk of cows receiving varying amounts of cytozyme was also not significantly different. The SNF content of milk was higher in cows fed cytozyme at a level of 0.34 kg/ton of feed than in cows supplemented with 0.17 kg cytozyme/ton of feed. The body weight of experimental cows was not affected by any of the three levels of cytozyme used. Up to a level of 0.34 kg/ton of feed, no marked effect of cytozyme (Ration+) could be observed on production and fat content of milk in Sahiwal cows.

Using a double reversal trial, Sahiwal cows divided into two groups were fed silage and routine fodder plus concentrate mixture for three consecutive periods of 28 days each. The average daily milk yield of animals in two groups was 4.31 and 4.60 kg on silage feeding and 4.78 and 5.31 kg with routine fodder. Similarly, the average daily feed intake values for the two groups with silage feeding were 23.81 and 20.86 kg, while with .routine fodder these were 40.41 and 34.00 kg, respectively. The differences in milk yield and milk composition due to the two feeds were non-significant, whereas significant differences in fed intake of cows in favour of the routine fodder were observed. It appeared that silage feeding could be adopted in Sahiwal cows since milk yield with silage feeding was almost comparable with that obtained by using routine fodder.

Wheat and rice straw was treated with 4% NaOH solution for 24 hours. The straw was then washed in running water to remove the unused alkali. The treated straw plus chopped green berseem were offered to lactating Sahiwal cows according to their body requirements, along with a fixed amount of concentrate mixture. The digestibility of crude fiber increased from 46.1 to 62.0% for wheat straw and from 45.2 to 63.4% for rice straw due to alkali treatment. The average daily milk yield of animals given treated straw was significantly higher than that of those given untreated straw. However, no influence was observed on milk composition and body weight of the cows.

In comparison to that of cows, buffalo colostrum had higher fat, protein, SNF and ash contents. The lactose, however, showed a reverse trend. The average percentage values for these constituents ranged from 6.10-3.80, 16.20-4.00, 18.66-8.18, 0.84-0.58 in cow and 8.30 -4.80, 17.36-4.84, 18.88-9.56, 1.56-0.72 in buffalo colostrum, respectively. In both the species, a progressive fall was noticeable in all the major constituents of colostrum except lactose which with the passage of time showed a gradual increase. On comparative basis the buffalo colostrum changed to normal milk earlier than that of cow.

The average percentage values for major constituents of Sahiwal cow milk, determined by employing standard methods were: fat, 4.75; protein, 3.76; lactose, 5.12; ash, 0.61; total solids, 14.24 and water, 85.76. The average carotene content in 100 ml of cow milk was 34.00 micrograms in the month of February, decreasing gradually to a minimum level of 26.75 micrograms in the month of February, decreasing gradually to a minimum level of 26.75 micrograms in June. Similarly, vitamin A content in 100ml of cow milk was 40.25 micrograms in the month of February. It almost followed the pattern of carotene content and decreased to 35.37 micrograms in June.

Lactating Sahiwal cows were fed different levels (0, 2, 4 and 6 %) of animal fat (tallow) as energy supplement in the diet to see its effects on their production performance. Daily milk production of experimental animals increased by feeding tallow supplemented diets (8.08 –9.5 lit/day) followed by the same trend in its composition in terms of fat, total solid (TS) and solids-not-fat (SNF). However, protein percentage decreased linearly as the level of fat increased in the diets. The specific gravity of milk was found unaffected in all the cases. Similarly body weights (BW) and body condition score (BCS) remained unaltered across all treatments. Feeding and production cost per cow increased linearly ($p < 0.05$) and quardratically ($p < 0.05$) with increasing amount of tallow in the diet whereas, income from milk produced (Rs. Per day per cow) was significantly ($p < 0.05$) lower for cows fed the control and diet containing six percent versus those fed two and four percent tallow. Income over feed cost was significantly ($p < 0.05$) higher in cows fed two and four percent supplemented tallow compared to those fed the control diet. No significant differences ($p > 0.05$) were noted in cows fed diets having two and four percent added tallow. The results showed that tallow is an economical source of energy for supplementation in the diet of lactating cows. The level of tallow up to 4% of the diet dry matter appears to be suitable one in cows diet as an energy source.

Data analysis on lifetime traits of Sahiwal cows revealed that the age at first calving did not significantly affect first lactation milk yield and other lifetime parameters studied except longevity and coefficient of

reproductive ability. Fist lactation milk yield was significantly correlated with milk yield per day of productive life. The herd life increased by 0.3632 ± 0.3312 days for each day increase in age at first calving. The lifetimes milk yield increased by 0.0973 ± 1.3726 Kg for each Kg increase in first lactation milk yield for any fixed value of age at first calving. The milk yield per day of productive life increased by 0.00015 ± 0.00034 for each day increase in age at first calving.

The productive (first lactation milk yield, total lactation milk yield, milk yield per day of lactation length, life time milk yield, lactation length and dry period) and reproductive (age at first service, age at first conception, age at first calving, service period, services per conception, gestation period and calving interval) in Red Sindhi cow. The lactation milk yield LY was 1531.02 ± 3489 Kg. The effect of season and year of calving was not significant while the effect of lactation number and length was significant ($p < 0.01$) on this trait. The life time milk yield (LTMY) was 5203.42 ± 178.43 Kg. The effect of season, year of birth and age at first calving was significant ($p < 0.01$) on this trait. Out of total culling (89.38 %) 26.55% culled due to reproductive disorders, 21.24% due to udder problems and 8.85 % had no proper reasoning. Out of total mortality (10.62 %) 33.33 % died due to snake bite, 33.33% due to hypocalcaemia, 8.33% due to tympany, and 8.33% due to retention of urine and remaining 16.67% mortality recorded due to unknown reason.

Production and reproduction data of imported and farm-born Holstein Friesian cows revealed that in imported cows the age at puberty, the age at first calving and the age at second calving averaged 564.61±13.5, 830.44±13.13 and 1307.07±23.51 days while in farm-born cows the corresponding values were 678.31±14.78, 956.97±14.66 and 1418.86±18.81 days, respectively. Imported cows had significantly longer productive and herd lives than farm-born cows.

2.2. Miscellaneous

The incidence of mastitis was higher in cows of urban area than those in the rural area. Compared with buffaloes, cows seemed to be comparatively less susceptible to mastitis. The highest incidence was observed during 2nd, 3rd and 4th lactations; it was especially true during peak production period of any lactation. Among various seasons, the summer appeared to have maximum incidence of mastitis. Cleaning of floors more than once a day helped in reducing the incidence of mastitis in cows.

It was observed that due to high temperature-humidity index (T.H. Index), low quality semen was produced in cow and buffalo bulls. Increased body temperature produced less marked effect on semen quality than did the high T.H Index. The correlations of T.H. Index and sperm concentration and body temperature and sperm concentration were -0.335 and -0.320, respectively. The correlations between T.H. Index and the percentage of dead spermatozoa and between body temperature and dead spermatozoa were 0.720 and 0.439, respectively.

Phosphorus supplementation to growing Sahiwal calves was studied. Statistical analysis of data indicated non-significant effect of phosphorus supplementation on weight gain. There was significant effect of phosphorus supplementation ($p < 0.05$) on blood serum phosphorus.

3. SHEEP

3.1. Body weight gain, wool production and carcass quality

As influenced by grazing plus supplemental feeding and grazing alone, the average body weight gain was 12.90 and 8.50 kg in experimental and control sheep of Salt Range breed, respectively. The average fleece weight was 0.51 and 0.39 kg, whereas the moan staple length was 6.15 and 5.77 cm in the same order. The true wool fibers were 72.00 and 68.83X; heterotypical, 16.80 and 17.87%; modulated, 10.40 and 11.84% and kemp, 0.8 and 1.5% in experimental and control groups. The mean fiber diameter of

supplemented sheep was 32.25 microns and that of control group was 32.01 microns. At visual appraisal, the carcasses of supplemented group were graded 'good' while those of sheep kept on grazing alone were of 'cull' grade, the dressing percentage being 53.50 and 46.03, respectively.

The difference in the fleece weight of the two experimental groups of Salt Range sheep, given 32 and 64 mg of thyroxin, respectively, was non-significant when compared with the control group. Similarly, the difference in fiber diameter and staple length between the three groups was not significant. The lambing percentage in various groups was: control sheep, 60; 32 mg group, 80; and 64 mg group, 50 only. Twinning, observed only in 32 mg group, was 20%.

The crossbred (fat-tailed Salt Range x thin-tailed Kajli rams) lambs weighed significantly heavier at birth as well as at slaughter at 13 months age than the purebred docked or undocked lambs. At slaughter the purebred docked lambs weighed on average 1.35 kg more per head than the undocked lambs. The crossbred F_1 lambs had higher dressed carcass weight, dressing percentage, weights of loin and flank and leg cuts than those of the purebreds. Mean levels of blood cholesterol and phospholipids were significantly higher in purebred docked and undocked lambs than in crossbreds.

The docked Salt Range sheep were more efficient in converting feed to flesh, requiring 5.6 kg of feed per kg gain, compared to 6.3 kg feed required by undocked animals. The docked rams served 67% of the ewes of which 88% conceived. The undocked rams served only 33% ewes of which 50% conceived. All of the docked ewes, as compared to only one-half of the undocked ewes, lambed successfully. The birth weight of the lambs of the docked ewes was significantly higher than that of their undocked herd mates. The finish (including marbling of meat), quality (including fineness in grain and juiciness) and flavour of mutton of the docked lambs were superior to that of the undocked animals. It showed that docking favourably influenced the body weight and feed efficiency of fat-tailed sheep.

The comparative evaluation of gross fleece weight, staple length and fiber diameter showed that the differences in this respect between the purebred docked, purebred undocked and F_1 crossbred sheep were non-significant. Five tail-types/shapes were observed in F_1 lambs, ranging from thin tail (41. IX) to fat tail (58.9%). The backcross lambs appeared to possess thin-tailed characters to a higher degree.

The height, girth, length and body weight of 400 sheep each of Damani and Thalli breeds were recorded to develop formulae to predict their live weight. It was found that highly significant .correlations existed between various body measurements and live weight of sheep. From the joint effects of body measurements, i.e., height, girth and length, prediction equations were derived separately for the two sheep breeds. These equations were tested for goodness of fit by comparing 20 randomly picked observations to their estimates by means of Chi-square test. The results showed that the equations fitted well with the data obtained.

Effect of feeding different levels of Iple Iple (Leucaena Ieucocephala) and berseem hay (*Trifolium alexandrium*) on the growth rate of lambs was studied. Three experimental forage/forage mixtures of Iple Iple and berseem hay in different ratios viz., 75: 25, 50:50 and 25: 75 were fed. The berseem hay served as control forage. The findings revealed that forage containing 50 per cent Iple Iple plus 50 per cent berseem hay was most economical and can be used without any hesitation or fear of adverse effect. At 75 per cent Iple Iple plus 25 per cent berseem hay reduced weight gain was observed.

3.2. Wool follicle

The primary wool follicle density in Kajli sheep on an average was 424.16, 445.41, 456.26 and 413.74 per sq. cm. in animals aged 1, 2, 3 and 4 years, respectively, whereas the density of secondary follicles in the corresponding age groups was 202.08, 210.41, 220.41 and 194.16 per sq. cm. The results evidently showed a slight increase in both types of follicle population from 1 to 3 years age, while a significant

decline took place during the 4th year. The diameter of primary and secondary follicles varied from 139.23 to 154.18 microns and 52.24 to 61.77 microns, respectively. The diameter of both types of follicles increased with advancing age. With minor exceptions, the trend in this respect in Lohi and Salt Range sheep was found to be the same.

3.3. Physico-chemical characteristics of wool

The percentage of true wool fibers and heterotypical fibers increased from 1 to 4 years age, while the medulated fibers declined from 18.76 to 10.98% in Kajli sheep during the same period. The average fiber diameter at 1 year age was 36.22 microns, whereas at 4 years it slightly increased to 37.62 microns. On average the grease contents from 1 to 4 years age were 0.59, 0.69, 0.78 and 0.96%, showing a significant increase with advancing age. The ash percentage in wool was 1.42, 1.83, 1.87 and 1.89 in animals aged 1, 2, 3 and 4 years, respectively. Maximum increase in body weight occurred during first six months age.

The physico-chemical characteristics of wool of non-descript sheep native to Gilgit district were: average grease fleece weight, 1.40 kg per annum; mean fiber length, 7.30 cm; mean fiber diameter, 29.78 microns; wool fiber types, i.e., true, medullated, heterotypic and kemp averaged 61.45, 18.03, 18.49 and 2.03%, respectively; mean moisture content, 10.03%.

3.4. Semen quality

Various tests conducted to determine the quality of semen of Lohi rams showed that the semen produced in winter was of significantly higher quality than that produced in autumn, spring and summer. The semen collected with electro ejaculator was watery and thin, while that collected with an artificial vagina was invariably thick and creamy white in winter as well as in summer. The volume of an ejaculate and sperm concentration was the largest in winter and lowest in summer. The preputial epithelial cells in semen were maximum in autumn and minimum in winter. Mortality was the highest in winter. The dead and abnormal sperm percentage and cytoplasmic droplets decreased in winter and increased in. summer.

Compared with undocked rams, the sperm density was significantly high in the semen of docked Salt Range rams and progressively increased from early to late winter. The percentage of abnormal and dead sperm was observed to be low in the semen of docked rams. The longevity rating was also markedly better for semen of docked rams as compared to that of the undocked rams since the semen of docked rams retained motility for more than 10 days in winter and not less than 7 days in summer.

Comparative efficiency of various diluents for semen' of fat-tailed rams was determined. The diluters rated in order of maximum effectiveness for maintaining motility over 7 days of storage under climatic conditions of this country were skim milk plus 10% glycerol, egg yolk-glycine, skim milk and egg yolk-citrate. The concentrations rated in order of maximum effectiveness for maintaining motility over 7 days of storage wore 30 x 10", 20 x 10^6 and 15 x 10^6 motile spermatozoa per ml. The maximum motility was observed on the first day of storage.

4. GOAT

4.1. Growth pattern and grazing behaviour

The average birth weights in male and female kids of Beetal and Barbari breeds were 2.80 and 2.15 kg vs. 2.07 and 1.93 kg, respectively. The mean milk consumption up to weaning age (4 months) was 32.76 and 26.90 kg per kid in Beetal and Barbari goats, respectively. The overall fodder consumption was 28.7% higher in Beetal than in Barbari kids. The latter consumed 129 kg green fodder per kid during 4 months experimental period. The amount of concentrate consumed per kid by Beetal and Barbari kids

was 18.19 and 12.19 kg, respectively. The mean live weight at the end of 17th week was 15.75 and 11.13 kg in the same order. The age at puberty in Beetal goats was 390.35 days compared to 196.95 days in Barbari. The average weight gain per kid per week was 754 and 532 gm in the corresponding animals. This showed 41.76% superiority in weight gain of Beetal kids over Barbari kids. The dressing percentage, however, was higher in Barbari (51 -54%) than in Beetal (50 - 52%). The plasma glucose contents in Beetal and Barbari kids averaged 45.37 and 44.28 mg/100 ml, respectively. The plasma proteins increased with advancing age in both the breeds. The Beetal kids had higher cholesterol contents than the Barbari kids (131.65 vs. 124.63 mg/100 ml blood).

Both the Beetal and Barbari goats showed a tendency to eat mainly top portions of the fodder plants (maize, millet, sorghum, swank and guar) for first 3-5 days. Then they would resort to close to ground grazing in the same fields. The goats actively consumed both the grasses and weeds during autumn. During winter months, usual grazing time was 10.00 AM to 4.00 AM. The animal H actively grazed for he first two hours, then they either resorted to inactive grazing or would rest. The cost benefit ratio for Barbari goats was 1:1.69 as against 1:1.67 for Beetal.

On range area, the overall preference index of Barbari goats was high for 'Khabble' grass *(Cynodon dactylon}* which constituted 40.57% of the total number of bites per day made on different plant species. The browsing species were utilized more during the drought period. In contrast, Thalli sheep heavily utilized 'Khabble' grass throughout the period of its availability. 'Wan' and fallen dry leaves of 'Wan' were considerably picked by the sheep. The sheep tended to browse only when young and succulent 'Khabble' grass was not available.

Study on Production and reproduction performance of Beetal and Nachi goats revealed that Beetal kids were significantly ($p < 0.01$) heavier than Nachi kids at weaning. Adult weight in Beetal females was significantly ($p< 0.01$) higher than that of Nachi females. Beetal females conceived at a significantly ($p< 0.01$) lower age than Nachi. Kidding interval averaged 358.02 ± 6.5 and 360.60 ± 9.90 days. respectively. The difference in kidding interval between the two breed groups was non-significant. Gestation averaged 147.9 ± 0.25 and 148.17 ± 0.46 days respectively. Rate of single, twin and triplet births was 79.28, 19.28 and 1.44 per cent and 71.59, 23.86 and 4.55 per cent in Beetal and Nachi females, respectively. Milk production of Beetal and Nachi in first and second lactations averaged 119.41 and 189.4 Kg, and 148.92 and 224.19 Kg, respectively. Milk production of Nachi goats was significantly ($p < 0.01$) higher than Beetal.

Atriplex species commonly known as saltbushes are strong candidates for introduction into degraded rangelands for increasing productivity in arid or semi arid regions of the world because of their high productivity and ability to establish under arid conditions. The effect of Atriplex amnicola alone and in combination with Sudex on performance of goats was studied and it was concluded that salt tolerant plants like Atriplex, could be fed to the dwarf goats for maintenance particularly during scarcity periods. Animals need some supplemental feeding if they are maintained on these salt tolerant plants. Atriplex amnicola can be fed to the small ruminants in combination with local fodders like Sudex, up to a level of 50 percent.

It was further concluded that satisfactory weight gains and milk production could be obtained when halophytes are fed to goats in mixed ration as substitute for conventional fodder. The digestibility of Atriplex substituted feeds are comparable to traditional feeds when given along with some concentrate supplementation. It is indicated that *Atriplex amnicola* can be utilized both in hay and fresh form in mixed ration with other local fodders.

4.2. Meat production

Meat production efficiency and blood picture of 4-6 months old Barbari goats were determined. The

average weekly weight gain of various experimental goats ranged between 0.22 to 0.48 kg. On average, the weekly fodder and concentrate intakes were in the range of 3.22 to 4.50 and 2.07 to 3.22 kg, respectively. The mean dressing percentage was 48.33. The average values for blood sugar, protein and cholesterol were. 54.16 rag, 6.19 gm and 154.96 mg per 100 ml of blood.

The data collected from various slaughter houses showed that the average dressing percentage was 48.40 and 47.97 in male and female goats, while in male and female sheep it was 45.16 and 42.88, respectively. Irrespective of the species and sex higher dressing percentage was observed in animals aged about 6 months. The goats showed better carcass yield than the sheep. The average amount of blood expressed as percentage of body weight in goats was 4.10, whereas in sheep it was 3.95. The mean weight of skin as percentage of body weight was 7.20 in goats and 9.91 in sheep. The age and species both had significant effect on the weight of skin. The age and sex significantly influenced the head and trotter weight in'' both the species. The average weight of full and empty stomach constituted 13.34 and 3.77% of the body weight in goats, whereas it was 16.17 and 3.81% in sheep, respectively.

4.3. Miscellaneous

The mean fiber length in different goat breeds such as Dera Din Pannah, Nachi and Pak-Angora and in Bahawalpuri camel was 10.71, 9.44, 14.82 and 8.35 cm, respectively. The mean fiber diameter varied from 30.43 to 100.65 microns in these animals. The percentage of wax content ranged from 0.87 to 2.27 in these animals and it was found linearly correlated with fineness of hair fibers of goats as well as camels. The highest suint content (5.76X) was observed in camel and the highest wax content (2.27%) was found in Pak-Angora goats.

5. MISCELLANEOUS STUDIES

5.1. Quality of milk and its production cost

The quality of raw milk marketed in the city of Faisalabad and that produced at the University dairy farm, and that of the packed milk marketed in various cities was determined. The following average values were observed for the major constituents in raw market milk, farm milk and packed market milk, respectively: water, 88.33, 84.44 and 87.91-89.31; fat, 3.32, 5.93 and 2.58-3.54; protein, 2.81, 3.97 and 3.44-3.90; lactose, 4.97, 4.97 and 3.82-4.65; ash, 0.57, 0.69 and 0.68-0.82; SNF, 8.45, 9.63 and 7.94-9.37%, respectively. The direct microscopic count in respect of raw milk in the same order was 32, 128, 000 and 2,544, 560 per ml milk, whereas for some brands of packed milk this count was nil, while the others had 32,000 to 34,000 bacteria/ml milk. The coliform count was 3, 69,665 and 45,960 per ml of raw milk. However, among various brands of packed milk, only two had 5 and "8 coliforms per ml.

The reduction of methylene blue dye in case of raw milk took place in less than 2 hours in 68% samples, while only 32% samples did not decolourise till after 5 hours. The methylene blue reduction time for the various brands of packed milk ranged from 5.55-8.70 hours since most of the packed milk was UHT milk. Compared to the farm milk, the milk marketed in the city of Faisalabad was found to be very poor in quality. Even in some brands of packed milk, the fat and SNF contents were much lower than the legal requirements of West Pakistan pure food laws.

The livestock owners randomly picked from 64 villages were divided into five categories (A, landless; B, possessing 5 acres; C, 6 to 10 acres; I), 11 to 15 acres; E, more than 15 acres). They were interviewed with the help of a questionnaire to determine the cost of milk production in 1979. The analysis of the costs and benefits revealed that the overall average expenditure for maintaining a buffalo or a cow was Rs. 14.83 or 8.55 per day, respectively. The average cost of producing one litre of milk was Rs. 1.81 and 1.78 in buffaloes and cows, respectively. On average, the net profit per annum per buffalo was Rs. 566.51, while it was Rs. 377.80 per cow. The profit in case of cows was low since the average yield of milk per

day per animal was only 4.79 liters compared to 8.79 liters per day per buffalo. Maximum net profit was obtained by livestock owners having 11 to 15 acres of land.

A simulating study showed that the expenditure incurred per buffalo was higher than that for maintaining a lactating cow in urban areas. This was because of higher cost of feed, labour and management in urban areas. However, higher production cost in cities was largely compensated in case of buffalo due to its higher milk yield as compared to that of cow. The net income from buffaloes maintained in villages nearby a road was more than that obtained from buffaloes maintained in the interior of rural areas. It was further observed that the income per buffalo per day in urban areas was higher than that obtained from buffaloes kept in villages nearby a road and those kept in the interior of rural areas. It was probably because of lack of marketing facilities for timely disposal of fluid milk in such areas.

Low profits seemed primarily due to the shortage of feed and fodder qualitatively as well as quantitatively and the low genetic potential of the milch animals.

5.2. Milk production and utilization

The trend of milk production and utilization was assessed in and around Bannu/D.I.Khan city, using interview method. The estimated average supply of milk from external and internal sources was 10,543 liters per day. There were 701 buffaloes, 339 cows, 73 goats and 60 sheep reported to be in milk at the time of interview. The daily average milk production of the buffaloes and cows owned by the professional 'gowalas' was 8.15 and 3.40 liters, respectively, while the corresponding production from the household buffaloes and cows was 6.81 and 4.26 liters per day, respectively. The utilization of milk by consumers in comparatively low, medium and high income grows was 191, 241 and 272 ml per head per day, respectively. The daily per capita consumption of milk by adults and children, respectively, was 230 and 239 ml. Prom the above it was evident that the milk supplied/produced in and around those cities was not in consonance with the demand of the dwellers.

A study was designed to investigate the milk production pattern, dairy herd composition, constraints, problems and shortcomings faced by farmers of irrigated Central Punjab. The preference for cattle was very low and only 9% farmers liked both the species equally. Almost 96% respondents were maintaining buffalo while cattle were kept by only 31% farmers. On an average the buffalo herd size (8.7 ± 0.88) was almost double in number than cattle herd size (3.7 ± 0.24) and was maintained by 55% farmers. It was observed that intensity of livestock keeping/acre decreased with increase the farm size. Small medium and large land owners had herd size comprised of 4.60, 10.49 and 28.98 animal units. Almost 50% respondents were having 3.11 animals units of buffalo.

A survey was conducted to study the cost of production of buffalo and cow milk and its utilization in and around Muzafarghar city in 1989. The average daily milk yield per buffalo and cow was 5.73 and 2.99 liters, respectively... It was observed that the feeding of concentrates was positively correlated with size of holdings.

5.3. Livestock production

The average herd size was found to be 9.9 animal units. The number of animal units was more with the farmers having large holdings. On average, 6.3% of the cultivated area was used for fodder production. The percentage of wet animals was higher in the irrigated areas as compared to that in rain fed areas (36.3 vs. 26.1). The average per annum cost of maintaining a buffalo was Rs. 4,267.76 which rose to Rs. 4,772.76 with large farmers and declined to Rs. 3,729.20 in respect of landless farmers. The maintenance cost of a cow producing on an average 552.44 liters milk per lactation (214 days) was Rs. 2,705.22 per annum. On average, a buffalo produced 1,062.75 liters milk during a moan lactation period of 246 days. The mean dry periods recorded for buffaloes and cows were 259 and 255 days, respectively. The cost of

production of animals other than buffaloes and cows was Rs. 1,256.56, 409.67 and 164.96 per head for draught animals, young stock and sheep/goats, respectively. Nearly 57% of the milk produced was used for domestic purposes, 25% was fed to the young stock, while the rest was sold as fluid milk. Only l/4th of the farmers were found selling milk to various agencies. Of the total income from livestock farming, more than 50% was derived from milk or milk products, while about 35% was from sale of animals. The income equivalent to 9% was considered to obtain from farm yard manure.

5.4. Draught efficiency

The weight pulled by various animal species was: camel, 574.64 and 555.73; bullock, 299.48 and 289.28; mule, 398.44 and 365.13; horse, 338.22 and 315.78; and donkey, 444.23 and 360.47% of their body weight in winter and summer, respectively. The draught developed by various species followed the same trend as observed in respect of weight pulled. On comparative basis, the horse showed the highest speed. The power developed both in winter and summer was the highest in camel, followed by that of bullock, horse, mule and donkey. The mule was found to have the highest gross work efficiency and the bullock had the lowest. Between camel and mule, the trend of net work efficiency was just converse to that observed for gross efficiency. The economic efficiency was the highest in donkey, followed by horse, mule, bullock and camel.

The draught efficiency was lowered when the ambient temperature increased since enhanced ambient temperature appeared to be a major cause of rise in body temperature. The level of relative humidity tended to show little effect on physiological functions of bullocks except respiration rate which was greatly affected. The ambient temperature may be considered an important environmental variable .with respect to physiological responses and draught efficiency.

5.5. Losses due to animal diseases

Bacterial diseases were found comparatively more fatal than viral, parasitic and miscellaneous diseases. Higher incidence of diseases and mortality was observed in the non-descript animals of bovine and caprine species. The female animals were found more prone to diseases as compared to males. As a consequent, mortality rate was also higher in females than in male stock. The buffaloes, cattle, sheep and goats in advanced age group showed maximum disease incidence and mortality. The dry animals were least affected but milch animals and idle (young as well as old) stock seemed more susceptible to diseases. It was also observed that mortality rate due to animal diseases was higher in 6-10 miles radius than in 1-5 miles radius of the veterinary hospitals in surveyed areas. The estimated losses due to animal diseases and allied factors when projected to the total population of buffaloes, cattle, sheep and goats in the province of Punjab, amounted to Rs. 2.5 billion per annum.

5.6 Productive, Reproductive and Behavioral Aspects of Camel

Of the total active browsing time, adults and sucklers spent 25.55 % and 26.145 % time respectively in browsing Acacia modesdta (Pholai), while young stock browsed Olea ferruginea (Kahu) for maximum time (31.86 %). Male camels on average spent 12.18±1.06 min. per coupling. She camels took on average 4.3 min. to expel the fetus and 12.25 min. in shedding placenta. Average daily growth rate of calves determined for first six months was 0.79±0.01 kg (attaining its peak 0.86 kg) in fourth month. They attained body weight of 126 ±4.64 kg during six months. Mean milk yield during first six months was 2100 ± 163 lit. with an average daily yield of 11.66±0.90 lit. using thrice a day milking. Average percentage values of protein, fat, solids-not-fat., total solids and acidity in milk were 2.85, 3.57, 9.00, 12.36 and 0.20, respectively. Mean specific gravity of camel milk was 1.03 ±0.007. Regarding welfare aspects, camels were found being put to work, irrespective of sex, at about 4 years of age. They worked up to 8.68 hr daily in summer (with interval) and 4.03 hr daily in summer (without interval). In winter, they worked throughout the day. Majority (61.33 %) of camels were used as pack animal followed by their use for certain

agricultural operations such as ploughing, planking, sugarcane crushing, chaff cutting and haulage of various agricultural commodities and for pulling carts. Male and females as pack animals carried on average about 414 and 306 kg, respectively. Male pulled up to 3400 kg cart load with a range from 3200 to 4600 kg.

POULTRY SCIENCES

I. EGG PRODUCTION

1. Breeds

The rural chicken possesses the most formidable survival mechanism, it has developed over centuries an adaptive balance with the harsh conditions of its ecosystem. To utilize the useful qualities of the rural chicken and to synthesize a new bird tailored to meet challenge of village conditions as well as to produce at a satisfactory level of production commensurate with the feed available to the rural chicken, a new breed named Lyallpur Silver Black was developed by cross breeding the local birds with the imported breeds namely, the White Leghorn, New Hampshire and White Cornish so as to produce a triple purpose bird geared to produce 150 eggs per year with a quicker maturity and to face high ambient temperatures upto 110°F in shade for a prolonged period.

The first year productive behaviour of local chicken was studied. The birds sexually matured at 222.5 days and laid 61 eggs in 325.8 days. The mean egg weight was found to be 43.5 gm. The pullets remained broody for 67.6 days on an average. The mean clutch size was 1.48 eggs. The age at sexual maturity was negatively correlated with egg production, while broody days and clutch size had a positive correlation with egg production. The hens with more number of broody days, and bigger clutch size laid more eggs.

The New Hampshire and Rhode Island Red breeds were compared as regards their fertility and hatchability. Percentage fertility, hatchability over fertile eggs and hatchability over all eggs set was found to be 85.20, 80.25 and 68.18 in Rhode Island Red and 83.85, 80.01 and 67.10 in New Hampshire breeds. The differences in the above mentioned values of the two breeds were found to be non-significant.

Reciprocal crossbred chicken of White Leghorn and local types of chicken were raised and the layers were observed through their first year of production. A significantly higher number of eggs (95.25) was produced against 78.78 eggs of the reciprocal cross. A lower incidence of broodiness (37.16 days) was observed in crossbred progeny involving White Leghorn male as compared to 50.5 days in the progeny from local male. There was no significant difference in the median age at maturity between the two crossbred groups. It was, however, significantly lower than the age of maturity (211.5 days) in Desi hens. There was no difference in both the groups as to the weight of eggs, it being 44.43 and 45.34 gm, in crosses A and B, respectively. The *egg* weight in both the groups was, however, significantly higher than the reported weight of 39 gm in Desi hens.

The productive performance of locally evolved Lyallpur Silver Black and Fayoumi breed (imported in Pakistan from Egypt) were compared. Birds of both the breeds showed a slight increase in their final wights over their respective initial weights. The Lyallpur Silver Black birds exhibited significantly lesser feed intake, heavier eggs, btter feed efficiency and better viability, but the egg production was found to be significantly lower ($P< 0.05$) in this breed than Fayoumi. The Fayoumi birds laid thin shelled eggs with higher incidence of blood and meat spots.

Fertility was significantly higher in White Leghorn than in White Cornish birds. However, the hatchability percentage, both over fertile as well as overall eggs set, was approximately the same in the two breeds. The number of dead-in-shell chicks was more in White Leghorn than in White Cornish, the difference being highly significant. However, the percentage of chicks dead-in-shell in both White Leghorn and White Cornish breeds was slightly more in males than in female chicks. The average percentage of dead

germs was 2.7 in White Leghorn and 2.3 in White Cornish breeds. The incidence of malpositions in White Leghorn was slightly higher than in White Cornish breed,

The data on egg production, egg weight, feed consumption, feed efficiency and viability among three groups each of Lyallpur Silver Black and White Leghorn breeds were analyzed. The percentage of egg production in White Leghorn was higher (46.63 vs 40.27) than in Lyallpur Silver Black. White Leghorns laid significantly heavier eggs (57.3 vs 53.1 gms) than their counterparts. The Lyallpur Silver Black consumed more fed and was less efficient in feed conversion as compared to White Leghorns. However, the birds of Lyallpur Silver Black were more viable than those of White Leghorn breed. The performance of White Leghorn and Lyallpur Silver Black hens was compared in their first and second laying years. Day-old chicks of each breed were raised up to maturity and one hundred pullets each of White Leghorn and Lyallpur Silver Black were randomly divided into two groups of fifty hens each. The birds in the pullet year were more viable, had significantly higher feed intake, exhibited better feed efficiency and laid higher number of eggs as compared to the second year of production. Heavier eggs were recorded in the second year than the first laying year. As regard breeds, the White Leghorns consumed more feed, had better feed efficiency and laid eggs which were higher in number and heavier in weight as compared to those of the Lyallpur Silver Blacks.

The observations on the albumen quality of eggs revealed higher weight of thick ainumen and less content of thin albumen in the eggs laid during the second year as compared to pullet year. The Lyallpur Silver Blacks were found to lay eggs with significantly lower amounts of thick albumen than their counterparts. The thickness of the dense albumen was also found to be greater in the second year of production. This was more true for the eggs laid by White Leghorns than those by Lyallpur Silver Blacks. The White Leghorn hens laid eggs with higher content of yolk than Lyallpur Silver Black birds. The incidence of higher number of blood and meat spots was noticed in the eggs of second laying year. The White Leghorns were observed to contain significantly less number of blood and meat spots in their eggs. The shell quality was determined by assessing the weight and thickness of shell. The shell thickness was better in the eggs of pullet year than the second year, while higher shell weight was recorded in the second year. The White Leghorns were found to lay eggs with better shell quality as compared to that of the other breed under study.

As regards the composition of egg albumen, the moisture percentage was higher in the eggs laid during the pullet year, while the total solids and protein contents were higher in the second year. The average values of' ether extract, total carbohydrates and ash contents were significantly greater in the albumen of second year as compared to the pullet year. The Lyallpur Silver Black birds were found to lay eggs with higher moisture and significantly lower content of total solids, protein, total carbohydrates and ash in the albumen. The yolk was found to contain less moisture in the second year, but the contents of total solids, other extract, total carbohydrates and ash were • higher as compared to the pullet year. The percentage of protein was significantly greater in the yolk of eggs laid in the first year than in the subsequent year. The White Leghorns manifested low moisture and higher percentages of total solids, protein, ether extract and ash in egg yolk than the Lyallpur Silver Blacks.

The fertility was higher in first year eggs than those of the second year. The incidence of dead germs and dead-in-shells was lower in the pullet year as compared to the subsequent year of production. Higher fertility and lower embryonic mortality was recorded in the eggs laid by the White Leghorn than the Lyallpur Silver Black breed. The hatchability percentages calculated on the basis of total eggs set as well as over fertile eggs, were found to be higher in the pullet year. The eggs laid by the White Leghorns exhibited a better hatchability than the other breed under study.

Positive 'returns were observed in both the laying years. The rate of return, however, reduced in the second year as compared to the pullet year. The White Leghorn breed was found to be more profitable as compared to the Lyallpur Silver Black.

The study was carried out at Poultry Research Centre, University of Agriculture, Faisalabad to determine the effect of male comb size and body weight on age at first lay and other productive and reproductive traits in a pedigreed LSB flock. Age at first lay was not affected by weight at first lay, however, egg weight was affected by weight of hen at 16th week. Feed intake, FCR and egg number were also not affected by the body weight. Number of infertile eggs, dead germs, dead in shell eggs, fertility (%) and hatachability (%) were not affected by any of the weight traits or comb index of the cock. While the day old chick weight in the subsequent generation was significantly affected by weight of dam at first lay. Comb index of sire at 39th and 41st week of age affected by the day old chick weight. For day old chick weight, number of observations was reasonable (n=425) and heretability estimate was 0.55+0.195 which indicated good scope of improvement in the trait through mass selection.

2. MANAGEMENT

The performance of layers kept under confinement and on free range during different periods of the year was studied. Twenty-five pullets of White Cornish breed were used in each of the two groups. The confined birds suffered more due to continuous heat stress of temperatures above 90.79 (+ 3.3°F). Egg production and feed intake declined in the confined birds exposed to higher air temperature. The birds on free range showed better feed efficiency than those in confinement.

The caged birds did not differ significantly from the floor-housed birds in egg production, though apparently floor-housed birds laid 1.89% more eggs. There was no significant difference in egg weight, in both the groups. The birds in cages were found to have laid eggs with highly significantly thicker albumen and had greater incidence of blood and meat spots than the floor-housed birds. The battery and the floor housed birds did not differ significantly in feed efficiency. On average mortality of 10.42% and 14.58% was observed in caged and floor-kept birds, respectively.

It was found that among poultry birds the highest mortality occurred in young chicks; smothering and chilling, Marek's disease, cannibalism, inclement weather, heat exhaustion, vitamin A deficiency and reaction due to Ranikhet vaccine were the major causes of mortality/ Spirochaetosis, fowl cholera, fowl pox and predations were rare and caused only small number of deaths.

The effects of light on the productive behaviour of chick were determined, using four hundred and fifty White Leghorn chicks that were brooded upto 8 weeks of age under 24 hours light. At 9th week the males were removed and the pullets were divided into three groups each comprising 60 pullets. From 9th to 24th week they were subjected to a decreased lighting schedule. One group was allowed a decrease of 26 1/4 minute per week while the other two groups received a decrease of 41 1/4 minutes per week. At 25th week the birds were placed on a 'step up' lighting pattern and this programme was followed until the birds were 48 weeks of age (laying phase). The results revealed that light had exerted a highly significant influence on egg production. There was no difference in the size of the egg among the three groups. However, the feed consumption and feed efficiency significantly differed among the three groups.

The number of females per male was determined so as to maintain optimum fertility in White Leghorn breed. Seventy eight layers were randomly divided in six groups in such a way that there were 8, 10, 12, 14, 16 and 18 hens in each group, respectively. One randomly selected male was allowed to run with each group respectively. The highest fertility (92.61X) was found in the group where 8 hens were mated to a cock whereas it was the lowest in the group where 18 hens were allowed to a cock. There was no significant difference in fertility percentage in between groups. It was concluded that 8 to 12 females per male may be mated in White Leghorn breed without adversely affecting the fertility level.

The weight gain of White Leghorn pullets increased significantly with an increase in the level of dietary protein during their pre-laying period (13-24 weeks). The gain, however, diminished in birds fed ration

containing calcium-phosphorus at 2.5 : 1 ratio than those fed at 2 : 1 to 2.5 : 1. The egg production, feed consumption and feed conversion ratio during laying period (25th to 72nd week) showed that better performance was directly related to higher levels of protein consumed by the birds during their prelaying period. The ratio of calcium to phosphorus in the diet, however, did not exhibit any significant effect on the subsequent egg production.

A study involving one thousand layers was conducted to investigate the effect of different housing systems in different seasons on the egg production behaviour of the laying birds under the existing environmental conditions. The research was conducted in two phases namely, "Winter and Summer phases (combined) the data revealed that caged birds had significantly (P< 0.05) higher egg production alongwith higher egg weight than the floor-housed birds. The eggs laid by the floor housed birds had significantly (P< 0.01) thicker shells while the incidences of blood spots were greater in caged birds. Significantly (P< 0.01) lower feed intake and mortality was observed in the caged birds. Although incidences of breakage of eggs were higher but the feed conversion was found significantly (P< 0.05) better than the floor housed birds. Non-significant differences, were recorded in respect of meat spots in both systems. In winter significantly (P< 0.01) higher egg production, thicker shelled eggs, higher incidences of blood spots, higher feed intake with better feed utilization was recorded in both systems. Similar was the case with mortality. The incidence of meat spots and broken eggs were significantly (P< 0.01) higher during summer than the winter phase.

Sugar cane pulp was found to be significantly superior to saw dust and highly significantly superior to wheat straw as litter material. However, there was no difference in the results between saw dust and wheat straw. The egg weight was better on sugar cane pulp and remained the lowest on wheat straw. There was non-significant difference in feed consumption of White Leghorns on the three litter materials. Better livability was found on sugar cane pulp than on the other two litter materials. The saw dust ranked second while wheat straw was found to be the lowest in fitness evaluation studies.

Commercial layer ration was supplemented with garlic powder (Allium sativum) @ 0.0, 1.0, 2.0 and 3.0 percent (A,B,C and D). Egg production increased significantly (P<0.01) by the treatment B. Feed consumption significantly (P<0.01) increased by the treatment D but decreased in treatment B and C than control. Feed conversion ratio/kg egg mass significantly (P<0.01) improved by the treatments B and C only. The best feed conversion ratio (1.23) was found in treatment B. The serum total cholesterol decreased significantly (P<0.01) by garlic powder supplementation. The highest value of serum cholesterol (336 mg/dl) was found in groups under treatment A and the lowest (283 mg/dl) in groups under treatment D. The effect of treatments on egg yolk cholesterol was also found to be significant (P<0.01). The highest mean egg yolk cholesterol (276mg/55g eggs) was found in groups under treatment A and the lowest (231 mg/56g egg) was in groups under treatment D.

Present study was carried out at Poultry Research Center, Department of Poultry Husbandry, University of Agriculture, Faisalabad, Pakistan to study the effect of Induced Moulted methods on subsequent productive performance parameters of Layers. The body weight loss, egg production, feed consumption, egg production and mortality were recorded for eleven weeks. The Feed conversion ratio/dozen eggs was calculated. The reduction in body weight during molting was maximum in control group (421.66), followed by Cu-2 (383.33), Al-2 (351.66), Zn-2 (340.00), Al-1 (333.33), Cu-1 (296.66), Zn-1 (91.66) gms respectively. The average egg production from the start (5% production) up to 8 weeks was recorded. Maximum egg production was found in Cu-2 (666.33) followed by Al-2 (648.33), Zn-2 (645.66), Zn-1 (645.33, Al-1 (631.00), Cu-1 (619.33) and control group (608.33) respectively. The Cu-2 group produced the maximum eggs and was non significantly different with Al-2, Zn-1 and Zn-2. The maximum feed consumption was observed in Cu-1 (77.63) which was non significant with Al-1 (77.34). Best feed conversion was in group Cu-2 (1.393) while the poorest was in group Cu-1 (1.497). The maximum mortality was in the control group (14.28) which was non significant with Al-2 (9.52) while all other group showed non significant differences with one another.

The effect of premoult body weight on the performance of the moulted layers was observed in this study. Two hundred fifty six layers (72 week old) divided into 12 experimental units were allocated to 4 treatment groups, A, B, C and D, ranging from 1200-1350, 1350-1500, 1500-1650 and 1650-1800g body weight, respectively, A commercial layers ration was fed to all the groups. The birds ranging from 1500-1650g body weight showed higher egg production and better feed utilisation than the other treatment groups. The egg quality in terms of shell thickness, yolk index and haugh unit was also better in this group. The lowest performance among the groups was observed in group D ranging from 1200-1350g in body weight. However, birds in the heaviest weight group (1650-1800g) produced larger size eggs than the other treatment group.

The study was conducted on the Babcock ISA White Leghorn layer strain to determine the effect of Photoperiod feed and nutrient restriction during growing period on subsequent performance of birds. The birds were reared up to 8 weeks under standard managemental conditions and on the commercial starter ration. At 7 weeks of age, 432 pullets were randomly distributed into 36 experimental units of 12 birds each in the three rooms one week period to the starter of the experiment so that the pullets become acclimatised with the new environments. Three photoperiod manipulation viz. Natural light (A), constant 11 hours day light (B) and decreasing (@ 20 min/week starting with 13 hours) day light (C) and four feeding regimes viz: ad libitum feeding (D) 85 percent of the requirement (E) 70 percent of the requirement (F) and low protein (13%) low energy (2500 k cal/kg) ad libitum feed (G) were employed from 8 to 20 weeks of age in a 3X4 factorial arrangement. Separate record of weekly feed intake and weight gain during the same period was maintained for each experimental unit and feed efficiency was worked out accordingly. Separate record of each replicated for age at sexual maturity, production parameters, egg quality and feed consumption from 20-56 weeks age were maintained and used to work out the efficiency. Statistical analysis of the date revealed that although the birds reared under natural and constant light had higher weight gain with not out perform during batter part of production period. The meat and blood composition of the birds reared under different photoperiods was, however, similar. The effect of feed and nutrient; on the other hand, was found significant during rearing as well as production periods. The birds exposed to higher level of feed restriction and those exposed to nutrient restriction gained significantly lower weights. Feed intake significantly decreased on employment of restriction with comparable improvement in efficiency but those kept on low protein, low energy ration consumed more feed and showed the poorest feed efficiency. The bird reared on 85 percent of the requirement consumed significantly less feed (1.527 kg) for each dozen egg produced, followed by those reared on 70 percent of the requirement (1.607 kg), low protein low energy (1.637 kg) and ad libitum feeding (1.645 kg) respectively. The birds reared on 85 percent of the requirements consumed significantly less feed (2.342 kg(for each kg man produced, followed by those reared on 70 percent of the requirement (2.469 kg), on ad-libitum feeding (2.548 kg) and those kept on low protein low energy diet (2.548 kg). an economic appraisal of the project led to the interference that the effect of lighting regimes within the tested limits was minimum. The birds reared on 85 percent of requirement, however, excelled all other groups followed by those fed on 70 percent of the requirement, on ad libitum feeding of a standard ration and protein energy deficient ration respectively.

3. ENVIRONMENT

The effect of graded heat stress on eight-month old indigenous and White Leghorn layers housed in especially constructed heat chambers was studied, using sixteen birds. The feed consumption declined significantly at 105°F., and progressively continued so till 110°C. The body temperature in both the types of stressed birds exhibited a significant rise at air temperatures of 100-105 °F. The suppression of thermoregulatory mechanism at high temperatures, irrespective of their breed properties was indicated. The regression studies showed an increase of 0.10 and 0.13 °F in body temperature per degree rise in air temperature for the indigenous and White Leghorns, respectively. The viability of the stressed birds indicated that contrary to some reports in the literature, all birds did not succumb to exposures of 110 °F

for 15 days.

The effect of morning and afternoon temperatures on egg weight and egg production in Lyallpur Silver Black pullets was studied. The rise in temperature adversely affected the productive behaviour of poultry. The egg weight and egg production both declined as the ambient temperature rose.

The influence of high ambient temperature on the productive behaviour of layers of local and Lyallpur Silver Baick birds was investigated. Feed consumption, body weight, egg production, egg weight and egg shell thickness did not differ significantly at 90 °F and under control conditions. The layers kept at 95 °F had reduced intake of feed and a decline in egg shell thickness, while *GSS* production, egg weight and body weight were non-significantly affected. At 100 and 105 °F were found to adversely affect the feed consumption, body weight, egg production, egg weight and shell thickness were adversely affected compared to control group of birds.

The effect of seasons and months on fertility, hatchability, dead germs, dead-in-shells, their sex ratio and malpositions in local chicken was studied. There was a non-significant difference in fertility due to the seasons and months. Maximum fertility (92.5%) was observed in February and minimum (83.7%) in May. The effect of months and seasons on hatchability over fertile eggs was found to be non-significant. Hatchability was found to be the highest in January and lowest in May. The results of hatchability over total eggs set, dead germs, dead-in-shells, sex ratio of dead-in-shells and incidence of malpositions also revealed non-significant differences among various months and seasons of the year.

The effect of different levels of high temperatures upon productive behaviour, physiological characters and viability in White Cornish and New Hampshire pullets was determined. Significant ($P< 0.05$) decline in feed consumption was recorded when the birds were exposed to 95°F temperature. The decline became highly significant ($P< 0.01$) when the temperature was raised to 100, 105 and 110°F. Highly significant decline in egg production body weight egg shell thickness, and egg weight, was recorded when the birds were exposed to temperature above 100°F.

The effects of cooled nights on the productive behaviour of White Leghorns and Lyallpur Silver Bicks were investigated. Two groups of each breed were kept in a room which was cooled only during nights with the help of an air-conditioner, while the remaining two groups were placed in a room which had no cooling device. The birds placed in a room where the temperature was lowered during the nights had significantly higher feed intake, exhibited better feed efficiency and consumed lesser amount of water than in the non air-conditioned groups. The White Leghorn and Lyallpur Silver Black breeds did not show any significant difference between themselves in respect of feed consumption and feed efficiency. The birds cooled during the night time had significantly higher egg production and laid heavier and thicker-shelled eggs. As regards breeds, the White Leghorns and Lyallpur Silver Blacks manifested no difference in respect of egg production, and egg weight, but thinner-shelled eggs were produced by the former breed. Regardless of environmental conditions White Leghorns suffered significantly a bigger loss in body weight than Lyallpur Silver Black birds.

The birds kept continuously at stressful temperature had significantly higher erythrocyte sedimentation rate as against the birds kept cooled during night, whereas the birds maintained under latter environments exhibited significantly higher mean value of red blood cells. The Lyallpur Silver Bick layer showed a higher amount of haemoglobin than the White Leghorn breed. Higher ambient temperature caused a significant difference in the lymphocyte count, being greater in the non-air-conditioned groups. On the contrary, nightly cooled bircis unlike lymphocytes exhibited significantly higher monocyte count. The breed or the temperature did not cause any significant effect on the neutrophil as well as basophil counts.

The effect of breed and season on the physical qualities of the eggs was assessed. The breeds used in

the study were White Leghorn, Lyallpur Silver Black and desi (local). The White Leghorns had the best performance with the highest egg weight and thick shells and albumen. The meat and blood spot incidence was also less in the eggs laid by the White Leghorn breed as compared with those of Lyallpur Silver Black and local birds. It was found that the eggs laid in winter were superior in respect of egg weight, albumen and shell thickness. The spring and autumn laid eggs were almost identical in this respect, while those laid in summer, had the thinnest shells and albumen and the least egg weight. The indidence of blood and meat spot was found to be the highest in summer.

The results of the present study indicated that the higher supplementation of vitamin A above normal, in the diets had beneficial effects on immune response of laying hens maintained at high ambient temperature. From the results it was concluded that a supplemental level of 12,000 IU of vitamin A/Kg of diet had optimum beneficial effects on antibody synthesis in heat-stressed laying hens. At the end, it was concluded that higher supplementation of vitamin A above normal (3,000 IU/Kg of diet) has a beneficial effects on the performance, egg quality and immune response of the birds maintained at high ambient temperature.

4. EGG CHARACTERISTICS

The experiment was conducted to investigate the effects of different preservatives on keeping quality of eggs. The eggs were stored for two months at 88-102°F temperatures while relative humidity ranged from 74-88%. After the storage period oiling proved to be the best preservative for maintaining the pH and albumen thickness while for weight loss and increase in air cell it was second to sodium silicate treatment which helped to maintain both of these as such most efficiently. There was rather an increase in weight in sodium silica'-e dipped eggs due to the deposition of silica on the egg shell. Thermostabilization was next to oil dipping and sodium silicate treatment. The untreated eggs had the poorest keeping quality as for as albumen thickness, pH value, weight loss and air cell were concerned.

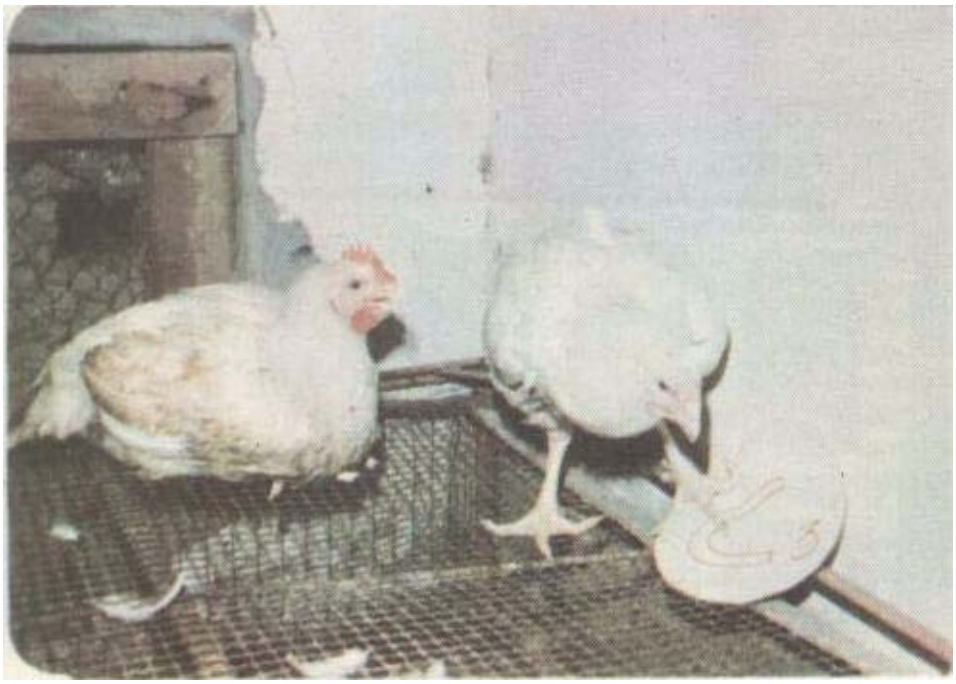
The eggs of Khaki Campbell ducks were found to be heavier than the eggs laid by White Leghorns?, their albumen and shell were thicker, the weight of albumen, yolk, shell and spots were apparently higher in number in White Leghorns than on the eggs laid by Khaki Campbell ducks. The eggs of Khaki Campbell ducks were found to be superior than those of White Leghorn birds.

The chemical composition of eggs of Lyallpur Silver Black was compared with those of White Leghorn and local breeds of chicken. The White Leghorn and Lyallpur Silver Black breeds did not differ significantly in respect of dry matter, crude -protein, ether extract and carbohydrate contents of eggs than the local breed. The ether extract values were significantly higher for the eggs of White Leghorns than those of the local breed. The eggs of the local breed had significantly higher carbohydrate contents as compared to those of the White Leghorns. Total ash contents of eggs of White Leghorns, Lyallpur Silver Black and the local chicken did not differ significantly.

The chemical composition of eggs of White Leghorn chicken and Khaki Campbell duck was compared. The percentage of moisture, crude protein, ether extract, total carbohydrates and ash was determined. The Khaki Campbell ducks were found to contain a significantly more crude protein ether extract and carbohydrates, while moisture contents were significantly higher in the eggs of White Leghorns. A non-significant difference was observed in ash contents of the two breeds. A study was conducted to find out the best cooking method for hard cooked eggs keeping in view the incidence of shell cracks, ease of peeling and minimum development of ferrous sulfide ring. It was observed that hot water boiling methods were superior to the cold water boiling methods in all respects. Of the boiling water methods, the one in which eggs were lowered in boiling water and as soon as the lowering was completed the heat was reduced to simmering temperature (85°C) for 18 minutes was considered more desirable.

Ninety six, white Leghorn layers of 40 weeks age were randomly divided into 12 experimental units with 8

birds each and these units were randomly allotted to 4 treatments in such a way that each treatment receives 3 experimental units/replicates. Commercial ration was supplemented with garlic powder (Allium sativum) @ 0.0, 1.0, 2.0 and 3.0% (treatment A, B, C and D). The data for 12 weeks regarding egg mass/bird week, feed conversion ratio/kg egg mass, eggshell thickness, egg albumen quality (Haugh Unit), yolk index and egg yolk cholesterol were analyzed by the analysis of variance technique with complete randomized design. Egg mass/bird/week increased significantly ($P<0.01$) by the treatment B (1% garlic powder). The highest egg mass/bird/week (0.303kg) was found under the treatment B (1% garlic powder) and the lowest (0.255kg) was found under the treatment D (3% garlic powder). Feed conversion ratio/kg egg mass significantly ($P<0.01$) improved by the treatments B and C only. The best feed conversion ratio/kg egg mass (1.85) was found in groups under treatment B. egg shell thickness decreased significantly ($P<0.01$) by the treatment D but increased in the treatments A, B and c. the highest and same eggshell thickness (0.32 mm) was found under treatments A, B and C and the lowest (0.30mm) was found under treatment D. Garlic powder supplementation had a non-significant effect on egg albumen quality (Haugh Unit) and yolk index. The highest egg albumen quality (67.83 HU) was found under treatment A and the lowest (64.52 HU) was found under treatment C. The highest yolk index (0.42) was found under the treatment A (control ration) and the lowest yolk index (0.40) was found under treatment C (2% Garlic powder). Egg yolk cholesterol (251 mg/50g egg) was found in groups under treatment A (control) and the lowest (201 mg/50g egg) was found in groups under treatment D.



Rearing of broilers on litter floor system

5. NUTRITION

The data on egg shell thickness revealed that the birds fed vitamin C supplemented rations laid eggs with significant ($P< 0.01$) thicker shells than the control. The average shell thickness by feeding rations supplemented with 75 and 150 ppm of vitamin C was 0.300 and 0.302 mm, respectively, while without vitamin C supplementation, it was 0.266 mm.

Supplementation of vitamin C to layer ration was found to increase the shell thickness and production of eggs.

The study was carried out at Poultry Research Centre, Department of Poultry Science, University of Agriculture, Faisalabad. *Chaetominum thermophile* enzyme prepared and standardized at NIBGE, Faisalabad was supplemented in diets of layer birds @ 0X (Control), 1X (B), 2X (C), 3X (D) and 4X (E). One hundred and fifty (150) laying white Leghorn single comb layers were divided into 15 experimental units containing 10 birds each. Egg production and egg mass production was not significantly affected by the treatments. While feed consumption significantly differed among the treatments. Highest feed consumption was recorded in treatment B but it was non-significant from C and D. Better feed conversion ratio/dozen egg was observed in treatment C followed by treatments B and D as compared to treatment A. Feed conversion ratio/Kg egg mass followed the similar pattern. Egg weight, egg shell thickness, yolk index and Haugh unit score differed non-significantly among the treatments. Egg breaking strength differed significantly among the treatments. Significantly higher egg breaking strength was reported in treatment C, followed by C, D and E. Treatment B and A showed significantly lower egg breaking strength and difference between them was non-significant. Maximum net income was observed in treatment C followed by B, D, A and E.

6. HATCHABILITY

Comparative studies were made to find out the hatchability percentage of White Leghorn eggs enclosed in nitrogen flushed polyethylene bags, air filled polyethylene bags and unpacked eggs. Pour lots of egg were stored for 4, 3, 2 and 1 weeks; it 58-68°F and 72 to 75% relative humidity. The highest hatchability percentage was recorded in eggs enclosed in nitrogen flushed polyethylene bags for all storage periods and the lowest in unpacked (control) eggs. Highly significant differences ($P< 0.01$) were observed between different storage periods. A reduction in the * hatchability took place as the storage period was prolonged. The loss of weight was greater in unpacked eggs. The number of dead germs was the lowest in eggs enclosed in nitrogen flushed polyethylene bags and highest in unpacked eggs.

A study conducted on the hatching eggs of White Leghorn breed in winter and spring seasons revealed that hatchability results wore better in winter as compared to spring stored eggs. Hatching eggs could be stored for one week without having marked effect on hatchability at a temperature of 55°F with 72 to 74% relative humidity. For obtaining maximum hatchability, the eggs should be gathered after every hour from conventional type of laying houses used in Pakistan. Significant difference ($P< 0.05$) was observed in egg hatchability between the plastic packed and unpacked eggs, the hatchability being higher in plastic packed eggs of White Leghorn. A reduction in hatchability took piece as the storage period was prolonged The unpacked eggs did not hatch after 3 weeks of storage. Greater loss of weight was observed in unpacked eggs. The percentage of dead germ and dead-in-shell were less in polyethylene packed eggs than in unpacked eggs.

II. MEAT PRODUCTION

1. MANAGEMENT

The effect of various chick densities and housing systems on performance of broiler chicks aged upto 8 weeks was determined. Two groups of chicks were randomly allotted of 0.75, 1.0 square foot per bird of the floor space both in the battery brooder and on the litter. The highest weight gain and the maximum feed consumption were observed in floor-kept broilers, given 1.0 square foot per bird while the feed efficiency was the highest in birds kept on floor on 0.75 square foot space per bird. The highest dressing percentage was observed in cage birds with 1.0 square foot space. Five per cent cases of leg weekness were observed in cages, whereas no such case was recorded in floor kept birds. Chicks should be debeaked at day-old as it is more convenient to perform the operation at this age.

The effect of restricted feeding on the performance of one hundred and eighty, day-old broiler chicks was

studied by rearing them for nine weeks. The birds in control group were given feed ad libitum, while those in restricted groups were fed daily only for three or two hours, respectively. Restriction of feed resulted in a significant reduction in weight gain and feed consumption of broilers. However, their feed efficiency and mortality rate were not affected. The average cost of production per broiler was less in birds provided with restricted feed. The feed restriction to three or two hours daily seemed to be rather drastic. Later, it was found that feed restriction for 7 1/2 hours daily in Hubbard broiler chicks at four weeks age led to significantly different results than obtained with three or two hours daily feeding.

The performance of broilers was studied using three different litter materials i.e., rice hulls, wood shavings and sugar cane bagasse. Better weight gain and feed utilization was observed in chicks kept on rice hulls, however, the differences were found to be non-significant between the results obtained with different litter materials.

The present study was conducted with broiler breeder hatching eggs to study the effect of different disinfectants applied to the setter/hatcher compartments on hatchability, early chick mortality and economic considerations. The hatchery facilities were fumigated with sanitiser (a formaldehyde based commercial product), Fourtedes (A quaternary ammonium compounds based product) or remained unfumigated. From the study it was concluded that treatment C that is Fourtedes is best disinfectant to control early chick mortality due to vertically or horizontally transmitted diseases.

A project was executed to see the effect of feed withdrawal during hot hours of the day on the performance of broilers. One hundred and eighty l-day old broiler (Hubbard) chicks were purchased from a local hatchery and were reared in a group for two weeks (adaptation period). At day fifteen all the birds were weighed individual) and one hundred twenty chicks of middleweight ($\mu+1\sigma$) range were selected as experimental birds. These chicks were randomly divided into twelve experimental units (replicates), having ten chicks each and the units were further allotted to four treatments (three replicates / treatment) A.B.C and D. Group A served as Control and fed ad libitum through out the experimental period. Whereas, the birds in groups B. C and D were kept off feed during hot hours of the day. i.e. from 9:00 a.m. to 3:00 p.m.. 9:00 a.m. to 5:00 p.m. and 9:00 a.m. to 7:00 p.m. respectively. The data on initial body weight weekly feed consumption, weekly body weight and mortality, were recorded to calculate efficiency of feed utilization. The results of the study showed that feed consumption, weight gain and feed conversion ratio of the birds kept off feed during hot hours of the day, especially those restricted from 9:00 a.m. to 7:00 p.m. were significantly ($P<0.05$) better than those fed ad libitum. However, neither ad lbitum nor restricted feeding influenced the dressing percentage and relative weights of heart, liver, gizzard and spleen of broilers under study. Similarly the treatments did not show any effect on the plasma glucose-cholesterol total protein, albumin, globulin, serum glutamic pyruvic transaminase and serum glutamic oxaloacetic transaminase.

The present study was conducted at the Poultry Research Centre, University of Agriculture, Faisalabad (Pakistan), to investigate the effect of different floor spaces on the performance of broiler chicks. Day-old broiler chicks (Hubbard strain) were purchased form local market. The chicks were given four treatments A (control, 1.0 ft2/bird), B (0.90 ft2 /bird), C (1.10 ft2/bird) and D (1.20 ft2/bird). Feed consumption of the birds was not affected statistically by the treatments of the four floor spaces. Non-significant difference in feed conversion was found between the treatments. The birds that were stocked at less space showed more mortality. Non-significant ($P>0.05$) difference was found in the dressing percentages for the treatments of floor spaces. Carcass composition for crude protein, fat and ash percentages was also measured in the laboratory by proximate analysis of the meat portion taken from breast and thighs. It might be concluded that floor space 0.90 ft2/bird had no adverse effect on the performance of the broiler birds because weight gain, feed consumption and FCR were not affected significantly by the floor space treatments. Meat production and live weight production per unit area was also inversely related to the area of floor provided to the birds.

The effect of feeding management and nutritional manipulation on the production performance of broilers during hot and humid climatic conditions was studied. After one week adaptation period, one hundred eighty chicks of middle weight range were selected as experimental birds. The chicks were divided into eighteen experimental units (replicates) having ten chicks each. These replicates were allotted to six treatment groups (A, B, C, D, E and F) having three replicates per treatment. Three feeding methods i.e., continuous feeding (CF, 24 hours feeding), intermittent feeding (IF, 1 hour feed and 3 hours off) and feed withdrawal (FW, no feed from 9:00 am, to 5:00 pm) were used for the study. Under each feeding system birds were fed a ration either without supplemented fat (NSF) or with 3% supplemented fat (SF). The weekly weight gain was significantly higher in continuous feeding system than intermittent or feed withdrawal system. Whereas, the feed efficiency was significantly higher in the birds kept under intermittent feeding system. Addition of fat showed non significant effect on the feed conversion ration. Fat supplementation significantly reduced the weight gain, feed consumption, respiration rate and body temperature in the birds kept under intermittent feeding than those kept under feed withdrawal and continuous feeding system. Significantly higher glucose level was also observed in the birds kept under feed withdrawal system. The titer for both the ND and IBD was improved with the addition of fat. The birds kept under intermittent feeding system showed maximum profit than the birds kept under the other systems used for the study.

2. NUTRITION

In day-old chicks the haemoglobin concentration and RBC count were found to be 8.27 gm per cent and 1.95 millions per cubic millimeter, respectively. Birds fed commercial ration had significant higher haemoglobin level and RBC count than those fed home-mixed. The RBC count remained unaffected at different ages but haemoglobin level was found to be significantly higher at the fifth and sixth month of age on both the rations. However, no marked difference was observed in RBC count and haemoglobin concentration among poor and heavy layers due to the use of different rations. It was further observed that the RBC count as well as the haemoglobin concentration was higher both in males and females in winter season than in summer season.

The effect of dextrose on growth rate, feed consumption, feed efficiency and mortality of Lyallpur Silver Black chicks was investigated. Chicks fed ration containing 2% dextrose recorded the highest weight gain followed by those fed rations with 4, 0 and 6X dextrose. Statistically there was no difference between birds fed 2 and 4% dextrose, but they differed significantly from those fed 6X dextrose. Chicks fed ration containing no dextrose consumed more feed than chicks on ration with 2, 4 or 6% dextrose and differences in feed consumption were highly significant. Birds receiving ration with 2% dextrose had the best feed efficiency. Ration with 2% dextrose produced the most economical weight gains. The influence of varying levels of dietary corn gluten meal on the performance of day-old broiler was determined. The highest weight gain and feed efficiency were observed in the birds kept on the ration containing 20% proved to be the poorest. No significant difference could be observed in respect of dressing percentage. The corn gluten meal supplementation did help in making the ration more economical.

The effect of different levels of added beef fat on weight gain, feed efficiency, feed consumption and dressing percentage of broiler chicks was studied. Significant differences were observed in weight gain due to the use of 3, 6 or 9% beef fat added to ration. Added beef fat significantly improved the efficiency of feed conversion. Feed consumed per unit gain in body weight was reduced by 6.88 to 9.97% in control birds. The differences in feed consumption as well as dressing percentage of different groups of chicks were non-significant. The addition of higher levels of fat were comparatively costly, but at lower level (3%) it helped in formulating an economical broiler ration.

The influence on the performance of broilers of the substitution of varying levels of blood meal with sesame oil cake in broiler ration was studied. Three rations containing 3, 5 and 7X blood meal were prepared by partially substituting sesame oil cake and were fed to broilers for eight weeks. Non-significant

differences were observed in weight gain, feed consumption and feed efficiency. However, the differences indicated a trend in favour of blood meal as partial replacement of sesame oil cake. The economic comparison of the experimental rations revealed that the chicks fed ration containing 7% blood meal resulted into most economical weight gains than those containing 3 or 5% blood meal.

The nutritive value of different commercially available micromixes was studied by assessing the performance of broiler chicks fed such micromixes. The results showed significant differences in weight gain of birds. The highest gain in weight was observed in birds on ration supplemented with 'Micropole' followed by those supplemented with 'Nutripol', Chicken-Tone' and control. A significant ($P< 0.05$) difference was observed in the feed efficiency of birds fed control ration and those on ration supplcincntod with 'Micropole* but there was no significant difference among the birds given rations containing 'Micropole', 'Nutripole' and 'Chicken-Tone.' The differences in feed consumption as well as in dressing percentage of different groups of birds were non-significant. The 'Micropole' micromix was assessed as the best as far as weight gain and feed efficiency was concerned.

The supplementary effect of berseem leaf residue in the rations of broiler chicks was stuided. The birds fed on ration containing 6% berseem leaf residue showed the highest feed consumption as compared to other groups, whereas the best feed efficiency was recorded in the chicks fed the ration containing 8X berseem leaf residue. Although the highest weight gain was observed in birds kept on ration containing 8X berseem leaf residue yet non-significant differences were observed among different rations. Similarly, the birds fed on ration with 4% berseem leaf residue showed the highest dressing percentage but again the differences due to airterent rations were observed to be non-significant.

The nutritive values of ground-nut cake as a major source of protein in broiler ration was evaluated. The results indicated that lysine and methionine were the main limiting amino acids in the diet containing 27% groundnut cake. Supplementation of this ration with 0.25% lysine and 0.10% methionine significantly improved the body weight and feed efficiency of broiler chicks. The chicks on 6 and 8% LPC ration supplemented with lysine gained significntly more weight than thoao on the same level of LPC without lysine supplementation. Lysine supplemented rations showed apparently better growth than control but the differences were observed to be non-significant. The chicks on the control ration consumed the maximum feed followed by those on rations containing 6 and 8% LPC supplemented with lysine. Lysine supplementation led to marked improvement in feed utilization as well as dressing percentage.

The effect of feeding of varying levels (4, 6 or 8 oz/900 kg of fend) of cytozyme (a feed additive) was determined on the performance of broilers. Non-significant differences were recorded in weight gain and feed consumption of broilers under various treatments. The feed efficiency of birds fed on ration with no cytozyroe or the one containing 4 oz/900 kg feed was significantly better than those on rations with 6 or 8 oz/900 kg feed. Under the conditions of this study, the use of cytozyme ration did not produce the desired response which might be due to the presence of some feed additives in the basal ration at unknown level and also due to some non-specific diseases in the experimental bird.

Three hundred l-day old broiler chicks reared in a group for two weeks were weighed individually at day 15 and 180 birds of middleweight range (u. ± lo) were selected as experimental birds. These birds were divided into 18 replicates (10 chicks ' replicate) which were further randomly allotted to six experimental rations (3 replicates / ration). Six iso-nitrogenous and iso-caloric rations (A.B.C.D.E. and F) were prepared such that 10. 30 and 30% of total energy was provided by berga fat-306 in rations A,B and C. and by soybean oil in rations D.E and F respectively. The birds were fed these rations ad libitum up to the age of six weeks. The data on initial body weight, weekly feed consumption, weekly weight gain and mortality were recorded. At the end of experiment two birds from each replicate were randomly picked and slaughtered for their dressing percentage, giblet weights and various blood parameters. The data analysed in Completely Randomized Design with planned comparison of means showed than the birds having soybean oil used their feed more efficiently than those kept on berga fat containing rations.

However, neither berga fat nor soybean oil influenced the dressing percentage and relative weight of heart, liver, gizzard and spleen of the experimental birds. Similarly the treatment did not show any effect on the plasma glucose, cholesterol, protein- albumen, globulin, serum glutamic pyruvic iransaminase and serum glutamie oxaloacetic transaiiiinase. The net profit gained/broiler was more in the birds fed rations containing soybean oil than those of barga fat.

The project was planned to study the effect of intermittent feeding on the performance and dressing characteristics of the broilers. Day old birds were purchased from local market and were reared in a group for a period of two weeks (adaptation period) under the same brooding and feeding conditions. They were randomly divided into 4 groups (A, B, C, D) of 30 chicks each. Group A served as a control and birds were given continuous feeding during 3 to 6 weeks whereas groups B, C and D were provided intermittent feeding during 3 to 6 week in such a way that birds of group B were kept on 2 h feed and 2 h off feed for 3 to 6 weeks. Birds in group C were provided continuous feeding from 3 to 4 weeks and intermittent feeding (2 h feed and 2 h off feed from 5 to 6 weeks while birds in group D were given intermittent feeding (2 h feed and 2 h off feed) from 3 to 4 week and continuous feeding from 5 to 6 weeks. Statistical analysis of the data showed significant difference in weight gain of birds during 3 to 6week. Significantly higher weight gain was in group A (Ad libitum feeding) while significantly lower weight gain was in group D (intermittent feeding 2 h feed + 2 h off feed) which was kept under intermittent feeding from 3 to 4 weeks of age. The data on feed conversion ratio revealed that best feed conversion ratio was observed in group B and the poor feed conversion ratio was in group A (continuous feeding). There was no significant effect of intermittent feeding on dressing percentage and weight of giblets of bird but significant difference in abdominal fat was found. Birds of group B has significantly lower abdominal fat than group A, C and D. The data on cost of feed revealed that lowest cost of feed per unit live weight gain was observed in group B (intermittent feeding from 3 to 6 weeks) while highest cost in group A. It was concluded that the feeding regime B (intermittent feeding from 3 to 6 weeks 24 feeding and 2h off feeding) is most suitable for reducing the broiler production cost. So intermittent feeding (2h feeding+2h off feeding) is recommended for profitable broiler farming.

Day old broiler chicks (Hubbard) purchased from a local hatchery and allotted to four treatments A, B, C and D, each having three replicates. Group A served as control and was fed ad libitum. Whereas, the birds in group B, C and D were fed according to a feed restricted program (three hours feeding and three hours off) during 2nd week of age, 2nd and 3rd week of age, and 2nd, 3rd and 4th week of age, respectively. The results of the study showed that the birds kept under feed restriction during 2nd week of life consumed significantly ($P<0.05$) less feed than those of the other restricted and ad libitum fed groups. Whereas, the highest feed consumption was observed in ad libitum fed or control group. Statistical analysis of the data revealed that the birds of group B, which were kept restricted during 2nd week of life gained significantly ($P<0.05$) higher weight than those of the other feed restricted and ad libitum fed groups. Whereas, poor feed conversion ratio was observed in control group. Data obtained from the study depicted that neither ad libitum nor restricted feeding had any effect on the dressing percentage and relative weights of heart, liver, gizzard and spleen of the birds under study. The duration of feed restriction adversely effected the immune response ($P<0.05$) of the birds against Newcastle and Gumboro diseases. Feed restriction helped in reducing mortality of the birds. The net profit per Kg live weight in groups A, B, C and D excluding the cost of labor was rupees 6.11, 8.63, 7.70 and 7.18 rupees per Kg live weight respectively. It was observed from the results of the study that feed restriction of the broilers during 2nd week of age may practiced to get maximum profit out of these.

Day old chicks were purchased and allotted to four treatments A, B, C and D, each having three replicates. Group A served as control and was fed ad libitum. Whereas, the birds in group B, C and D were fed according to a feed restricted program one hour feeding and three hours off during 3rd week of age till sale, one hour feeding and three hours off during 5th and 6th week of age, and one hour feeding and three hours off during 3rd and 4th week of age, respectively. Maximum feed consumption and weight gain was observed in group A (Control) while best feed conversion ratio was observed in groups B (1.70)

and C (1.75). Dressing percentage, heart weight, liver weight, gizzard weight, spleen weight, intestinal length and intestinal weight differed non-significantly. Maximum fat pad was observed in A (2.973 and D (2.597) while B (1.673) and C (2.095) showed significantly lower relative abdominal fat pad weight. Birds from groups B and C were also economical. It was recommended from the experiment that one-hour feeding and three hours off during 5th and 6th week (group C) of broiler production may be adopted to get maximum profit and leaner birds.

The study was conducted at Poultry Research Center, Department of Poultry Science, University of Agriculture, Faisalabad. One hundred and eighty (180) day old chicks after adaptation of one week were divided into eighteen experimental units comprising of ten chicks each of similar weight. Three feeding methods i.e. continuous feeding, intermittent feeding (1 hour feed and 3 hours off feed) and feed withdrawal (no feed from 9:00 a.m. to 5:00 p.m.) with or without supplementation of 3% fat were studied under completely randomized design with 3X2 factorial arrangement of treatments. Body temperature, respiration rate, weight gain, feed consumption and feed conversion ratio were significantly reduced in intermittent feeding. Fat addition significantly reduced body temperature, weight gains and feed intake. Significantly less chance of leg abnormalities were observed in intermittent fed birds while more abdominal fat was recorded in feed withdrawal than continuous fed birds. Relative weights of organs were not affected by the treatments except feed withdrawal where pancreas weight was increased. Significantly lower plasma glucose and urea concentration were observed in intermittent fed birds while pack cell volume and monocytes were increased significantly, however, albumen concentration was not affected. Intermittently fed birds showed higher antibody titres against Newcastle and Infectious bursal disease followed by feed withdrawal and lowest titres were recorded in continuous fed birds. 0%, 1.66% and 8.3% mortalities were observed in intermittent, feed withdrawal and continuous fed birds. Especially intermittent fed birds fetched more profit followed by feed withdrawal birds while lowest profit was earned from continuous fed birds. Fat supplementation reduced profit when compared with birds fed diets without fat supplementation.

3. GROWTH PROMOTORS

Feed efficiency value in birds implanted with 5 mg diethylstilbosterol was significantly better than those implanted with 10 or 15 mg. The dressing percentage also showed the same trend. The tenderness and juiciness of carcasses showed non-significant difference in chicks. The highest mortality was observed in birds- implanted with 15 mg diethylstibesterol while birds in other groups did not show much difference in this respect. The addition of different antibiotics in ration fed to White Plymouth Rock chicks for a period of eight weeks showed that the ration containing TM-5 at the rate of 1/2 pound per 1000 pounds of feed was the best for growth, efficiency of feed utilization and controlling the mortality, followed by neftin (1/2 lb/1000 Ih), penicillin (10 gm/100 lb). However, the feed consumption and dressing percentage remained unaffected by all the rations.

Virginiamycin at a dietary concentration of 5 ppm stimulated growth used in a complete ration, 3-nitro (50 ppm) plus erylhromycin (006 gin/liter in drinking water) also improved the growth rate and feed efficiency. Virginiamycin supplementation and the use of 3-nito plus erythromycin are recommended provided the addition of these feed additives does not render the ration uneconomical. Virginiamycin and 3-nitro aided in yielding significantly high edible meat percentage from the carcass. Viginiaroycin had shown highly significant reduction of bono percentage with the best bone moat ratio. Erythromycin alone or in combination with 3-nitro resulted in highly significant reduction in production in protein percentage.

The effect of different water soluble antibiotics on the performance of White Plymouth Rock broilers was determined, using four medication treatments such as plain water, and water with polymycin, gibb-mycin and neo-terramycin-25. Significantly more weight gain and improved feed efficiency were observed in the birds treated with different antibiotics as compared to thosio maintained on plain water. The administration of neo-torramycin-25 was found to be economical followed in descending order by

polymcin and gibb-mycin.

The effect of growth promoters viz.; albac, fermecto and grow-for was studied on 120 day- old Hubbard broiler chicks. No difference was found in feed intake and weight gain of the birds fed rations supplemented or without supplementation; with growth promoters. However, the birds on ration containing growth promoters utilized their feed more efficiently than the control group. The best feed efficiency was recorded in grow-for (2.06) followed by fermecto(2.13), albac (2.22) and control (2.42). Supplementation of the growth promoters in ;the rations exhibited 1.11, 2.38 and 2.85% more dressed weight in; albac, fermecto and grow-for respectively than those of control. However, the values were statistically non-significant. Similarly, the relative weights (gram organ weight per 100g body weight) of giblets (heart, liver, gizzard) did not show any effect due to the presence of growth ;promoters ;in the diets. The profit rate was also higher in the treatment groups than control.

Every year poultry industry encounters a great deal of economic losses due to aflatoxicosis. A number of efforts have been made to immunize the toxin effects. The use of sodium bentonite is one of them. Sodium bentonite (SB) has been found to antagonize the aflatoxin in broiler chickens. This project was planned to study the ability of sodium bentonite as an aflatoxin binder to minimise the aflatoxin effects in broiler feeds. The experiment was conducted at poultry Research Centre, University of Agri. Faisalabad, Pakistan. One hundred and twenty day old Hubbard broiler chicks were randomly divided into twelve experimental units (replicates) of ten chicks each. The experimental birds were fed starter(1-28 days) and finisher (29-42 days) ration. The aflatoxin values in feed were tested by thin layer chromatography (TLC). The data on initial body weight per chick, weekly feed consumption of each experimental unit, antibody titer at the end of 3rd and 5th week, leg deformities and mortality, if any, were recorded. The comparison of means showed significantly ($P<0.05$) higher weight gain (1746 + 20.13) in group D where 1.5% bentonite was added and the lowest ($P <0.05$) value (183 + 1025) was found in B (no bentonite added). While, differences were non- significant ;among other groups. The addition of SB improved the FCR significantly ($P <0.05$). The best FCR was found in D (2.01 + 0.24) and the poorest in B (2.21 + 0.24). The FCR differed significantly in the groups except in A and C. The production of toxin caused a depression on growth, feed consumption and feed conversion ratio. The probable reason of poor weight gain in group (B) could be the effect of aflatoxin that interfered with normal metabolic pathway through the inhibition of protein synthesis and enzyme system, which is involved in carbohydrate metabolism and energy release. The highest mortality was recorded in the chicks fed on treatment ”C” “A” and “B”, respectively. The lowest mortality on group D may be due to production of DNA binding proteins. The highest antibody titer against ND at 3rd week found in the group A (158.43) being fed on the control diet while lowest (73.25) in B fed on contaminated feed without binder, 99.2 in group C and 112.43 in group D. For the 5th week, the antibody titres recorded for ND were the lowest (128) in group B highest (247) for group A. At the end of week 3rd the geomean of antibody titers against infectious bursal disease were the lowest (21.11) for the group B and highest (40.06) for group A. The differences in titres of antibody of C and D experimental groups were non-significant but there were significant differences in groups A and B. At the end of 5th week the geomean values for group A (52.22), B (16.00), C (36.76) and D (42.22), respectively. The GMT was the lowest (16) and the highest (52.22) relating with group B and A respectively. The results of present study showed that heameagglutinin inhibition titer against Newcastle disease was reduced in birds of group B, C and D, respectively. The reduction in antibody titer was more in group B (aflatoxin 100 ppb) which may be attributed to adverse effects of aflatoxin, which causes the regression of bursa of fabricious. The results showed more reduction in antibody titres in contaminated group, but bentonite @ 1.5 percent improve the titers by decreasing the immune suppression effect of aflatoxin.

Present study was conducted to investigate the effect of different levels of kalongi (Nigella sativa) seeds on the performance of broilers. Chicks were fed commercial ration, supplemented with ground kalongi (Nigella sativa) @ 0, 0.5 and 1.0% (A, B and C). At the end of the experiment, meat samples from breast and thigh portion were taken to determine total cholesterol. The data was analyzed by analysis of variance technique. The difference between the means was calculated by LSD test. The weight gain, feed

conversion ratio and slaughter data showed a non-significant increase in C. Feed consumption was decreased significantly (P<0.05) in C but increased in B. The breast and thigh total cholesterol was affected significantly (P<0.05) by the treatments. The breast total cholesterol was decreased significantly (P<0.05) from 8.10 to 17.20% while the decrease in thigh cholesterol was from 4.5 to 11.6%, with kalongi supplementation. The highest value of breast cholesterol was found in A (73.6 mg/dl), followed by B (67.7 mg/dl) and the lowest in treatment C (61.0 mg/dl). The highest value of thigh cholesterol was in A (85.61 mg/dl), followed by B (81.8 mg/dl) and the lowest in treatment C (75.71 mg/dl).

The study was conducted at Poultry Research Center, Dept. of Poultry Husbandry, U.A. Faisalabad, comprised of three phases. In the phase-I, six herbal plants (different parts were used) were tested and three plants from these were selected by conducting performance trial. In the second phase, three levels (1.25, 2.5, 5.00g) of each were tested in contrast to antibiotic growth promoter TM-200. Best levels of the respective plants from the phase II were investigated at various combinations and were compared with an imported herbal product. It was concluded that combination of Neem, Kalongi and Asghand @ 1.25g/kg of feed was best to get maximum growth in broilers.

The study aimed to determine the comparative efficacy, as growth promoter, of six medicinal plants namely *Nigella sativa, Boerhavia diffusa, Withania somnifera, Ipomea digitata, Azadirachta indica* and *Corylus avellena* @ 4g/kg of feed. The performance of 210 Hubbard broiler chicks in terms of weekly weight gains, feed intake, feed conversion ratio and mortally, if any. These chicks were randomly allotted to 7 treatments comprising of 3 experimental units each. Commercially formulated broiler starter and finisher rations supplemented with authenticated samples of the plant materials. Maximum gain in weight and better-feed conversion ratio were observed with *Withania somnifera* followed by *Nigella sativa* and *Azadirachta indica*. The lowest results were recorded for *Boerhavia diffusa* and *Ipomea digitata*. The results of *Corylus avellena* and control were statistically similar. The maximum profit per bird was obtained from *Azadirachta indica* followed by *Nigella sativa* and *Withania somnifera* compared with control.

4. STRAIN

The performance of one hundred and eighty, day-old chicks of four commercial hatcheries namely Arbor Acres, Hy-brcd, Pilch and PIA Shaver was assessed. Significant differences were found in weight gain and feed consumption while non-significant differences were observed in case of feed efficiency, dressing percentage, edible meat percentage and bone:met ratio in different broiler strains.

Present study was conducted to evaluate the performance of various broiler strains viz Hubbard, Arbor Acres and Starbro, ninety day old chicks were randomly divided into 3 groups (A, B and C) respectively. Hubbard chicks showed significantly higher growth rate (1666gm) and significantly lower feed conversion ratio (2.15). Dressing percentage was significantly higher in Hubbard (88.71%) while edible meat percentage was highest in Starbro (81.25%) but was non significant statistically. Shank length, keel bone length, liver weight, heart weight and gizzard weight were found statistically non-significant. The highest net profit per bird was found in Hubbard chicks (25.12 Rs.) and lowest net profit was found in Starbro chicks (4.03 Rs.)

INSTITUTE OF ANIMAL NUTRITION & FEED TECHNOLOGY

The Institute of Animal Nutrition and Feed Technology, University of Agriculture, Faisalabad is pioneer in animal nutrition and technology research and teaching. This institute has four divisions: Ruminant Nutrition, Non-ruminant nutrition, Nutritional Biotechnology and Feed Technology. Research activities of Institute focus on improvement of the nutritive value of low quality feedstuffs through chemical and biological treatments; nutritional evaluation of local forages, crop residues and low grade industrial by-products; efficient and economical ration formulations for quail, broiler and layers and ruminant livestock; detoxification of naturally occurring toxins and anti-nutritional factors to improve the feeding value of indigenous feeds; production of single cell proteins and feed enzymes through bioconversion/ fermentation; and recycling of animal excreta for small and large ruminants.

The major innovations in the field of animal nutrition and feed technology developed at the institute are summarized below:

Ruminant Nutrition

Nutritional deficiency is one of the major constraints in the growth and productivity of livestock. Generally, feed covers 70% of the meat and milk production cost. Currently, livestock in Pakistan annually requires about 10.9 and 90.36 million tons of crude protein (CP) and total digestible nutrients (TDN), respectively. However, the respective availability of these two nutrients is 6.7 and 69.0 million tons. Thus, CP and TDN are 38.53 and 24.60% deficient per annum, respectively. The gap between requirement and availability of nutrients could be minimized through better use of fibrous crop residues (wheat straw, rice straw, corncobs and stovers) and non-conventional feed resources (cane molasses, corn steep liquor, enzose, urea, etc.) in the diets of dairy and meat animals.

TECHNOLOGIES FOR BETTER USE OF CROP RESIDUES

Treatment of wheat straw and corncobs with urea

The 5% urea treated wheat straws ensiled with 6% acidified cane molasses or corn steep liquor for 15 days under anaerobic conditions improve crude protein contents, increase intake and digestibility of straws. This serves as a least cost feed resource for the ruminant livestock. The treated wheat straws can be included up to 60%, on dry matter basis, in the total ration of lactating buffalo rations without any ill effect on productivity. Corncobs, after crushing to a small particle size, and treated the same way as wheat straws can also serve the same purpose and can be included up to 70% in the total ration of dairy animals.

UREA MOLASSES BLOCKS

Urea molasses blocks can be used to supplement crude protein and energy along with essentials minerals to animals. They are especially important for growing animals and in areas where there is less availability of green fodder. Urea molasses blocks typically contain wheat bran, molasses, urea, sunflower meal, DCP, salt and bentonite 50, 30, 8, 5, 3, 1 and 3% respectively. However, ingredient composition of the urea molasses blocks can be changed according to the price and availability of the feed ingredients used to make it cost effective for the farmers.

UREA MOLASSES LICK

This is another way of supplying crude protein and energy to growing ruminants. Molasses can be supplemented with 4% urea and can be offered to animals through a special urea molasses licker

(wooden or metallic), specially designed for the purpose. The purpose of the licker is that animals should be able to lick the urea mixed molasses but not drink it.

FODDER COMBINATIONS FOR BETTER PRODUCTIVITY

Combination of leguminous and non-leguminous fodders is a way of providing 'balanced fodder' to the livestock for better animal productivity. Inclusion of berseem or lucerne increases the CP contents of the non-leguminous fodders. The leguminous fodders are berseem, shaftal, lucerne and rawan) and non-leguminous fodders are corn, sorghum, mott grass, napier grass, oat, barley and jambo grass, etc. The farmers are advised to grow a combination of leguminous and non-leguminous fodders for providing balanced fodder to their livestock. Examples of such combinations are cowpeas with sorghum, cowpeas with millets, moth with sorghum or millets, barseem with oats, etc.

FODDER PRESERVATION

Fodders have maximum nutrients for livestock when they are in early bloom stage. Delayed harvesting, though increases per acre dry matter yield of the fodders but it decreases their nutritive value. Therefore, it is recommended that the fodders be harvested at a stage when they have maximum nutrients and preserved in forms of hay or silage. Hay and silage making preserves the nutritive value of fodders and can be fed at any part of the year. The other advantage of preservation of fodders is that it ensures the continuous supply of fodder to the livestock round the year.

High yielding multi-cut fodders and grasses e.g., Jambo grass, mott grass and oat fodder ensiled with 2% molasses for 30 days and form a good replacement for green fodder. Berseem and lucerne fodders ensiled at 30% DM level with 2% molasses can replace the conventional leguminous fodder. Legumes have about 20% dry matter. To reduce the concentration of moisture, and increase dry matter to 30%, wheat straw can be used with berseem before ensiling. This technique has not only preserved the fodder but it has also enhanced the nutritive value of wheat straw used as moisture absorbent.

Hay making is another way of preserving nutrients. Leguminous fodders, grasses and oats are used for making hay. The fodder is dried to moisture contents of less than 10%. This dried fodder is called hay. The hay, then, can be stored and fed to livestock at any time of the year.

ORGANIC WASTE RECYCLING

The manure can be recycled in the animal feeds. Addition of manure to wheat straw at rate of 30% and fermented with 4% urea and 4% molasses for 40 days under anaerobic condition can be used as concentrate source in the diets of buffalo and cattle. Wheat straw prepared in this way can be supplemented upto 25% of the total ration of the ruminant animals.

DIETARY CATION ANION DIFFERENCE FOR BETTER PRODUCTIVITY IN BUUFALOES IN TROPICS

Heat stress, a major problem lowering buffalo productivity in Pakistan can be overcome by manipulation of disturbed acid base balance through dietary electrolytes (salts). Enhanced productive (milk production) and reproductive (cyclic ovaries) performance of buffaloes in summer can be achieved by formulating diet having dietary cation anion difference around 250 mEq. / kg. This is done by addition of minerals in the diet that have positively charges ions.

Poultry Nutrition

BIOTECHNOLOGY

Biomass (single cell protein) production

Dramatic increases in the prices of animal feed ingredients have awakened interest in "single cell protein" (SCP)- microbial cells from algae, bacteria, fungi and yeast for use as a source of protein in poultry diets. Bio-conversion of defatted rice polishings to a routine protein concentrate for poultry diets was achieved with *Candida utilis* (a yeast organism) and a soil fungus *Trichoderma harzianum*. This biomass was biologically evaluated in broilers and found of high biological value. Similarly, bio-conversion of beet pulp into microbial biomass was also achieved by using *Candida utilis*. The further enhancement of the biomass protein with special reference to lysine amino acid, the inoculation of *Brevibacterium flavum* was done. It was observed that feed intake of birds significantly improved when fish meal (a costly poultry feed ingredient) was replaced by the microbial protein partially or completely. Like wise biomass protein was also produced from wheat bran through fermentation by *Candida utilis* and *Bravibacterium flaviumi.*

Furthermore the experimental birds fed aflatoxin along with biomass had better growth rate and feed consumption indicating that there was less absorption of aflatoxin and more aflatoxin was passed out in the feces

Enzyme production

i. Cellulase enzyme:

Cellulolytic enzymes, produced from *Arachniotus sp.* were used for the upgradation of nutritional value of sunflower oil meal (highly fibrous but a cheap plant protein ingredient) for poultry diets through saccharification of its fibre.

Multi enzyme produced from fungus, Arachniotus species with 6% corn stover; 0.0075% $CaC1_2$; 0.0055 Mg $SO_4.7H_20$; 0.1% KH_2PO_4; 1.5% cane molasses; pH 4 and 32^oC temperature resulted in maximum saccharification of sunflower oil meal (SFOM) fibre after incubation at enzyme substrate ratio 1:1, pH 4.0, 40ºC temperature for 36 hours. Supplementation of this enzyme can be helpful to increase the inclusion levels of sunflower oil meal up to 15% in broiler diets.

ii. Phosphatase enzyme:

Phytase enzyme was produced from a fungal species *Aspergillus niger.* This enzyme was successfully used in corn-soybean meal based broiler diets for the release of phytate phosphorus.

Adding phytase (1.075 PU/gm of substrate) from *Aspergillus niger* to a low phosphorous diet (3.6% non-phytate P) could give results similar to diet having di-calcium phosphate (4.5% nP).

Product evaluation

Effect of different levels of EM_4 (probiotic) in broiler chicks diets revealed that EM_4 has a considerable growth promotion potential and it may by incorporated up to 0.02% in the diets.

The effect of *Roxazyme* (saccharolytic enzyme) supplementation in wheat based poultry diets indicated better utilization of high dietary levels of wheat (rich in non-starch polysaccharides).

Better broiler performance with higher levels of sunflower oil meal can be achieved by using fibrolytic enzyme. Three dietary levels (5-15%) of sunflower oil meal supplemented with Kemzyme (500g/ton) result in better broiler performance.

Supplementation of broiler diets with enzyme “Roxazyme G (@ 200 g/ton of feed) increased the inclusion rate of wheat (upto 50%) in diets.

Burga meal and fat in broiler rations: Burga meal, a product of palm oil industry and produced from the processing of palm kernel after oil extraction. It contains 16% CP and can be used in broiler diets upto 15% by replacing corn and soybean meal on protein equivalent basis. Burga fat, a rich source of essential fatty acid linoleic acid, used up to 2% in broiler diets improved feed efficiency by reducing the cost of production.

FEED TECHNOLOGIES

Study on the nutritive value of sunflower meal for poultry feeding given heat treatment revealed improved growth rate of the chicks fed diets containing sunflower meal processed at 90^0C. Different treatments viz, autoclaving, soaking, and direct heat, were applied to enhance the protein quality by lowering the trypsin inhibitor and urease activity of indigenous raw soybeans. Techniques like extrusion (to remove trypsin inhibitor) and enzyme supplementation (to improve fibre and gum utilization) were used to enhance the nutritional value and utilization of guar meal in broilers diets. Autoclaved and sodium carbonate treated rapeseed meal was used upto 8% in poultry diets. These treatments reduced the sulfur containing glucoside called Goitrin, which during digestion by endogenous enzyme myrosinase hydrolyzed to volatile isothiocyanate, an antinutritional factor for poultry. Similarly, autoclaved guar meal was safely used in broiler diets.

Autoclaving, soaking and direct heating of soybean meal or rape seed meal treatment with sodium carbonate enhanced the nutritional value by reducing their anti-nutritional factors.

Dried buffalo manure was recycled and used in broiler rations upto 9% without any problem of ill health and growth rate of broilers.

The effect of different feed additives viz., Albac, Polymycin and N-Fac-1000 and probiotics, T. M. 50, Biovin 40 and Albac on broiler performance were studied. The results indicated that feed additives significantly improved dry matter and protein digestibility, reduced intestinal thickness and slowed the flow rate of ingesta. Caecal salmonella and E. coli load was also reduced by feed additives. Among different chemical viz sodium bentonite, Myco-fix and Myco-add employed to detoxify the effect of aflatoxin contamination in the poultry feed, the sodium bentonite proved better. Commercially available different antioxidants were evaluated to establish their dosage level for the fortification of rice polishing and complete poultry diets from rancidity, especially during summer seasons.

NUTRITIONAL STARETAGEIS TO COMABT HEAT STRESS

Different studies were conducted to device an appropriate nutritional therapy to overcome the problems of high environmental temperatures.

Ascorbic acid supplementation enhanced the productive efficiency of heat-stressed broilers and layers (Lyallpur silver black and white leghorn) birds.

Supplementation of 100-200 ppm ascorbic acid in feed is effective for better productive efficiency in broilers layers reared during summer season.

Dietary electrolyte balance was established for heat stressed broiler birds. The best sources of electrolyte were also identified to alleviate the adverse effect of heat stress. Dietary supplementation of sodium bicarbonate ($NaHCO_3$) in heat stress broiler chicks indicated highest body weight gain in birds fed diets containing only 0.75% $NaHCO_3$. Under heat stress conditions, DEB 50 and 250 mEq/kg enhanced

the performance and survivability of broilers. The diet having DEB 50, achieved by supplementation of $NaHCO_3$ and NH_4Cl to have Na (0.26 and 0.20%), K (0.71 and 0.65%) and Cl (0.88 and 0.71%), in the starter and finisher diets, respectively can be fed to get better broiler performance during summer season. Similarly, supplementation of both $NaHCO_3$ (0.6 and 0.71%) and NH_4Cl (0.03 and 0.03%) to have DEB 250, with Na (0.36 and 0.35%), K (0.71 and 0.65%) and Cl (0.32 and 0.23%), in the starter and finisher diets, respectively is also another beneficial therapy for heat stressed broilers.

NUTRITIONAL EVALUATION OF LOCAL FEED INGREDIENTS

Locally available conventional feedstuffs were evaluated for incorporation in poultry diets.

Studies on different sources of dietary phosphorus dicalcium phosphate, bone meal, rock phosphate (as such) and rock phosphate) on calcium and phosphorus utilization and the productive performance of broiler chicks revealed that the apparent availability calcium and phosphorus was maximum in dicalcium phosphate fed birds and minimum in rock phosphate (as such) fed birds. The DCP also proved as the economical source of phosphorous in poultry diets.

FACULTY OF VETERINARY SCIENCE

VETERINARY PHYSIOLOGY AND PHARMACOLOGY

1. RUMINANT PHYSIOLOGY

A number of studies have been conducted to understand the physiology of ruminant stomach in buffaloes and sheep. Studies were focussed on motility, microflora and boi-chemical aspects of the reticulorumen. Studies on reticuloruminal motility in sheep revealed triphasic contraction of reticulum immediately before the biphasic contraction during rumination but not durig eating. The primary cycle of the reticuloruminal motility comprised of biphasic reticular contraction followed by another powerful contraction and occasionally the primary cycle was observed to be followed by a secondary cycle. Longer duration and greater amplitude of reticular contraction was observed in calves reared on calf starter as compared to milk fed group durig 11^{th} to 20^{th} week of age, the animals fed on mixed ration had a longer duration of reticulo-ruminal contraction of greater amplitude as compared to those fed on all roughage ration, however, the frequency was greater in roughage fed group. Microbial population of buffalo reticulorumen has been identified as fourteen bacterial groups of which six species were isolated.' Effect of low and high plan of nutrition showed significant levels of protein in the rations. Out of the 14 morphologically different organisms, only three could be identified as belonging to genera Veillonella, Lactobaccillus and Selenomonas. Effect of different sources of nitrogen as well as dry roughages on total bacterial count, viable bacterial count and cellulolytic bacterial count have been measured. The NPN nitrogen resulted into increase in the bacterial count.

2. HAEMATOLOGY

Heamatology of different species of animal has been studied to provide the normal values for determining stage of health or disease. Haemoglobin, RBC, WBC, DLC, PCV and ESR were measured to establish the norms. In haematological study of fat-tailed sheep it was observed that sex exerted a significant effect on the blood coagulation time, ESR and total number of erythrocytes. Month of study period significantly influenced the amount of haemoglobin and TLC in all groups. Biochemical components of the buffalo blood were measured at different ages and physiological states. Blood calcium, inorganic phosphorus, glucose, protein and cholesterol have been determined. A non-significant positive correlation was found to exist between calcium level in young animals as against the negative correlation in the adult buffaloes. Serum calcium did not vary in different groups of adult female buffaloes. Decrease in phosphorus with increase in age was recorded. No significant variations could be observed in the blood glucose serum protein and cholesterol levels of lactating, pregnant lactating, non-pregnant dry and pregnant drybuffaloes.

Differences in haematology during various diseases like piroplasmosis, traumatic pericarditis, chronic mastitis and haemorrhagic septicaemia were studied ESR. Hb and RBC counts were found to vary durig different diseased conditions but no significant variation could be recorded in WBC counts.

Blood groups were determined in buffaloes to provide information in blood transfusion in this species. At least eight blood groups were detected. There were four antigens and five antibodies present in the red cell and sera of the buffaloes, respectively.

Significant effect of antibiotics on monocyctes and eosinophils showed no significant variation. Effect of

level of tetracycline and oxytetracycline was however observed to be significant on lymphocytes and neutrophills.

3. ENVIRONMENTAL PHYSIOLOGY

Studies were focused to observe the changes in various physiological parameters of cattle, sheep and mice. Photo-periodicity and ambient temperature were found to influence the reproductive efficiency of mice. Diurnal changes in ambient temperature influenced significantly the rectal temperature in sheep. Body temperature, respiration and semen characteristics of dairy bulls were recorded to note the effect of season.

Pure and cross bred dairy heifers were studied for their adaptability towards summer season. The responses were measured in terms of haematology and other physiological parameters. No significant change was observed in rectal temperature among pure and crossbred heifers during different periods of summer season. Pulse rate was higher in Sahiwal-Friesian cross and lower in pure Sahiwal during the month of August. Respiration rate increased with the increase in environmental temperature in all the genetic groups. However the increase in respiration rate was much higher in the Friesian cross. Summer season responses were also visible when RBC, Hb, PCV and ESR were examined.

4. SEMEN PHYSIOLOGY

Studies have been conducted to investigate different causes of sluggishness, lowered libido, morphological characteristics of spermatozoa and preservation of spermatozoa. The results showed that collection of semen three times a week have adverse effect on libido, reaction time and some semen characteristics. It was concluded that optimum collection frequency is twice a week. Treatment of the bulls with PMS and thyroxine improved the libido.

The differences among bulls and within each bull were found to be non-significant so far as the volume, colour, concentration, percentage motility and size of spermatozoa were concerned. The average overall length of buffalo-bull spermatozoa was 75.4 + 34µ. It was found longer than the cow-bull spermatozoa. The peculiar shape of head made it quite distinguishable from that of cow-bull spermatozoa. The cow skim milk was found superior diluent than buffalo' skim milk for buffalo spermatozoa preservation. A definite beneficial effect of glycerol addition on spermatozoa motility was also observed.

5. PHYTO-HORMONES AND SUPEROVULATION

Commonly cultivated fodders like Alfalfa, Guara, Maize and Berseem were extracted for their oestrogenic activity. The potency of oestrogenic activity of the extracts was bioassayed with reference to diethylstilbestrol in mice. The oestrogenic activity in these fodders was found to be too low to cause any significant effect on growth and reproduction of livestock. Human chorionic gonadotrophin (CG) and pregnant mare's serum (PMS) each 50 iµ resulted in superovulation in rabbits shedding a maximum number of ova when administered subcutaneously.

6. RENAL PHYSIOLOGY

Kidney functions in the indigenous species of common ruminants under extreme climatic conditions prevailing in the country have been studied. A comprehensive study recently concluded on these aspects revealed significant increase in diuresis during winter in cows, sheep and goats except buffaloes where seasonal differences were non-significant. Renal clearance of creatinine increased significantly in winter in cows, sheep and goats, but in buffaloes the situation was reverse. Urea clearance increased significantly during winter in cows and goats but seasonal variations were not significant in buffaloes and sheep. The results also showed variations among indigenous and exotic species with regard to GFR.

Active secretion of urea from kidney tubules seemed probable in sheep and require further work to establish the phenomenon. Kidney function during its post natal development are suggested for future research.

7. GEONETICAL INFLUENCES ON BIODISPOSITION OF DRUGS AND KIDNEY FUNCTION

The developing countries like Pakistan are importing raw material or finished drugs for their veterinary or medical health programmes. These drugs are developed and produced in the soil and environments where genetic make up of man and animals are entirely different from those under indigenous conditions. Therefore, the applied research on drugs, needs to be conducted in the population and environments where the drugs are to be used clinically. In view of this, extensive investigations have been conducted on the biodisposition and optimal dosage regimen of sulphonamides, ampicillin, chloramphenicol oxytetracycline and rifampicin in goats, sheep, cows, buffaloes, dog and human beings. Some studies also dealt with the bioavailability of the chemotherapeutic agents following different routes of administration. The biodisposition studies have clearly demonstrated differences under indigenous conditions when compared with the values given in literature, in text books or for products sale promotion literature.

The investigations were continued to further explain the reasons for these variations and it was found that the differences exist for; pH of blood and urine, plasma protein contents, drug metabolizing enzymes, renal glomerular filtration rate, and mechanisms involved in the renal excretion.

These variations are likely to affect the therapeutic response to drugs.

The seasonal differences in the biodisposition of drugs were recorded during summer and winter seasons. Likewise, the alloxan induced diabetes significantly affected the dosage regimen of weekly acidic sulfonamides while such differences were insignificant in febrile conditions.

From these investigations several facts have emerged showing that the geographical influences on the genetics are manifested by various physiological and biochemical characteristics which have been described by an original terminology "GEONETICS". This area has vast scope of investigations in various disciplines and deserves concerted efforts to generate local data and informations.

The geonetical influences on the kidney function have been explored extensively. There are several new informations amongst which some are worth mentioning. The renal glomerular filtration rate is lower in the local species of ruminants and the renal hanlding of urea seems to involve mechanisms analogous to active tubular secretion in sheep. The active tubular secretion of neutral molecule like urea has not been documented earlier. The counter current transport mechanism also seems to involve a multiphasic phenomena. Seasonal influences on the kidney function have been found to be significant and during summer a lower blood volume as a result of hemoconcentration manifests lower blood pressure and lower glomerular filtration rate. There is a need to establish the postnatal development of renal function on which a project has already been planned.

8. EVALUATION OF INDIGENOUS MEDICINAL PLANTS

During the last 25 years, several indigeneous medicinal plants have been evaluated for pharmacological, toxicological, antidiabetic and anthelmintic activities. Milky juico of *Calotropris procorn* (AK) was found to contain toxic, stomachic, cardiotonic activity in dogs and rabbits. Aerial parts of *Tribulus terrestris* (Gokhru) was found to act as chronotropic and diuretic in rats and rabbits. A compound prescription of *Melia azedarach* (Bakain) *Tinospora cordifolia* (Gilo) *Berberis vulgaris* (Zarishk) was found effective *antibacterial* agent against *Salmonella typhi* and *Salmonella typhimurium. Melia azedarach* (Bakain), *Punica granatum* (Anar) and *Caesalpina crista* (Kuth) were found effective against experimental Ascaridia

galli infection in chickens. *Saussurea lappa* (Kuth), *Punica granatum* (Anar), *Morus alba* (Toot) *Psoralia coryliforia* (Babchi) and *Lagenaria siceraria* (Kadoo ke beej) showed anticestodal and antinematodal activity in sheep. *Peganum harmala* (Harmal), *Veronia anthelmintica* (Kalizeeri) and *Melia azeadarach* (Bakain) were found effective in reducing the fecal egg counts of round and tape worms in goat. *Artemesia maritima* (Afsanteen), *Caesalpinia crista* (Karanjwa) glycosides of *Caeslalpinia crista* (Karanjwa) effectively reduced the faecal egg counts of *Neoascaris vitulorum* in buffalo-calves. A combined prescription of *Embelia ribes* (Babrang) and *Veronia anthelmintica* (Kalizeeri) effectively reduced the gastro-intestinal nematodes in goats. *Melia azedarach* (Neem) and its neutral fraction of alcohlic extracts in purified and unpurified forms were found effective in reducing the number of nematode eggs on sheep and goats.

The following plants were studied for their antidiabetic activity and these plant drugs in the crude form were found effective in lowering the normal blood glucose levels in rabbits.

Euphorbia prostata (Dhodi), Fumaria parviflora /Shahterah,) *Cuminun nigrum* /Kalizeeri^ *portulaca oleracae* /Kulfa^, *Taraxacum officinale* /Dudhal^, *Zizyphus sativus* fUnab^ *Acacia arabica (Kihar), Grewia asiatica (Falsa,), pterocarpus marsupoim (Chob), Cassia fistula (Amaltas), Onosma echioides* /Ratanjot^ *Lodocea sechellarum* (haryal Daryai^, *Cralluma edulis (Chung)f Asparagus racemosus (Satawar), Gossypium hirsutum and Can tharan thus roseus (Sada bahar).*

The following plants were found to produce a decrease in the blood glucose levels of alloxan-treated diabetic rabbits.

Cuminum nigrum (TKali zeeri).FuinarJfa *parviflora* /Dhodi,) *and compound prescription containing Bergenia ligulate* (Pakhan Bed), *Astracanthus longifolia* /Tal Makhana^ *Saxifraga ligulata, Argeria speciosa* /Samandar Sokh^ *Cinnamonum cassia Cl'aJ).*

Most of the potent anthelmintic antidiabetic plants, so far evaluated, have shown that the highest effective dosage levels of the crude powders, their equivalent extracts in alcohol or water and the control drugs are equipotent. Moreover it was also clear that the crude forms of these medicinal plant drugs were more effective and safer than those of their extracts. This proves that the natural form of the above cited plants have some adjuvant or corrective principles which prevent the incidence of side effects as compared to their isolated punned chemical constituents.

The glycemic indices (GI) of moong and mash meal in normal and diabetic subjects were estimated to be 45 and 56 respectively which indicates usefulness of legumes in diabetic condition.

Blood glucose levels of normal and diabetic rabbits after oral administration of three types of honey in low doses may be recommended as a source of carbohydrate to human patients suffering from diabetes mellitus.

A study on induced nitrate poisoning in rabbits showed decrease in body weight, increase in heart rate and increase in methemoglobin percentage during the first two weeks of oral administration.

VETERINARY PATHOLOGY

1. REPRODUCTIVE PATHOLOGY OF BUFFALO

The biometrical values of 4057 normal reproductive organs and those from 90 pregnant buffaloes were determined. The biometrical values of paired reproductive organs were similar on each side. In pregnant animals, the organs ipsilateral to gravid horns showed significantly higher values than those of contralateral side except for the thickness of uterine walls and the number of caruncles, various diseased conditions of 847 reproductive organs were also studied.

The organ-wise incidence of diseases showed 51.23 per cent involvement of uteri, 29.75 per cent ovaries, 15.11 per cent cervices and 3.89 per cent oviducts. The age-wise incidence of diseases revealed, 90.08 per cent incidence in adult buffaloes, 9.68 per cent in heifers and ,0.24 per cent in calves.

The incidence of various diseases in 252 ovaries showed ovaro-bursal adhesions in 169 and cystic degeneration in 78 cases which comprised of follicular cysts in 52, luteal cysts in 14 and cystic corpus luteum in 12 cases. Other ovarian abnormalities were atrophy in 24, dermoid cysts and abscesses each in 6, granulosa cell tumors in 4 and parovarian cysts in 44 cases.

A total of 33 diseased oviducts showed salpingitis in 66, pyosalpinx in 4, hydrosalpinx in 12 and mucosal cysts in 11 cases. Gross and histopathological examination revealed that most of the conditions were inflammatory in origin while the mucosal cysts appeared as remnants of mesonephric ducts.

A total of 434 diseased uterine horns showed highest incidence of 64 cases of acute and 241 cases of chronic endometritis. Acute endometritis was characterised by swelling, flabbiness, enlargement and haemorrhages which on histological examination showed neutrophilic infiltration in most of the cases. Chronic endometritis showed hardening of uterine walls due to thickening of endometrium which on histological examination revealed changes varying from early cellular reaction to extensive fibroblastic proliferation. The other uterine abnormalities included perimetritis in 41, perimetrial cysts in 6, pyometra in 41, hydrometra/mucometra in 71, segmental aplasia in 2 and tuberculosis in 4 cases. In tuberculosis, both the uterine horns showed generalized miiliary tubercles in the form of small discrete nodules.

Acute and chronic cervicitis were seen in 79 and 48 cases, respectively. Inclusion cyst was also recorded in one case.Acute cervicitis showed congestion and in few cases haemorrhages of the cervical canals. Histologically, there was infiltration of noutrophils and few mononuclear cells. Chronic cervicitis showed collection of mucopurulent exudate, thickening, fibrosis and tortuosity of cervical canals. Histologically, different degrees of celluar hyperplasia and hyalinization of blood vessesis were observed.

Of the 1003 buffaloes examined, 385 showed pathological changes. Of these, 48 animals with advanced bilateral lesions were infertile whereas 138 showed lesions amenable to treatment and 199 showed conditions which did not disturb the reproductive functions and could possibly breed.

The pituitary glands in buffaloes were examined for anatomical, biometrical and pathological observations. Anatomically all the pituitary glands were found located in the sella turcica enclosed in the diaphragma sellae. The biometrical values such as the length, width and depth of adenohypophysis and weight of each pituitary were recorded.

Of the total pituitary glands, 30 showed the presence of gross pathological alterations including thin wallod cysts, hypertroyphy and atrophy of glandular parenchyma. Of all these lesions, the incidence of cysts was as high as 21 cases and the remaining lesions were present in 9 cases. Microscopically,

pituitary gland revealed acidophils, basophils and chromophobes varying in number in normal, pathological and pregnant animals.

Reproductive tracts of 2357 adult sheep showed 2157 normal and 200 diseased ovaries and oviducts. Among 2157 normal reproductive tracts, 447(18.96%) were pregnant. The pregnancies on left side were 44.29 and on right side 55.71 per cent. The incidence of ovarian and oviductal abnormalities were 2.29 and 1.95 per cent respectively. The ovarian abnormalities were found to be of follicular cysts (0.15%) luteal cysts (0.09%), cystic corpora lutea (1.46%), persistent corpora lutea (0.21%),ovaro-bursal adhesions (0.30X) and oophoritis (0.08%). The oviducts showed salpingitis (0.76%), hydrosalpinx (0.19%), pyosalpinx (0.17%) and par-ovarian cysts (0.83%). The gross and histopathological picture of each condition was also studied.

2. THE KIDNEY DISEASES IN ANIMALS

A morphological study was made of 30 dogs and 28 cats, with and without clinical signs of renal disease, for evidence of glomerulonephropathy. In 83 per cent of the dogs and 72 per cent of the cats there were mild to severe glomerular changes. The major type of lesion encountered in dogs was membranoproliferative glomerulonephritis and in cats diffuse membranous glomerulonephritis. The glomerular alterations consisted of mesangial hypercellularity, increase of basement membrane-like material, thickening of peripheral capillary walls, and lobular accentuation of the capillary tufts. Ultrastructurally, the lesions were charaterized by prominent local or diffuse mesangial proliferation and by thickening, wrinkling, doubling and splitting of glomerular basement membrane. Vacuolizatioon and deposition of electron dense material was frequently observed within glomerular basement membranee and mesangium. Tubular and interstitial changes were commonly observed with glomerular changes. Immunofluorescence patterns, although studied in only 5 dogs and 3 cats confirmed the depsition of IgG and C3 in. the capillary loops and mesangial areas and indicated the immune complex nature of the disease both in dogs nd cats.

The kidneys have been examined for alkaline phosphatase in 8 dogs and 5 cats. Light microscopy revealed that the convoluted and a portion of straight segment of the proximal tubule was strongly positive for alkaline phosphatase both in the dog and cat. In the cat, and much less regularly in the dog, the ascending limb of Henles loop was also positive. The distal convoluted tubules and collecting tubules were negative. The glomeruli of cat kidney were strongly positive while the dog glomeruli showed variable regative to slight positive reaction

Ultrastructurally, the enzyme was primarily localized to membrane surfaces of cells. The glomerular reaction was mainly confined to the epithelial cells, surfaces of podocytos, the membrane surfaces of erythrocytes, endothelial cells and the glomerular basement membranes. The enzyme activity in the tubules was localized on the brush border to membranes covering the microvilli.

Naturally occurring calculi were collected from kidneys of 19 buffaloes including 13 females, 6 males and 13 cattle representing 12 females and one male from the local abattoir. No visible differences were observed between the calculi of both the species of animals. The calculi were multiple and ranged from sand like particles to as large as the size of an almond. These were hard in consistency and brown to greyish white in colour.

3. COMMON POULTRY INFECTIONS

A selected group of adult fowls of either sex and different breeds which showed severe respiratory symptoms for 2-3 weeks; comprising of gargling sounds, tracheal rales, gasping for wind, jerky movements of the head and nasal as well as ocular discharge; was subjected to the rapid plate aggluination test. Twenty five of these birds, showing an antibody titre of 1:640 or more against the

Mycoplasma gallisepticum were salughtered and examined for gross and microscopic lesions of the affected organs.

Evidence in the present study suggested that field cases of CRD were not easy to diagnose on purely clinical grounds but if the respiratoty symptoms were slow to develop, persisted for over three weeks and to a marked drop in feed consumption, * appreciable reduction in egg numbers and gradual loss in weight and condition without heavy mortality, CHD could be suspected.

At autopsy every upper respiratory tract was found studded with a more or less thick slimy exudate which in majority of the cases was found mixed with fibrin. Epithelial lining specially of the thoracic air sacs was found much thickened. In addition to the typical beading reaction, tracheal mucosa in the majority of the cases, showed necrotic foci which in six cases were accompanied with sloughing. Except for some congestion and focal consolidation, lung tissue was mostly normal. Exudate of cheesy nature was observed in four of the affected lungs.

Under the microscope, the lining of the respiratory tract was found largely inflammed and at places undergoing degeneration. Tracheal epithelium in additon, showed some nectrotic foci as well as discrete desquamation. When denuded underlining cartilage cells of the trachea! rings were in many cases, calcified. Lung tissue when infectod, showed focal granulomas made of large mononuclear cells, reticuloendothelial cells, lymphocytes and a few giant cells.

In flocks with history of slow developing respiratory infection of long standing and low mortality rapid plate agglutination test seems a very reliable procedure for diagnosing CKD.

The artificially infected Lyallpur Silver Black and White Leghorn chicks and layers showed a variable incubation period of Newcastle disease. On an average, this period ranged from two to seven days in young chicks and three to twelve days in adults. The respiratory symptoms such as gasping, coughing, gargling sounds and serous nasal discharge appeared first followed by the nervous symptoms including torticollis, nodding of the head, somersaulting, walking in circles, prostration and death. The Lyallpur Silver Black breed was found to be more susceptible to artificial Newcastle disease infection than the White Leghorns. The gross picture of the affected organs was haemorchagic and necrotizing. It was mainly the proventriculus, small intesine, liver, and lungs which showed the maximum lesions. The spleen, kidneys and brain were also affected. Under the microscope, degenerative and nectrtic changes with haemorrhages, cellular infiltration and oedema were the main pathological observations.

The blood picture of 38 female white leghorn birds experimentally inoculated with infective material from a natural case of lymphoid leucosis was studied. The results were compared with those of normal birds. Eleven birds showed leucocytosis. Of these, 6 showed increase in lymphocyes, in 2 birds heterophils were increased, in 3 eosinophils were increased and in 2 basophils were increased. Five birds showed increase in heterophils and in 3 eosinophilia was observed without leucocytosis. Lymphoblasts varying in number were seen in 36 cases. In 20 cases, mitotic changes were seen. Anaemic changes were observed in 6 birds. Studies on the cytology of bone marrow were made in 5 spontaneous and 12 experimental cases of lymphoid leucosis. Three normal birds were also studied for comparison.

The blood picture and pathology was studied in 51 birds experimentally infected with spirochaetosis by intramuscular, intraperitoneal and subcutaneous routes. The results were compared with 97 healthy birds. The birds comprised of Rhode Island Red, Lyallpur Silver Black and White Leghorn breeds of poultry. The clinical picture was almost similar in the throe groups. The total erythrocytic counts, haemoglobin contents and packed cell volume decreased with the duration of infection. The average incubation period was 46.7 hours by subcutaneous route. The overall average incubation period was 52.3 hours, feeding of 1, 2 and 3 per cent fish liver oil to the poultry did not induce any pathological lesions.

4. COMMON DISEASES OF SHEEP AND GOATS

One hundred diseased lungs from sheep and similar number from *goats* were collected alongwith mediastinal lymph nodes from Faisalabad abattoir. The overall incidence of diseases of lungs was as follows in order of frequency, pneumonias of various types 77.5 per cent of which bronchopneumonia was 51 per cent, hydatidosis 21.5 per cent and tuberculosis 1.0 per cent.

5. EXPERIMENTAL STUDIES IN ANIMALS

Experimentally induced carbon tetrachloride toxicity in buffalo calves revealed that there was no change in the cellular blood picture, however the erythrocyte sedimentation rate was considerably increased in all the three cases. SGOT activity was markedly increased and SGPT activity was not altered. The total serum proteins were decreased. There was a decrease in beta globulins whereas alpha globulins remained within the upper normal limits. The values for albumin, gamma globulin ratio remained unaltered. There was an increase in blood urea nitrogen value while the creatininc concentration did not show any change.

Supplements of desi ghee, vegetable ghee and corn oil were fed for a period of twelve weeks at the rate of 20% of the feed to three groups of rabbits. During this period, serum cholesterol and phospholipids were found elevated to a significant level in rabbits given desi ghee and vegetable ghee. The feeding of desi ghee, however, resulted in higher level as compared to the rabbits given vegetable ghee. The serum cholesterol-phospholipid ratio in desi and vegetable ghee groups of rabbits was also found elevated. Insignificant rise of serum cholesterol[1] and phospholipids were recorded in rabbits given corn oil supplement. The tissue cholesterol determined at different intervals showed maximum concentration in aorta followed by kidneys, liver and heart in rabbits given supplements of desi ghee.. In rabbits given vegetable ghee supplement, higher level of tissue cholesterol was recorded in the liver, then in the aorta, heart and kidneys. No marked variation in the level of tissue cholesterol was recorded in rabbits given corn oil mixed diet.

6. NEOPLASIA IN ANIMALS

Studies were conducted to determine the incidence of lymphoid leucosis in various breeds of chickens reared on 52 commercial poultry farms in and around Lyallpur (Faisalabad city). The clinical picture and postmortem findings of birds which died of lymphoid leucosis wore recorded. Of the 15,200 Sarcross, 9,100 Brown Queen and 21,000 White Leghorns reared on these farms, mortality due to lymphoid leucosis in these breeds was 26.15, 24.01 and 22.50 per cent respectively. Most of the birds died between 3 and 11 months of age, though the mortality rate was higher from 6 to 9 months of age. The malignant epithelial tumours recorded during these studies were squamous cell carcinomas (3 cases), bartholins gland carcinoma (1 case) and adenocarcinoma (1 case). The malignant connective tissue tumours comprised of reticulum cell sarcoma (1 case) and lymphosarcoma (2 cases).

7. EFFECTS OF INJECTIONS

Gentamycin, Kanamycin, Tobramycin and Oxytetracycline intramuscular injections in rabbits manifested elevated levels of serum creatine phosphokinase (CPK), Lactic Dehydrogenase (LDH), Aspartate Aminotransf erase (AST), and Alanine Aminotransferase (ALT). The peak levels of CPK and ADH were obtained after 6 hours and 12 hours, respectively. Maximum AST and ALT activity was noticed after 24 hours of injection. The levels of CPK, AST and ALT declined to normal within 72 hours of injection but LDH acctivity who sustained uptil 72 hours. The elevation of serum enzymes in test groups was compared with the elevation in control group. There was significant rise in CPK level in Gontamycin, Kanamycin and Tobramycin injected groups as compared with control. Elevation in LDII activity was nonsignificant in Gentamicin and Oxytetracycline injected groups. A significant rise in AST level was seen

in Gentamycin and Tobramycin injected groups while Kanamycin and Oxytetracycline groups showed nonsignificant rise in AST levels as compared with that of control. Neither control nor any of the test groups showed significant rise in ALT level after injection.

The study of haemotological values indicated that total leukocyte count and neutrophilic counts were slightly raised after 24 hours of injection as a part of general reaction to the drug administration.

There was no significant change visible to nacked eye examination at the site of injection except few pin point haemorrhages. Slight paleness around the injection site was also seen. Microscopically mild, haemorrhages, degeneration and coagulative necrosis was observed in the muscles at injection site.

The results of this study revealed that the antibiotic injections caused more local tissue damage than normal saline injection. Gentamycin injection resulted in maximum tissue damage followed by Oxytetracycline while Tobramycin and Kanamycin injections inflicted least damage at the injection site.

In the present study, local and systemic reactions were observed after intramuscular and intraperitoneal administration of the commonly used antibiotics (Lincomycin and gentamycin) and sedatives (diazepam and chlorpromazine) in rabbits. Therapeutic dose of each drug was administered according to per kg body weight. The systemic reaction was manifested as elevated levels of creatine phosphokinase (CPK), lactate dehydrolgenase (LDH), aspartate aminotransferase (AST) and alanine aminotransferase (ALT). The peak levels of CPK and LDH were obtained after 6 and 12-48 hours while maximum activity of AST and ALT was found at 24 hours. The levels of CPK, AST and ALT declined to normal after 72 hours of injection but activity of LDII still sustained at 72 hours. All the levels were compared with the control group injected physiological saline.

Intramuscular injection of lincomycin inflicted more damage than intraperitoneal one. This was manifested by the significant rise in LDH and AST levels after intramuscular administration. The levels of other enzymes in this group showed nonsignificant elevation. Serum activity of LDH and AST was also found to manifest significant rising levels after intramuscular injection of gentamycin. However, the intraperitoneal administration of gentamycin caused significant elevation of CPK and LDH. On the whole gentamycin caused more damage than lincomycin.

There were significant rising levels of CPK, LDH and AST after intramuscular injection of diazepam. The intraperitoneal administration of diazepam nevertheless inflicted less damage and there were only significant rising levels of LDH. Intramuscular and intraperitoneal injections of chlorpromazine led to signiicant rising titres of LDH while the rise in the levels of CPK, AST and ALT was insignificant as compared to control. The diazepam caused more systemic reactions than the chlorpromazine.

The study of haematological values indicated that total leukocytic and neutrophilic count was slightly raised after 24 hours as a part of general reaction phenomenon to these drugs but the count declined towards normal after 48 hours. Moreover, the study of peritoneal fluid after intraperitoneal injection showed elevated protein levels due to local irritation.

Macroscopically there were no significant findings in both intramuscular and intraperitoneal groups except very slight pinpoint haemorrhages in few cases at the site where needle was introduced. There was a slight lymph node enlargement in two cases of intraporitoneal group. Microscopically, mild haemorrhages and coagulative necrosis was observed in the muscles of rabbits given intramuscular injectables. There were mild inflammatory changes after injections of gentamycin and chlorpromazine.

8. COMMON DISEASES OF BUFFALOES

Studies were undertaken to know the incidence and pathology of common lung diseases in buffaloes

slaughtered at Faisalabad abattoir during 1985. Out of 100 morbid lungs examined, pneumonias were recorded in 90 per cent, tuberculosis in 8 per cent and abscesses in 2 per cent cases.

Three different types of pneumonia were recognised. Bronchopneumonia was seen in 55.5 per cent, fibrinous pneumonia in 21.1 per cent and interstitial pneumonia in 23.2 per cent cases.

The incidence, etiology and pathology of Deg Nala Disease has been described. The disease is seasonal and occurs in winter months when fungal infested rice straw is fed to cattle and buffaloes in large quantities due to scarcity of green fodder. Buffaloes were more frequently affected than cattle and younger animals appeared to be more susceptible.

The disease has been successfully produced experimentally in a large number of buffaloes and cattle fed on fungal infested rice straw and on different combinations of fungal. mats of species moat frequently isolated from fresh rice straw. The possibility of mycotoxin in the causation of the disease has been discussed. The results of cellular blood picture and serum proteins in expoerimentally infected buffaloes appeared within the normal ranges.

9. DIAGNOSTIC FACILITIES RENDERED BY THE DEPARTMENT

During the year under report 80 postmortem examinations of large animals and more than one thousand poultry birds from about 500 flocks of various sizes have been examined.

10. ANIMAL DISEASES

10.1. Food Animals

10.1.1. Aetiopathology and Treatment of Neonatal Mortality

Calf mortality has been reported to be very high in cow and buffalo neonates. This mortality has mostly been attributed to infectious agents, i.e. rotavirus, coronavirus, enteropathogenic *Escherichia coli*, salmonella species and cryptosporidium. Other important causes of calf mortality include immunodeficiency, seasonal effects parity of the dam, difficult parturition, sex and birth weight of the neonate and faulty management conditions. Of the infectious agents, rotavirus and *E. coli* are mainly involved in the causation of neonatal calf diarrhea which lead to high mortality and morbidity in young calves. *E. coli* mainly plays its role up to second week of life while rotavirus up to third week. Pneumonia causes great economic losses in neonatal calves. Electron microscopy is the standard technique for virus diagnosis, however, enzyme-linked immunosorbent assay (ELISA) is widely used now-a-days because of its easy handing, less technical still involved and availability.

A study was concluded on 325 neonates of Nili-Ravi buffalo and 354 of Sahiwal cows maintained at the Livestock Production Research Institute, Bahadurnagar during 1990 to 1992. The overall incidence of mortality among buffalo and cow neonates was 7.08 and 11.02 per cent, respectively. The mortality was not influenced by sex and birth weight but age of neonates, parity of dams and season of the year had a significant effect. The mortality was significantly higher during 3rd week, summer and among neonates of 2nd parity dams. Diarrhoea in neonates of both the species caused higher morbidity, mortality and fatality than pneumonia and pneumo-enteritis. Navel-ill, umbilical hernia and mange caused only morbidity whereas heat stroke proved fatal in one cow neonate.

Haematological values with regard to sex of neonates and parity of the dams showed non-significant differences in both the species. The number of RBCs was significantly less whereas Hb. concentration, PCV, MCV, MCHC and TLC were significantly higher at birth in healthy neonates. Significantly low ESR at birth in buffalo neonates was recorded whereas in cow neonates it showed non-significant variations. Rouleaux

formation was observed in buffalo neonates. Neutrophils showed significantly higher counts at birth than lymphocytes and from 2nd week onward, lymphocytes were more in number than neutrophils and this trend continued upto 4th week of age in neonates of both the species.

In diarrhoeic and pneumo-enteric buffalo and cow neonates significantly higher values of RBC and PCV were recorded whereas MCHC were significantly decreased. Leukocytosis mainly due to neutrophilia along with lymphocytopenia was recorded in diarrhoea, pneumonia and pneumo-enteritis in neonates under observation.

Significantly higher morbidity due to diarrhoea, pneumonia and pneumo-enteritis in neonates having intermediate and low concentration of IgG, was recorded with a relative risk of 3.65 and 5.03 times more in buffalo and 3.21 and 4.28 times more in cow neonates. Mortality was three times more in neonates having intermediate and as high as nine times in neonates with low IgG, concentration as compared to neonates having high IgG, concentration.

Enteropathogenic *E. coli* and Salmonella spp. were isolated from faecal samples of diarrhoeic neonates. The incidence of the former was significantly higher in 1st week and of the later in 3rd week of age. Bacterial organisms isolated from nasal discharges of pneumonic neonates showed highest incidence of *Pasteurella haemolytica* followed by *Corynaebacterium pyogenes,* Staphylococci, Streptococci and P. *multocida.*

Diarrhoeic lesions in neonates of both the species were nearly the same whether caused by enteropathogenic *E. coli,* Salmonella spp. or with no established aetiology. The carcasses showed moderate to severe emaciation and dehydration. Milk curds in abomasum and mucosal haemorrhages were recorded. Lesions in the duodenum were minimal and less severe than those in the jejunum and ileum which showed focal to diffuse hyperaemia and petechial or linear haemorrhages. The faeces were yellowish-watery mixed either with mucous, blood or fibrino-necrotic material. Hepatomegaly with distended gall bladder were also observed.

Histologically, the most severe and most frequent changes were observed in the mucosa, followed by those in the submucosa, muscular and serosal layers of small intestines of diarrhoeic neonates. Sloughing of lining epithelium and villi, congestion on the tips of villi along with stunting and fusion and in severe cases, necrosis of villi were the salient features. Among infiltrating cells, neutrophils were followed by lymphocytes, plasma cells and macrophages in lamina propria, periglandular areas and lumen of crypts of Lieberkuhn. The submucosa showed dilatation, oedema and congestion. Sections of intestines of buffalo neonates having parasites in their lumen showed sloughing of villi, hyperplasia of crypts of Lieberkuhn, massive infiltration of neutrophils and few macrophages in the periglandular areas. Buffalo and cow neonates died of pneumonia and pneumo-enteritis showed diffusely distributed consolidated areas in the apical, cardiac and intermediate lobes which appeared congested or anaemic and firm in consistency.

The overlaying thickened and congested pleura was covered by serofibrinous inflammatory exudate. The affected lobules yielded frothy, sanguinous or mucinous exudate from the bronchi and bronchioles. Histologically, the alveolar capillaries were dilated and studded with blood. Congestion and infiltration with neutrophils was followed by lymphocytes, plasma cells and macrophages in the peribronchiolar connective tissue and within the bronchiolar walls. The alveolar lumens were filled with RBCs, neutrophils, few macrophages and desquamated epithelial cells. Alveolar septa was thickened whereas the interlobular septa was dilated with exudate, inflammatory cells, some newly formed fibroblasts and capillaries.

A study was conducted on 535 neonates born during 1995-2000 at Livestock Production Research Institute, Bahadurnagar, Okara. The overall incidence of mortality in buffalo neonates was 7.66%. The mortality was not influenced by sex and birth weight but age of neonates, parity of dams and season of the year had a significant effect ($P<0.05$). The mortality was high ($P<0.05$) during summer and among neonates of 1st, 2nd and 4th parity dams. Diarrhoea occurred predominantly causing the highest morbidity and mortality than pneumonia, pneumo-enteritis and salmonellosis.

Experimental trials for the treatment of diarrhoea were carried out on 24 buffalo calves divided into 4 equal groups. Diarrhoea was induced with oral administration of enteropathogenic E. coli in three groups, G-1 (antibiotic + rehydration solution), G2 (antibiotic alone), G3 (rehydration solution alone) while 4th group served as uninfected, untreated control. The calves of all groups were monitored twice daily. Diarrhoea developed in all treatment groups within 2-6 hours after induction of infection. The nature of diarrhoeic contents varied from semi solid to watery. The colour of diarrhoeic fluid was yellowish to greenish yellow mixed with blood flakes or mucous. The frequency of defecation also varied from 6-10 times per day.

All the calves appeared clinically normal during the initial stages of diarrhoea. Signs of lethargyness and dehydration related to intestinal fluid loss developed progressively but were marked high at the time when the rate of faecal fluid loss significantly increased. In G-1 calves, signs of mild dehydration (4-5%) were evident in the form of dry cornea, some loss of skin elasticity and animals were unable to rise without assistance. Signs appeared in G-3 calves were of higher degree as compared to G-1 neonates. However, most severe forms of signs appeared when degree of dehydration reached to 10-12% in G-2 calves treated with Kanamycin. Neonates in this group showed severe dryness of cornea, loss of suckling reflexes, sunken eyes, dry mucous membrane and cold extremities. Overall general condition was worse. Physical parameters including temperature was significantly higher in G-3 calves than G-1, G-2 and control calves. Pulse rate was lower in G-2 than the control ($P<0.05$) and other treatment groups. Respiration rate was lower in all treatment groups (G-1 to G-3) than the control group.

Total erythrocytic count and PCV were high ($P<0.05$) in G-2 calves. Whereas no specific trend was observed in the haemoglobulin concentration in control and treatment groups. Rouleaux formation is a feature of buffalo blood. Buffalo neonatal calves treated with Kanamycin showed crenated erythrocytes in the blood smears. Leukocytosis mainly due to neutrophilia was observed in all the treated calves than the control group. In G-2 and control group calves, neutrophil were negatively correlated with lymphocytes in all the experimental groups.

Serum total protein (STP) and globulin were low ($P<0.05$) in control calves than all treatment groups. Albumin was higher in G-2 calves than calves of G-1, G-3 and control group STP showed positive correlation with albumin, globulin and immunoglobulins (Igs) in all experimental groups except in control group. Immunglobulins were high ($P<0.05$) in G-2 calves than G-1, G-3 and control calves. Igs showed positive correlation with STP, albumin and globulin in all treated groups except G-3.

Overall mean values of serum potassium and chloride concentration were high in all treatment groups, whereas mean values of sodium were high in control group calves than all treatment group. Serum sodium showed negative correlation with potassium in G-1 and G-2 and with chloride in G-1 and G-3 calves. Potassium showed positive correlation with chloride in G-1 and control group. Mean values of pH in all treatment and control group did not differ significantly throughout the study. Mean values of BUN concentration were high ($P<0.05$) in all treatment groups than the control group at various days of experiment. BUN showed positive correlation with creatinine in G-1 and G-3 calves. BUN also showed positive correlation with TLC in control group while negative correlation was recorded in globulin in all groups. Mean values of serum creatinine was high ($P<0.05$) in calves of all treatment groups than the control group. Creatinine showed positive correlation with Ig in G-2 calves and negative correlation with chloride in all groups except G-2 calves. The values of glucose was low ($P<0.05$) in all treatment groups than the control group. Mean values of AST were higher in G-1 calves than G-2, G-3 and control calves. AST showed positive correlation with ALT in G-3 and negatively correlated in control group. Mean values of ALT was lower in G-2 calves than G-1, G-3 and control calves. Mean serum values of AP was high ($P<0.05$) in G-2 calves than G-1, G-3 and control calves.

Moderate to severe emaciation and dehydration, dryness of cornea, some loss of skin elasticity, sunken eyes, dry mucous membrane and cold extremities were present in calves treated with antibiotic (G-2) only

but these changes were prominent in calves treated with rehydration solution alone (G-3) or in combination with antibiotic (G-1). Histopathological studies revealed congestion on tips of villi and intestinal mucosa along with denudation and fusion of villi which were more prominent in G-2 calves but these changes were less severe in calves of other treatment groups.

The study was conducted on 85 neonatals of Pak-Karakul sheep at the Sheep and Goat Development Centre, Rakh Khairewala, District Layyah, Pakistan, with the aim of assessing the relationship of immunoglobulins to neonatal lamb mortality. Overall mortality in neonates was 8.24%. Surviving lambs (3.77±0.07 kg) were significantly ($P<0.001$) heavier than those that died during the neonatal period (2.79±0.018 kg). Males were significantly ($P<0.05$) heavier than females (3.84±0.11 vs. 3.52±0.09 kg). The lambs that survived the neonatal period had a significantly ($P<0.001$) higher level of immunoglobulins (30.89±0.87 ZST units) than those that died (7.08±1.99 ZST units). The mean total serum protein values for surviving and dead lambs, using a refractometer, were 78.51±1.86 and 47.14±4.84 g/l, respectively. The turbidity values below 10 ZST units and total serum protein level below 50 g/l may be considered as an indication of hypogammaglobulinemia

The study on 86 Thalli ewes revealed that erythrocytic indices did not differ significantly and showed no relationship with parity of the dam and sex of the neonatal lamb at the pre- and post-lambing stages. However, erythrocyte sedimentation rate, total leukocytic counts (TLCs) and neutrophils were significantly higher at post-lambing, while lymphocytes were higher ($P<0.05$) at the pre-lambing stage. Leukocytic indices did not show any trend with the parity of the dam. In dams with live lambs, the neutrophil count was lower ($P<0.05$), while lymphocytes were significantly higher at the pre-lambing stage, compared to the dams whose lambs died. Aspartate aminotransferase (AST) and alkaline phosphatase (AP) showed non-significant differences at the pre- and post-lambing stages, but alanine aminotransferase (ALT) level was higher ($P<0.05$) at the pre-lambing stage. All the enzymes studied did not show any trend with the parity of the ewe and sex of the neonatal lamb except AP, which was significantly higher at the post-lambing stage in ewes which gave birth to male suckler lambs. The enzymes studied were significantly higher at the pre-lambing stage in dams whose lambs died as compared to the dams with live lambs. It was concluded that in Thalli ewes, neutrophils, lymphocytes, AST, AP and ALT at pre-lambing stage may be used as an indicator of possible neonatal lamb mortality.

10.1.2. Infectious Diseases

Bovine tuberculosis (BTB) caused by *Mycobacterium bovis* (*M. bovis*), is an important zoonotic disease of livestock and human characterized by progressive emaciation and formation of tuberculous nodules in most of the organs mainly in the lungs. The OIE has classified bovine tuberculosis as a list B disease, a disease that is of socio-economic or public health importance. In Pakistan, limited information is available about prevalence and hemato-biochemical parameters of BTB. This project had been designed and executed to know prevalence, hematology and biochemistry changes in cattle suffering from BTB at various Government Livestock Farms, in the Punjab.

To know the prevalence of the bovine tuberculosis (BTB), the animals were injected 0.1 ml bovine tuberculin intra-dermally and reaction was read after 72 hours. A prevalence of 7.18 % was found. Non-significant difference was found in the prevalence of BTB in different breeds of cattle (chi-square value 0.089; $p>0.957$). Overall significant ($p<0.001$) difference was found in the prevalence of BTB in relation to age and parity in various breeds of cattle. It was noted that with increase in age of cattle, the prevalence of BTB also increases. Prevalence of BTB has significant ($p<0.001$) relationship with increasing body weight as the highest incidence was in >350 Kg body weight cattle and disease was not found in cattle having body weight <250 Kg at various livestock farms.

The hematological examination carried out in healthy and positive reactor cattle showed that in healthy cattle, RBC counts and PCV were significantly ($p<0.01$ and $p<0.04$; respectively) higher as compared to

the positive reactor cattle whereas ESR was significantly ($p<0.000$) higher in positive reactor cattle as compared to healthy cattle. Neutrophils and lymphocytes decreased and increased significantly ($p<0.000$) in positive reactor cattle as compared to healthy cattle, respectively. A strong negative (-0.979) correlation was found between neutrophil and lymphocyte counts in positive reactor cattle

The serum proteins determined in both healthy and positive reactor cattle showed statistically non-significant difference among total serum proteins, albumin and globulin. However, strong positive (0.929) and weak positive (0.474) correlation was found between total serum proteins and globulin, total serum proteins and albumin, respectively. A significant ($p<0.002$) variation was present in the plasma fibrinogen in the positive reactor cattle as compared to the healthy animals.

The study was conducted on 460 sheep at Livestock Production Research institute Bahadarnagar (Okara). Comparative intradermal tuberculin test was used as screening test on various animals under study and various samples were collected from positive and doubtful reactors and from control animals. The samples included of blood, serum, nasal swabs, faecal samples and milk samples. The prevalence of tuberculosis in positive reactors at Livestock Production Research institute Bahadarnagar (Okara) was 2.9% in sheep. Doubtful reaction was observed 2.82% in sheep. The overall prevalence of tuberculosis on the basis of positive tuberculin reaction was 2.35%. In haematological studies in overall, 9.52% and 57.14% sheep with positive or doubtful reaction respectively showed RBCs count less than value of control. In overall 38.09% and 19.045% sheep with positive or doubtful reaction had PCV less than those of control values. In overall significant percentage of sheep showed leukocyte count higher than the values of control with 19.04% and 28.57%.The present result of differential leukocyte count particularly neutrophil count , eosinophil count and monocyte count were higher, while lymphocyte count was lower than normal and control values in considerable number of animals. In overall considerable number of sheep had serum total proteins, albumin and globulin less than those of control. Higher number of animals had doubtful reaction were between the age of three to six years while the result was non significant in positive animals.

The present study was conducted on 415 female buffaloes at three Government Livestock Experiment Stations including Bahadarnagar, Univesity of Agriculture, Faisalabad and Khushab. Comparative intradermal tuberculin test was used to screen the animals under study. Blood samples were collected with and without anticoagulant for haematological and serum biochemical analysis. For isolation of *Mycobacterium bovis*, faecal samples, milk samples and nasal secretions were also collected. Flies were collected from each farm premesis and were triturated for isolation purpose. Epidemiological proforma was used to collect additional information regarding the husbandary practices and disease record. The prevalence of tuberculosis at farms under study varied from as high as 8.48% to as low as 2.45% in buffaloes, while doubtful reaction was observed in 8.48% to 2.45% in buffaloes with overall prevalence of 4.33%. In haematological studies significant percentage of buffaloes showed total erythrocyte counts, haemoglobin, erythrocyte sedimentation rate and PCV less, while leukocyte count higher than those of control and normal range. Differential leukocyte count particularly lymphocyte count, eosinophil count and monocyte count were higher, while neutrophil count was lower than normal and control values in considerable number of animals. In overall, considerable number of buffaloes had serum total proteins higher and also lesser, while albumin and globulin levels were higher than those of control and normal range.

The study was conducted on 497 cattle at three Government Livestock Experiment Stations including Bahadurnagar, Qadirabad, and Univesity of Agriculture, Faisalabad. Comparative intradermal tuberculin test was used as screening test for the animal under study and various samples were collected from positive and doubtful reactors and from control animals. The samples included of blood, serum, nasal swabs, faecal samples and milk samples. Flies were also collected from each farm and epidemiological proforma was used to obtain additional information. The prevalence of tuberculosis at farms under study varied from as high as 6.1% to as low as 1.18% in cattle. Doubtful reaction was observed in 8.57% to

5.49% cattle. The overall prevalence of tuberculosis on the basis of positive tuberculin reaction to bovine tuberculin in cattle was 2.41%. In haematological studies in overall, 23.52 and 55.88% cattle with positive and doubtful reaction respectively showed RBCs count less than value of control and the normal range for cattle. In overall, 17.64 and 47.05 % cattle with positive and doubtful reaction had PCV less than those of control. In overall significant percentage of cattle showed leukocyte count less than the value of control and normal range. In differential leukocyte count, lymphocyte count was lower than control in considerable number of animals while neutrophil count in cattle was opposite to the lymphocyte count and eosinophil count showed no variation. However, monocyte count showed less variation. In overall, considerable number of cattle had serum total proteins levels below those of normal. The percentage of cattle having albumin and globulin less than 3 gram /100 ml were significantly higher in doubtful reactors.

The study was conducted on 510 goats at two Govt. Experiment Livestock Stations including Bahadar Nagar and Rakh Kherewala. Comparative intradermal tuberculin test was used as screening test on various animals under study and various samples were collected from positive and doubtful reactors and from control animals. The samples included of blood, serum, nasal swabs, faecal samples and milk samples. The prevalence of tuberculosis at farms under study varied from as high as 2.9% to as low as 1.70% in goats. Doubtful reaction was observed in 2.12% to 1.09% goats. The overall prevalence of tuberculosis on the basis of positive tuberculin reaction was 2.35%. Prevalence in animals reacted to mammalian PPD is 1.57% and to avian PPD was 0.39% and to both PPD was also 0.39%. In haematological studies in overall, 35% and 15% goats with positive or doubtful reaction, respectively showed RBCs count less than value of control and the normal range for goats. In overall 10% positive and 10% doubtful goats had PCV less than those of control and normal range. In overall, significantly less percentage of goats showed leucocyte count less than the value of control and normal range. In differential leukocyte count, lymphocyte count was lower than normal range for the specie in significantly less number of animals. The neutrophil count in goats was opposite to the lymphocyte count and was lower in considerable number of goats than values of control and normal range. In eosinophil count and monocyte count no variation both in positive or doubtful animals than the values of control and normal range was observed. In overall, considerable number of goats had serum total proteins levels higher than those of normal and of standard values. The results of the serum proteins revealed higher values than control values in only 10% animals which was significantly less percentage. In overall, 60-70% of goats with positive or doubtful reaction had albumin and globulins lower than those of control.

10.1.3. Metabolic Diseases

In view of the diverse aetiological factors associated with parturient haemoglobinuria (PHU) in different parts of the world, a local work was needed to elucidate the aetiopathology of this syndrome in buffaloes. Therefore, the present investigation was undertaken with the objectives to study: Clinical picture of the diseased buffaloes, Haematological, biochemical and pathological changes in affected buffaloes, Soil and fodder samples analysis from disease prone areas, and Correlation of these parameters.

This study was carried on 120 buffaloes. Out of these, 60 PHU affected and 60 apparently healthy buffaloes were randomly selected from districts of Faisalabad, Toba Tek Singh and Jhang, Punjab. These animals were subjected to collection of urine, blood/serum and tissue samples for various studies. Soil and fodder samples of the disease prone areas were collected and analysed for macro and micro-minerals.

The most prominent clinical sign in all the PHU affected buffaloes was passing of red to coffee coloured urine. Other symptoms included dullness, anaemia and dehydration. Milk production in affected buffaloes before disease (7.54±3.40 litre/day) was significantly ($P<0.001$) higher than the milk production after disease (4.50±2.68 litre/day). Respiration and pulse rates were significantly ($P<0.001$) accelerated and ruminal motility was significantly weak and reduced. Anorexia, ruminal stasis, severe straining while defaecating, dyspnoea, tachycardia, and icterus were observed. The case fatality rate was 15%.

Haematological studies revealed significantly (P<0.001) decreased in total erythrocyte count, haemoglobin concentration, packed cell volume and lymphocytes and significantly increased (P<0.001) ESR and neutrophils in PHU affected buffaloes as compared to healthy buffaloes. Biochemical studies revealed significantly (P<0.001) high concentrations of blood glucose, urea, serum total bilirubin, creatinine, alkaline phosphatase, potassium, iron and molybdenum while significantly (P<0.001) low concentrations of erythrocytic glucose-6-phosphate dehydrogenase, inorganic phosphorus, copper and selenium in PHU affected buffaloes as compared to healthy buffaloes.

Results of haemogram, leukogram and biochemical parameters in relation to season, parity, stage of lactation and stage of pregnancy did not differ in haemoglobinuria affected buffaloes. The Hb concentration showed significant (P<0.001) difference in relation to milk yield. It was found to be high in high yielding buffaloes.

Urine of PHU affected buffaloes was positive for haemoglobin (100%) and albumin (95%) but negative for sugar and ketone bodies. Microscopic examination of urine of PHU affected buffaloes revealed no intact erythrocytes and the pH of urine in PHU affected buffaloes was significantly (P<0.001) higher (more alkaline) than in healthy buffaloes (less alkaline).

The differences in the levels of Ca and K between upper and lower soil surface of disease prone areas under study were statistically non-significant. The mean values for P, Cu, Fe, Se and Mo in upper soil surface were significantly (P<0.05) higher than in lower soil surface.

None of the fodders analysed/offered to the diseased animals met the dietary requirements of P and Cu whereas none of the fodders was deficient in K, Fe, and Se rather were having excess of K, Fe and Se. The concentration of Ca was adequate in lucerne, berseem, sarson and sorghum, while maize, sugarcane and wheat straw did not meet the required levels meant for dairy animals. Mo contents in all fodders were adequate to meet the requirements of the dairy buffaloes.

Grossly carcasses were anemic and jaundiced. Liver, kidneys and spleen were pale, enlarged and congested. Liver was also friable and swollen along with distended gallbladder. Epicardium and endocardium showed ecchymotic haemorrhages. Lungs were emphysemated and oedematous. Histopathologically, kidneys showed necrosis of tubular epithelium and deposition of hyaline casts along with glomerulous atrophy. Liver exhibited centrilobular necrosis, haemorrhages and congestion. Kidneys, liver and spleen showed hemosiderin deposition. Heart muscles showed degenerative changes. Lungs were haemorrhagic congested and emphysemated.

Reproductive disorders

This study was carried out on 16 buffalo bulls (*Bubalus bubalis*), at Semen Production Unit (SPU), Qadirabad, District Sahiwal, Punjab. These bulls were divided into four age groups having four bulls in each. Three age groups (< 5, 6-10 and > 11 years of age) were having bulls with good quality semen. While Bulls selected in an abnormal group (6-10 years of age) were having poor semen quality.

The study was undertaken for one year period, starting from 1st May 1995 to 30th April 1996 and the year was divided into five seasons (dry summer, humid summer, autumn, winter and spring). All the bulls were kept under identical conditions of management, feeding and watering throughout the study period. Different parameters studied were as follows:

The daily temperature and relative humidity during study period revealed high temperature (42.54±3.89 °C) in dry summer and low in winter (23.22±2.75 °C). Relative humidity was high in humid summer (82.68±2.08 °C) and low in winter (69.79±9.04 °C).

Overall body weight was 673.03±2.90 kg and was higher (P<0.05) in bulls < 5 years of age in apparently healthy groups, however, it was higher (P<0.05) in abnormal group than apparently healthy groups. Overall BW of apparently healthy groups was higher (P<0.05) in autumn than dry summer. Overall scrotal circumference was 33.20±1.85 cm and was lower (P<0.05) in bulls of < 5 years and abnormal group. Overall SC of apparently healthy groups showed non-significant difference in various seasons. However, SC was higher (P<0.05) in winter than dry and humid summer in bulls of < 5 years, while it was higher (P<0.05) in dry summer than spring in bulls of 6-10 years of age.

Overall libido and mating behaviour scores were 2.61±0.55 and 4.83±1.00, respectively. Libido and mating behaviour score were higher (P<0.05) in 6-10 years old bulls than all other groups. Both libido and mating behaviour score of apparently healthy groups were higher (P<0.05) in winter, however, bulls of abnormal group showed non-significant difference between seasons. Overall time between two ejaculates was 10.60±1.06 minutes. Time between two ejaculates (TBTE) revealed non-significant difference between age groups including abnormal group. All the groups showed higher (P<0.05) time between ejaculates in winter.

Overall semen volume was 4.67±1.62 mL and showed non-significant difference between age groups including abnormal group. Semen volume was higher (P<0.05) in autumn followed by spring than other seasons. Overall semen pH was 6.55±0.50 and was lower (P<0.05) in 6-10 years than > 11 years old bulls and abnormal group. Volume was higher (P<0.05) in abnormal group than bulls < 5 and 6-10 years old bulls. It was lower (P<0.05) in autumn while higher (P<0.05) in winter than other seasons. Colour score was higher (P<0.05) in bulls < 5 years than 6-10 and > 11 years old bulls, however, it was lower (P<0.05) in abnormal group than bulls of healthy groups. In overall it was lower (P<0.05) in dry summer, however, all the groups showed non-significant difference in various seasons.

Overall mass activity score was 2.65±1.03. It was lower (P<0.05) in bulls of > 11 years of age than other apparently healthy groups, however, it was lower (P<0.05) in abnormal group than all apparently healthy groups. Mass activity score was higher (P<0.05) in dry summer and spring than humid summer and winter. Overall sperm motility score was 56.89±0.65 per cent and showed no difference in apparently healthy groups, but was lower (P<0.05) in abnormal group. It was lower (P<0.05) in winter than humid summer and autumn. Overall sperm concentration was 1.00±0.50 millions/mL and was higher (P<0.05) in bulls of < 5 years than > 11 years of age, however, it was lower (P<0.05) in abnormal group than apparently healthy groups. Sperm concentration was lower (P<0.05) in winter than autumn and spring. Overall dead sperm percentage was 14.35±0.63 and showed non-significant difference between bulls of apparently healthy groups, however, it was higher (P<0.05) in bulls of abnormal group. In overall it was lower (P<0.05) in autumn than dry and humid summer.

Overall head abnormalities were 3.04±0.30 per cent and showed non-significant difference between apparently healthy groups, however, these were higher (P<0.05) in abnormal bulls than 6-10 and > 11 years old bulls. Head abnormalities were higher (P<0.05) in autumn than dry summer and winter. Most prevalent head abnormalities observed during present study in apparently healthy bulls were tailless (1.05%), pyriform (0.41%), narrow at base (0.43%), misshapen (0.32%), elongated (0.28%), micro (0.15%) and underdeveloped (0.12%) heads. While in apparently abnormal bulls were tailless (1.02%), pyriform (1.36%), narrow at base (0.64%), misshapen (0.71%), elongated (0.28%), micro (0.13%) and underdeveloped (0.25%) heads. Overall tail abnormalities were 17.69±0.93 per cent and were higher (P<0.05) in bulls of abnormal group than healthy groups. These were higher (P<0.05) in winter while lower (P<0.05) in autumn and spring. The most prevalent tail abnormalities observed during present study were bent-tail (11.29%), coiled tail (2.23%), tail containing proximal droplet (1.88%), tail coiled around head (0.71%), loosely attached (0.56%) and loop tail (0.40%). While in abnormal bulls were bent-tail (17.85%), coiled tail (6.94%), tail containing proximal droplet (2.27%), tail coiled around head (0.97%), loosely attached (0.27%) and loop tail (0.78%). Overall mid piece abnormalities were 0.69±0.49 per cent and were higher (P<0.05) in bulls > 11 years than < 5 years of age. However, abnormal group showed

non-significant difference from apparently healthy groups. These abnormalities showed non-significant difference between seasons. Various mid piece abnormalities observed during present study in apparently healthy bulls were abaxial attachments (0.45%), thin mid piece (0.12%), thick mid piece (0.08%) and double mid piece (0.04%). While in apparently abnormal bulls were abaxial attachments (0.45%), thin mid piece (0.18%), thick mid piece (0.03%) and double mid piece (0.03%). Overall total sperm abnormalities were 21.42±0.95 per cent and showed non-significant difference between apparently healthy groups. However, TSA were higher ($P<0.05$) in bulls of abnormal group than healthy groups. These were higher ($P<0.05$) in winter while lower ($P<0.05$) in autumn and spring.

Overall seminal plasma testosterone concentration was 0.97±0.12 ng/mL and was higher ($P<0.05$) in 6-10 years old than < 5 and > 11 years old bulls. Testosterone showed non-significant difference between seasons. Overall seminal plasma oestrogen concentration was 43.67±7.62 pg/mL and showed non-significant difference between apparently healthy groups. Abnormal bulls also showed non-significant difference from healthy groups in oestrogen concentration. However, it was relatively lower in bulls of abnormal group than healthy groups. Oestrogen was higher ($P<0.05$) in winter than other seasons in all age groups.

Volume of semen showed low correlation with sperm concentration ($r = 0.06$), mass activity ($r = 0.06$) and seminal plasma testosterone ($r = 0.05$), while higher with dead sperm percentage ($r = 0.11$). It showed negative correlation with oestrogen ($r = -0.14$), total ($r = -0.11$) and tail ($r = -0.12$) abnormalities. The pH of semen showed negative correlation with colour ($r = -0.38$), sperm concentration ($r = -0.37$), mass activity ($r = -0.37$) and motility ($r = -0.17$). Total sperm abnormalities ($r = 0.21$), tail abnormalities ($r = 0.27$) and dead sperm percentage ($r = 0.15$) showed positive correlation with pH except head abnormalities ($r = -0.20$). The pH showed negative relation with testosterone ($r = -0.29$) and sperm concentration ($r = -0.38$).

Mass activity and motility showed positive correlation with testosterone ($r = 0.16$, $r = 0.18$) and negative with oestrogen ($r = -0.13$, $r = -0.17$) and total sperm abnormalities ($r = -0.34$ & $r = -0.38$, respectively). Sperm concentration correlated negatively with dead sperm percentage ($r = -0.11$) and total sperm abnormalities ($r = -0.23$) while positively with mass activity ($r = 0.86$) and progressive motility ($r = 0.16$). The dead sperm percentage correlated negatively with mass activity ($r = -0.26$), motility ($r = -0.17$) and oestrogen ($r = -0.06$) while positively with total ($r = 0.20$) and tail ($r = 0.17$) abnormalities and plasma testosterone ($r = 0.17$). Total sperm abnormalities also showed positive correlation with oestrogen ($r = 0.12$), head ($r = 0.20$) and tail abnormalities ($r = 0.95$). There was negative correlation between seminal plasma testosterone and oestrogen ($r = -0.28$).

BULL NO. 323 AND 321

The SC of bull No. 323 decreased from initial 26.40±0.55 to 25.00±0.00 cm at the end of the year, with an overall SC of 25.54±0.60 cm which was lower than of healthy bulls (33.20±3.20 cm). The SC of bull No. 321 was initially low (25 cm) but it increased apparently due to swelling of the scrotum. Swelling was uniform in appearance and remained throughout the study period. The sperm characteristics including volume of semen, mass activity, progressive motility and sperm concentration were also low in these bulls compared with healthy bulls. While dead sperm percentage and total sperm abnormalities were high than healthy bulls. Head abnormalities were much higher in bull No. 321 while tail abnormalities in both. Overall seminal plasma testosterone was lower in these bulls (0.94 and 0.71 ng/mL, in bulls 323 and 321 respectively), while oestrogen was lower in bull 323 (23.58 pg/mL) but higher in 321 (55.29 pg/mL) than apparently healthy bulls.

Testis

The histopathological studies of testes of bull No. 323 showed 100 per cent loss of germinal epithelium (DGEL) in all the three regions of right testis. However, DGEL was 79.50, 92.08 and 98.29 per cent in

dorsal, middle and ventral regions of the left testis, respectively, with an overall DGEL of 89.96 per cent. The vacuolated Sertoli's cell-only (grade 4) tubules were 33.33 per cent and Sertoli's cell-only tubules (grade 4a) were 65.0 per cent in right testis. Left testis of bull No. 323, however, showed spermatogenic activity and 30.16 per cent tubules showed hypoplasia (grade 4a). The DGEL was, however, high in all three regions (dorsal, middle and ventral) of this testis and so was percentage of grade 4+ tubules.

The bull 321 did show spermatogenic activity compared to bull No. 323. The DGEL in this bull was 35.88 per cent in right and 31.70 per cent in left testis with higher DGEL in ventral part in both testes. There were no hypoplastic tubules in the testes of this bull (no grade 4a tubules), although SC initially was low (25.00±2.87 cm).

DGEL correlated negatively with sperm concentration (r = -0.98) and progressive motility (r = -0.88), while positively with dead sperm percentage (r = 0.89) and total sperm abnormalities (r = 0.99). DGEL and G4+ tubules correlated positively with testosterone (r = 0.98, r = 0.99) while negatively with oestrogen (r = -0.87, r = -0.88).

Epididymis

Total diameter (TD) of epididymal ducts in caput regions of left and right epididymides were 518.80 and 383.30 μm in bull 323 while 821.40 and 445.40 μm, respectively in bull 321, with an overall 427.00 μm in bull 323 and 627.40 μm in bull 321. Total and lumen diameter was greater (P<0.01) in cauda region of left epididymis as compared with other regions of same sides and its right counterpart in both the bulls. Total and lumen diameter of epididymal ducts in caput region was greater both in right and left epididymis in bull 321 than bull 323 (having testicular hypoplasia). Similarly, TD and LD were high in corpus and cauda epididymis of bull 321 than bull having testicular hypoplasia. The DGEL in left testis was low while lumen diameter in left epididymis was higher in both the bulls. Both total and lumen diameter in present study was positively related with DGEL (r = 0.40 and r = 0.39, respectively) and lumen diameter with sperm concentration (r = 0.98).

Epithelial height (EH) in caput region of both epididymides (right and left) was higher than corpus and cauda regions with exception to corpus of right epididymis in both bulls. The EH was high in caput region of left epididymis in both bulls than other regions of the same epididymis. Epithelial height showed negative correlation with DGEL (r = -0.88) and seminal plasma testosterone (r = -0.87) while positive with oestrogen (r = 0.89).

This study was carried out on 200 Nili-Ravi buffaloes those came for artificial insemination (AI) in the Clinic, Department of Animal Reproduction, University of Agriculture, Faisalabad to know the incidence of repeat breeding, haematological, some biochemical and histopathological findings in repeat breeding buffaloes. Overall incidence of repeat breeding in buffaloes was found to be 15.5 per cent. A relationship was existing between parity number and repeat breeding in buffaloes. Of the 31 (15.5 %) repeat breeding buffaloes, the highest percentage of was observed in 3rd parity buffaloes (29.03 %). This incidence was followed by 4th (19.36 %), heifers (16.13 %), 2nd (12.90 %) and 5th (9.68 %) parities. Whereas 1st and 6th parities showed the lowest (6.45 %) incidence of repeat-breeding. T-test revealed significant (P<0.01) differences in between different parities of buffaloes. Haematological studies revealed that red blood cell counts, haemoglobin concentration, packed cell volume and erythrocyte sedimentation rate were found significantly (P<0.01) lowered in repeat breeding buffaloes as compared to healthy buffaloes. Rouleaux formation in blood smears from all buffaloes was a consistent feature. Cerenated erythrocytes and few erythrocytes showed paler areas in the center in most of the blood smears from repeat breeding buffaloes. Results of mean corpuscular volume and mean corpuscular haemoglobin concentration revealed that repeat breeding buffaloes were suffering from macrocytic normochromic anaemia. Relatively increased total leukocyte counts alogwith neutrophilia and lymphocytopenia were observed in repeat breeding buffaloes as compared to apparently healthy buffaloes. Immature cells of neutrophilic

series like megakaryoblasts and megakarocytes were also seen. Eosinophils though differed non-significantly in between apparently healthy and repeat breeding buffaloes, but were relatively higher in the later group. Non-significant differences were found in the values of total proteins, glucose and cholesterol in between apparently healthy and repeat breeding buffaloes. Total proteins and glucose concentrations were comparatively higher in apparently healthy buffaloes as compared to repeat breeding buffaloes, whereas cholesterol concentration was reverse in order. Endometrial biopsies from repeat breeding buffaloes showed inflammatory condition characterized by the infiltration of neutrophils, lymphocyte aggregations and plasma cells in the lamina propria, interglandular lamina propria as well as in uterine glands. Proliferation of fibrous connective tissue was also observed.

Hydropic degeneration in zona spongiosum and compactum was an other feature recorded in the endometrial biopsies from repeat breeding buffaloes. Atrophy of uterine glands was also observed. Blood vessels were showing arteriosclerosis. Necrosis in the stratum functionalis and basalis including necrosis of uterine glands, interglandular lamina propria, and even of fibrous connective tissue was recorded.

10.2. Equines

Strangles is one of the most important disease of the equines, which cause high morbidity and low mortality. The disease is common in the equine population of the country. But despite the importance of equines and the strangle, no study had been carried out on the epidemiolgy and clinico-pathological aspects of strangles in the country. Twenty five horses and twenty five mules of 1-2 years of age showing clinical signs of strangles were kept under observation during the course of the disease. Initially during the early phase of the disease the affected horses and mules showed nasal discharge followed by rise in rectal temperature. Nasal discharge was a constant finding in every affected animal in both the species. It was always bilateral, creamy in colour and varied from serous to purulent in nature. In both the horses and mules the maximum rectal temperature was 104.6° F. The temperature gradually became normal in 18 days in horses and 15 days in mules. There was appearance of a general tendency for higher rectal temperature persisting for longer periods in horses than in mules.

The peak phase of the disease showed occular discharge and involvement of lymph nodes with certain respiratory signs. All the affected horses and mules showed involvement of one or more lymph nodes of various regions of the body. In horses, maxillary, pharyngeal, parotid, periorbital and brisket lymph nodes were involved. Chi square analysis revealed that involvement of submaxillary lymph nodes alone in mules was significantly greater than in horses though simultaneasely involvement of multiple lymph nodes was more in horses than in mules (chi-square value 8.01, df = 1, $P<0.005$). The overall duration of disease in the affected horses under 2 years of age was 30.50 $\pm$ 0.37 and 31.97 $\pm$ 057 in horses of more than 2 years of age. In case of mules under 2 years of age it was 33.19 $\pm$ 0.59 days and 35.4 $\pm$ 0.91 days in the animals of more than 2 years of age. Body condition was poor in 100 percent of the affected horses. In the affected mules body condition was good in 88 percent and fair in 12 percent. None of the mules deteriorated to the poor condition.

Various complications followed strangles included big-head, purpura haemorrhagica and roaring. These complications were mostly observed in horses than in mules. Mortality in horses suffering from the disease was 2.47 $\pm$ 0.659 percent per annum where as in mules it was 1.36 + 0.85. There was no consistent pattern of difference in mortality of strangles between the two species. Nasal swabs and pus from lymph nodes of affected animals revealed chain forming cocci of variable length. None of the blood samples showed any type of bacteria in stained smears. There were two bacterial colonies developed from the samples, A and B types, which were further purified. All the pure isolates from the B type colonies after biochemical characterization confirmed the bacterial colonies of *Streptococcus equi*.

In horses higher number of field isolates of *Streptococcus equi* were sensitive to cephalosporin followed by penicilline, erythromycine, ampicilline or cloxacilline. In mules maximum number of *Streptococcus equi*

were sensitive to cephalosporine, cloxacilline and penicilline, erythromycine and ampicilline. The haemogram of the affected animals revealed that in case of erythrocytic count and haemoglobin concentration there were no significant changes in blood of normal and affected horses. However, the erythrocytic sedimentation rate was significantly higher in both the species affected with strangles than the normal animals in the first and second week and became almost normal in the third week. The packed cell volume over the time were non significant. However, these parameters were significantly lesser as compared to normal animals than the affected animals.

The neutrophylic count was significantly less in normal animals of both the species than the affected animals except in horses in 2nd week in which it was significantly lower than the normal horses. In horses absolute lymphocyte count was significantly higher at 2nd week than 1st and 3rd week post infection. However, in mules it was not significant difference in 3 weeks. However it was significantly lesser in animals of both the species affected with strangles than normal animals. In horse and mule absolute monocytic count was significantly lesser at 2nd 3rd week post infection than the 1st week post infection. In horses absolute eosinophilic count was lesser at 2nd & 3rd week post infection than the 1st week. Whereas in the mules it was significantly lesser at 3rd week post infection than 1st & 2nd week post infection. In horses absolute basophilic count, was significantly higher at 2nd week than 1st and 3rd week but in mules there was non-significant difference between weeks.

In horses, biopsy specimens from the affected lymph nodes showed extensive involvement and typical changes showing abscessation. The degenerated lymphocytes showed pyknosis and karyorrhexis. There was infiltration with neutrophils and rare eosinophils were seen. Necrosis was followed by liquefaction. Pus consisted of dead and dying neutrophils, tissue debris, lymphocytes and fibrin. Repair occurred mainly through fibrous tissue proliferation. In mules, histololgical changes in the affected lymph nodes were less extensive than in horses and tissue changes were rather localized. Neutrophilic infiltration and liquefactive necrosis were lesser than in horses. Fibroplasia was a predominate reaction but lesser in degree than in horses. The overall incidence of strangles in horses was 63 + 7.84 percent per year over the past five years, whereas it was 60.6 + 10.1 percent per annnum in the mules. It was 73.52 + 5.34 percent per annum in horses under 2 years of age and 26.48 + 5.34 percent per annum in horses of more than 2 years of age. The difference between the two age groups over the past five years was statistically significant (Chi square valg<36.885,df 4, P < 0.000).In case of mules under 2 years of age the incidence of strangles was 73.36 + 3.39 percent per annum and 26.6 + 5.34 percent per annum in mules over 2 years of age. The susceptibility to strangles between the two groups was statistically significant.

11. POULTRY DISEASES

11.1. Infectious diseases

To check the hypothesis that infectious bursal disease (IBD) can be controlled by giving immunoglobulins isolated from hyperimmune yolk or not, an experiment was designed. One hundred and twenty five day-old broiler chicks were divided in to five equal groups. Groups A and B were given immunoglobulins at the rate one ml and one and half ml per bird. These groups were challenged with one ml of antigen (IBDV) intravenously, 72 hours after giving immunoglobulins to birds. Groups C and D were challenged by antigen and 72 hours post challenge; immunoglobulins were given to birds at the rate of 1 ml and 1.5 ml respectively. Last group i.e., served as infected untreated control. The broiler of group A were depressed and anorexic for five days from 6th day the birds were becoming active and started taking feed. The carcase was dehydrated in three birds and bursa was slightly larger in volume after 48 hours. Yellowish creamy white thick exudates was observed after 96 hours in five birds and other had clear axudate in bursa, its weight was increased than the last two days. Thigh haemorrhages were mild and some bloody spots were noted at breast muscles. There was more mucous production in intestine in more than 70 % of birds. Kidneys were swollen and clear axudate was present in the respiratory tract. In the medullary areas of bursa shows degenerative changes in lymphocytes after 48 hours. A few heterophils were also

present in the affected bursae .In later stages pyknotic debris and hyperplastic reticuloendothelial cells appears in birds that were slaughtered after 96 hours of infection. Erythrocytic count of broilers of groups A, and B were significantly higher as compared to the control group while it was non-significant in broilers of group C and D at the time of first slaughtering. During the second slaughtering erythrocytic count of broiler of group B was significantly higher while it was non-significant in groups A, B and D. At the time of third slaughtering erythrocytic count of broiler of group A and B was significantly higher as compared to control group .The erythrocytic count of broiler of group C and D was non-significant as compared with the control group. During first slaughtering the haemoglobin concentration in groups C and D was same as that of control while it decreased in A and B groups as compared with the control .The results were non significant in the 2nd and 3rd slaughtering. During first slaughtering there was non-significant difference between the various groups and control group. At the time of second and third slaughtering PCV of broilers of group D was significantly higher as compared to control group. Similarly the group A, B, and C had higher values than control but they were non-significant. At the time of first slaughtering the total leukocytic count was significantly higher in the broilers of groups A and B while it was non-significant in the broilers of group C and D. During first slaughtering the lymphocytic count of broilers of group C were significantly higher as compared to control group, while it was non-significant in broilers of groups A, B and D. There was non-significant difference between the eosinophils count of broiler of all groups at first second and third slaughtering.

The results of the study revealed that vitamin A deficient feed had adverse effect on body weight gain; lymphoid organs; and antibody production. Body weight of broilers kept on vitamin A deficient diet was significantly lower ($P<0.001$) as compared to control group. The feed consumption ratio was also significantly lower as compared to control group. There was decreasing trend in Leukocyte count in vitamin A deficient birds as compared to control group. There was also decreasing trend of lymphocytes in vitamin A deficient birds as compared to control group. There was non-significant difference in heterophil, eosinophil and monocyte count in both groups. There was also a decreasing trend in the weight of the lymphoid organs in vitamin A deficient group as compared to control group. Vitamin A concentration in the serum of vitamin A deficient group was significantly lower as compared to the control group. There was no gross and histopathlological lesions on lymphoid organs. The clinical sign in vitamin A deficient birds were paralysis, dullness, depression, and after ND infection sickness, anorexia, muscular tremors, convulsion, abnormal respiration, ruffled feathers, greenish mucoid white and yellowish diarrhea and lethargic. The birds of control group remains healthy. GMT against NDV and IBD of vitamin A deficient bird was significantly low as compared to control group. From this study it can be concluded that vitamin A deficiency had detrimental effect on immune system in termes of lowered humoral and cellular responses and these condition become more pronounced under the influence of disease condition, therefore, to select an ideal level of vitamin A to be supplemented per Kg feed to strengthed immune system and to overcome the different stress condition.

Trachea, lungs and spleen were collected from field outbreaks of ND for viral isolation. The suspected material was inoculated in embryonated eggs for viral isolation and its confirmation was done by haemagglutination and haemagglutination inhibition tests. The isolates were characterized through mean death time, intracerebral pathogenicity index and intravenous pathogenicity index. Two of the isolates were mesogenic while one was velogenic. ELD50 of velogenic strain of NDV was determined for experimental production of disease in pigeons. Newcastle disease was produced in pigeons through intramuscular and itnraocular routes. Newcastle disease virus fail to produce disease in vaccinated pigeons. The clinical signs of Newcastle disease in pigeons were anorexia, greenish white diarrhoea, unability to fly, ruffled feathers, paralysis, respiratory problems and mortality. The postmortem lesions included haemorrhages in proventriculus, trachea, lungs and intestine. Spleanomagaly and encephalitis was also observed. In experimentally infected pigeons erythrocytopenia and leucocytosis was observed while packed cell volume and haemoglobin concentration remained normal. Geometric mean titre (GMT) of pigeons vaccinated against ND was higher as compared to non-vaccinated group. This antibody titre protected the pigeons against NDV. It can be concluded that pigeons can be infected by NDV of chicken

and these pigeons may act as carriers for disease transmission. LaSota vaccine can help in the development of protective antibody titre against Newcastle disease.

Lungs, trachea and spleen were collected from pigeons showing typical clinical signs of Newcastle disease, for viral isolation. The suspected material was inoculated in embryonated eggs for viral isolation & confirmed by heamagglutination and heamagglutination inhibition test. ELD 50 of vologenic strain of NDV was determined by method as decreased by Read and Much (1938) as modified by Villages and Parchase (1989) for experimental production of disease in broilers. Newcastle disease was produced in broiler chicken through intraocular route. The virus unable to produce disease in vaccinated group while in non-vaccinated group there were loose drooping and mild paralysis of wings. Postmortem lesions included splenomegally, patechial hemorrhages in thymus and cecal tonsils were observed in broiler of infected group. In experimentally infected broilers there was increased serum globulin level and at the same time there was decreasing trend in the total serum proteins. Geometric means titer (GMT) of broilers of vaccinated group was high as compared with non vaccinated group. So vaccination in broilers can help to protect against pigeon origin Newcastle disease virus. In experimentally infected broilers leukocytosis with marked heterophilia was observed. From this study it can be concluded that PPMV-I can produced mild ND in commercial broilers. Lasota vaccine can protect broilers from PPMV-I infection.

11.2. Toxicity of Chemicals/drugs

A small survey of poultry medicine shops and commercial poultry feed manufacturing units was conducted to ascertain the commonly used coccidiostats in this area. Coccidiostats used, in order included salinomycin, robenidine, Hiper-DOT, DOT, clopidol, monensin, lasolocid and amprolium. Of these salinomycin and robenidine were selected for this study. Effect of salinomycin and robenidine was studied experimentally on health of layer chicks and broilers. At the recommended dose and higher doses of salinomycin body weight was significantly ($P< 0.001$) reduced in female layer chicks. In male layer chicks and broilers body weight was not affected significantly at recommended dose but decreased significantly ($P< 0.001$) at 120 ppm and 180 ppm salinomycin. There was inverse correlation between dose of salinomycin and weight gain in layer chicks ($P<0.01$) and broilers ($P<0.05$), suggesting that growth suppression was dose dependent. In the present study, feed intake was lesser in salinomycin treated layer chicks and broilers than the control. This was also accompanied by poor feed conversion ratio. There was a significant positive correlation between feed conversion ratio and dose of salinomycin which shows dose related affect of salinomycin. Weight of gizzard, proventriculus, intestine, caeca and heart was not affected significantly in layer chicks and broilers receiving various doses of salinomycin.

In the present study salinomycin did not affect liver weight and appearance but histologically liver of layer chicks receiving 180 ppm salinomycin had multiple foci of necrosis. Serum aspartate transaminase (SAST) concentration was normal in female layer chicks receiving 60 ppm and 120 ppm dose but increased significantly ($P< 0.001$) at 180 ppm salinomycin. In broilers SAST concentration increased significantly ($P< 0.001$) at 120 ppm and 180 ppm salinomycin. Serum alanine transaminase (SALT) concentration remained unaffected with salinomycin at 60 ppm and 120 ppm dose but it increased significantly ($P<0.001$) at 180 ppm dose both in layer chicks as well as broilers. Serum bilirubin concentration was normal at 60 ppm salinomycin but increased significantly ($P< 0.001$) in female layer chicks and broilers receiving 120 ppm and 180 ppm salinomycin.

Serum total protein concentration was not affected at 60 ppm and 120 ppm salinomycin dose but decreased significantly ($P< 0.001$) in layer chicks receiving 180 ppm salinomycin and in broiler receiving 120 ppm and 180 ppm salinomycin. Serum albumin and globulin concentrations were not affected in female layer chicks by various doses of salinomycin but in broilers it was decreased significantly ($P< 0.001$) at 180 ppm salinomycin. Salinomycin did not affect kidney weight, appearance and histology of layer chicks and broilers receiving various doses of salinomycin. Blood urea concentration was not affected in layer chicks and broilers receiving 60 ppm and 120 ppm salinomycin but increased

significantly (P< 0.001) in layer chicks and broilers receiving 180 ppm salinomycin. Serum creatinine concentration was not affected in layer chicks receiving 60 ppm salinomycin. Its concentration was significantly increased in female layer chicks and broilers receiving higher doses of salinomycin (120 ppm and 180 ppm, P<0.001).

Salinomycin did not affect the erythrocyte count in female layer chicks and broilers. In male layer chicks erythrocyte count was not affected significantly at 60 ppm and 120 ppm salinomycin dose but decreased significantly (P< 0.001) at 180 ppm salinomycin upto first 8 weeks of treatment. Haemoglobin concentration (Hb) was not affected at 60 ppm salinomycin dose but decreased significantly (P< 0.001) at 120 ppm and 180 ppm salinomycin in female layer chicks and male layer chicks upto 10 weeks buy not thereafter. Packed cell volume (PCV) was decreased significantly (P< 0.001) at 120 ppm and 180 ppm dose salinomycin in female layer chicks and at 180 ppm in male layer chicks upto first 8 weeks of treatment. In broilers haemogram values at various doses of salinomycin were not affected significantly (P<0.001). Among the lymphoid organs, bursa index was significantly (P< 0.001) decreased in layer chicks receiving 60 ppm, 120 ppm and 180 ppm salinomycin in feed at 4 weeks of age but thereafter the difference from control was non-significant. Index of thymus was not affected at 60 ppm but at 120 ppm and 180 ppm salinomycin it was significantly decreased in female layer chicks at 8 weeks and in male layer chicks at 4 and 8 weeks of treatment but not thereafter. Spleen index was not affected at 60 ppm dose but at 120 and 180 ppm dose of salinomycin it decreased significantly (P< 0.001) in layer chicks at 4 and 8 weeks of treatment but not later. In broilers there was no significant effect of salinomycin on bursa, thymus or spleen index.

Grossly the lymphoid organs appeared normal. Histologically, thymus and spleen of layer chicks receiving 180 ppm salinomycin showed necrotic foci. Salinomycin at the recommended dose did not affect the total leucocyte count (TLC) but it was significantly (P< 0.001) reduced in layer chicks and broilers receiving higher doses of salinomycin in feed. In layer chicks and broilers receiving various doses of salinomycin the absolute heterophil count was not affected. However, the absolute lymphocyte count was substantially reduced at 120 ppm and 180 ppm salinomycin in layer chicks and broilers. Geometric mean titre (GMT) in primary and secondary responses against ND vaccine virus was not affected in layer chicks receiving various doses of salinomycin in feed but tertiary response against ND vaccine virus was reduced at higher doses of salinomycin i.e., 120 ppm and 180 ppm. However, GMT in primary and secondary responses against ND vaccine virus was decreased in broilers receiving 60 ppm, 120 ppm and 180 ppm salinomycin in feed. Salinomycin did not affect GMT in primary, secondary and tertiary responses to SRBCs in layer chicks and broilers at 60 ppm dose. At 120 ppm dose salinomycin had no effect on primary response to SRBCs but there was decrease in secondary and tertiary responses to SRBCs in layer chicks. In broilers primary and secondary responses were decreased at 120 pm salinomycin. At 180 ppm salinomycin secondary and tertiary responses to SRBCs were decreased in layer chicks nd broilers.

Wattle response against mallein antigen was not affected at the recommended dose but decreased significantly at 120 ppm and 180 ppm salinomycin in layer chicks. In broilers primary response against mallein was decreased significantly (P< 0.001) at 180 ppm and secondary response was decreased significantly (P< 0.001) at 120 ppm and 180 ppm salinomycin. Wing web reaction against bovine serum albumin was not affected in layer chicks and broilers receiving 60 ppm salinomycin. At 120 ppm salinomycin primary, secondary and tertiary wing web responses were not affected in female layer chicks, in male layer chicks tertiary response was decreased significantly (P< 0.001) and in broilers primary and secondary responses were decreased significantly (P<0.001). At 180 ppm primary wing web response was not affected but secondary and tertiary wing web responses were decreased significantly (P< 0.001) in female layer chicks. In male layer chicks and in broiler primary, secondary and tertiary wing web responses were decreased significantly (P< 0.001,) at 180 ppm salinomycin.

Robenidine at the recommended dose rate i.e., 33 ppm did not affect body weight in male and female

layer chicks and broilers. Body weight of layer chicks receiving 66 ppm and 132 ppm robenidine was decreased significantly (P<0.001). Body weight of broilers receiving 66 ppm robenidine did not differ significantly from the control but it was decreased significantly (P<0.001) in broilers from 7th week post-treatment. There was inverse correlation between dose of robenidine and weight gain in male layer chicks (r= -0.966, P<0.01). The non-significant correlation between dose of robenidine and weight gain in female layer chicks and broilers. The non significant correlation between dose of robenidine and weight gain was also accompanied by non significant correlation between feed conversion ratio (FCR) and dose of robenidine in female layer chicks and broilers. In the present study, weight of gizzard, proventriculus, intestine, caeca and heart was not affected in layer chicks and broilers receiving various doses of robenidine. Liver index was not affected at 33 ppm robenidine but decreased significantly (P< 0.001) in female layer chicks and broilers receiving higher doses of robenidine. In male layer chicks liver index showed nonsignificant effect of robenidine. Grossly and histologically the liver did not show any significant change in broilers receiving various doses of robenidine. Histologically the liver in layer chicks receiving 132 ppm robenidine was congested and had micro haemorrhages. In the present study, serum aspartate transaminase (SAST) and alaninc transaminase (SALT) concentrations were not affected at 33 ppm and 66 ppm robenidine but significantly (P< 0.001) increased in female layer chicks and broilers receiving 132 ppm robenidine. Serum total bilirubin concentration in female layer chicks was not affected by various doses of robenidine. Its concentration was not affected at recommended dose but increased significantly (P< 0.001) at higher doses in broilers.

Serum total proteins and albumin concentrations were not affected at 33 ppm and 66 ppm robenidine but significantly (P< 0.001) decreased in female layer chicks and broilers receiving 132 ppm robenidine. Serum globulin concentration was not affected in female layer chicks but in broilers it was reduced significantly (P<0.001) at 132 ppm robenidine at 8 weeks post-treatment. Kidneys indices were not Influenced by to be made in layer chicks and broilers. Grossly and histologically the kidneys appeared normal in structure in layer chicks and broilers receiving various doses of robenidine. Blood urea concentration was not affected at 33 ppm and 66 ppm robenidine but its concentration was significantly (P< 0.001) increased in female layer chicks receiving 132 ppm robenidine and broilers receiving 66 ppm and 132 ppm robenidine. Robenidine did not influence the erythrocyte count in male, female layer chicks and broilers. Haemoglobin (Hb) concentration and packed cell volume (PCV) were not affected at 33 ppm and 66 ppm robenidine but decreased significantly (P< 0.001) in female layer chicks receiving 132 ppm robenidine. Hb concentration and PCV were not affected in male layer chicks and broilers receiving various doses of robenidine. Robenidine did not affect bursa index in female layer chicks and broilers. In male layer chicks bursa index was not affected at 33 ppm and 66 ppm robenidine but decreased significantly (P< 0.001) at 132 ppm robenidine at 4 and 8 weeks post-ireatment. In female layer chicks thymus index was not affected at 33 ppm and 66 ppm robenidine but decreased significantly (P< 0.001) at 8 and 12 weeks post-treatment. In male layer chicks and broilers thymus index was not affected by various doses of robenidine. Spleen index in female layer chicks was decreased significantly (P<0.001) at 66 ppm and 132 ppm robenidine at 4 weeks post-treatment but not thereafter. In male layer chicks and broilers spleen index was not affected by various doses of robenidine. Grossly and microscopically the lymphoid organs appeared normal in structure. In the present study robenidine did not affect the total leucocyte count (TLC) in layer chicks and broilers receiving 33 ppm robenidine. TLC was significantly (P< 0.001) reduced in layer chicks receiving 66 ppm and 132 ppm robenidine, but not in broilers. In layer chicks among DLC, absolute heterophil count was not affected but absolute lymphocyte count was reduced. In broilers absolute heterophil count was increased at 132 ppm robenidine and absolute lymphocyte count was not affected at various doses of robenidine.

In the present study GMT in primary and secondary response against ND vaccine virus in layer chicks was not influenced by various doses of robenidine. GMT in tertiary response against ND vaccine virus was not affected at 33 ppm robenidine reduced in female layer chicks receiving 66 ppm and 132 ppm robenidine in feed. GMT in primary, secondary and tertiary responses was not affected by various doses of robenidine in male layer chicks. However GMT in primary and secondary response against ND vaccine

virus was suppressed in broilers receiving various doses of robenidine. Robenidine did not influence GMT against SRBCs in layer chicks. Primary and secondary response against SRBCs was not affected at 33 ppm and 66 ppm robenidine but suppressed in broilers receiving 132 ppm robenidine. In the present study, wattle response against mallein antigen was not affected at the recommended dose i.e., 33 ppm robenidine but suppressed significantly ($P<0.001$) at 66 ppm and 132 ppm robenidine in female layer chicks. In male layer chicks secondary and tertiary wattle responses were decreased significantly ($P< 0.001$) at 66 ppm and 132 ppm robenidine. In broilers wattle response against mallein was not affected at various doses of robenidine. In the present study, at 33 ppm robenidine did not affect the wing web reaction to BSA in layer chicks and broilers. At 66 ppm robenidine tertiary wing web reaction was decreased significantly ($P< 0.001$) in female layer chicks but not in male layer chicks and in broilers. At 132 ppm robenidine wing web response was decreased significantly ($P<0.001$) in layer chicks and in broilers.

The beneficial and toxic effects of chromium chloride alone and in combination with copper sulfate were investigated, on health and performance of the broiler chickens. One hundred and seventy five day-old broiler chicks were procured and randomly divided into seven groups viz. A, B, C, D, E, F and G each having 25 chicks. Group G served as control receiving no treatment. Groups A, B and F received chromium chloride at the rate of 2g/kg and nicotinic acid 150 mg/kg, while C, D and E received chromium chloride 8mg/kg and nicotinic acid 150 mg/kg. Broilers of groups A and C received copper sulfate at the rate of 200 mg/kg and groups B and D received 400 mg/kg feed in the feed. During the experiment trial no clinical signs were observed in broiler receiving chromium chloride 2g and 8g /kg feed, nicotinic acid 150mg/kg feed and copper sulfate 200 and 400 mg/kg feed. There was non-significant effect of treatment on body weight, and carcass weight of broiler, however from two to four weeks there were relatively higher treatment groups. During the withdrawal period the significant increase in bodyweight and carcass weight was observed in experimental birds. Both live and carcass weight showed non-significant difference between treatment groups and control group during treatment period, however during withdrawal period these were higher ($P< 0.05$) in chromium chloride fed birds (alone and in combination). The feed conversion ratio was better in treatment groups, the weight of heart, gizzard and proventriculus was higher in birds fed chromium chloride in combination with copper sulfate at both lower and higher levels. The liver weight was higher in birds fed lower level of chromium chloride alone and in combination with copper sulfate. The lung and kidney weight showed non-significant difference between treatment and control group. Among haematological parameters significantly lower levels of PCV were observed in birds fed higher levels of chromium chloride alone at the end of the treatment period. The results of serum protein viz. total protein, albumin and globulin showed lower levels in treatment groups. Both gross and histological studies showed no change in structure of organs and cells respectively. From these experiments it can be concluded that chromium chloride at the dose of (2 and 8g/kg) of feed improves the body, carcass weight and feed conversion ratio while visceral organs included heart, gizzard, proventuculus, liver kidney and lungs weights were not affected. The hematological and histopathological results showed increase in protein gain during whole the experiment, but no change on the cellular level of the visceral organs.

Recently, chromium in broilers is recommended for lowering body fat and cholesterol as well as for growth promoting effect. Trial was conducted to use much higher levels of chromium along with Nicotinic acid to study its toxicity if any. Copper was also combined with chromium in some groups to see whether chromium and copper have some combined toxic effects. One hundred and seventy five day-old broiler chicks were randomly divided into seven equal groups having twenty five birds in each. Four groups were given chromium (2 & 8 g/kg) + Nicotinic acid (150 mg/Kg) and copper sulphate (200 & 400 mg/kg) in various combinations, two groups were given chromium (2 & 8 g/kg) + Nicotinic acid (150mg/kg) through feed, while one group was kept as control. RESULTS: Results of the study indicated that chromium caused a relative increase in body weight and carcass weight and at withdrawal period the effect was significant. FCR was better in treatment groups and weight of heart, gizzard and proventriculus was also higher in chromium fed birds. PCV was higher in birds fed higher levels of chromium. Serum proteins

including total protein, albumin and globulin were lower in chromium fed birds. No gross or histological alteration was observed in any group.

Male japans quails (n-75) at 35 d of age were fed 20.0, 10.0, 5.0, 2.5 or 0 ml formalin (37% formaldehyde)/kg of their daily ration for 8 w. Quail fed 20.0 or 10.0 ml formalin/kg feed showed depression, decreased responsiveness. Feed consumption, and body weights, and had vacuolation in the germinal epithelial layer of their seminiferous tubules. Formalin feeding at up to 5ml/kg was associated with decreased weight of testes, and up to 2.5ml/kg feed resulted in smaller diameter of seminiferous tubules.

Broiler chicks of 2 weeks of age were grouped and fed lead (1200mg/kg feed), selenium (15mg/kg feed), selenium plus vitamin E(15+ 200mg/kg feed) and monensin(240 mg/kg feed) to induce subacute toxicosis. One group was kept on basal feed. After four weeks the first subgroup from each group was perorally given 250 mg levamisole/kg body mass, the second subgroup was subcutaneously administered l00 mg levamisole/kg body mass and the third subgroup was given no treatment. The oral administration of levamisole did not produce any clinical signs. The subcutaneous administration of levamisole resulted in shivering, partial or complete paralysis and death in different groups. The higher number of death and severe clinical signs following levamisole subcutaneous administration were observed in birds subacutely intoxicated with lead,selenium and monensin compared with control group. This observation suggests that subacute toxicosis of these substances may alter the clinical pattern of levamisole toxicosis.

Male japans quails of 7 weeks of age, divided into different equal groups, were fed furazolidone(Fz) at rate of O(control), 400, 600 mg per kg feed. After four weeks of Fz feeding the birds in all groups were switched to Fz free basal feed for another 4 weeks. A pair-fed(PF)group was maintained and given daily ration as much as consumed by quails of group fed 600 Fz/kg feed. Fz fed quails showed significantly ($p<0.05$) lower feed consumption, body weight, testes weights, testes volume and diameter of seminiferous tubules than control quails. Microscopically seminiferous tubujles of Fz fed quails showed decreased population of germinal epithelial cells, absence of round and elongate spermatiids, pyknotic nuclei of round spermatids, and round heads of elongate spermatids and young spermatozoa. After cessation of Fz feeding the feed consumption, body weight, testes weights and volume gradually increased and became non- significantly different from those fed 0 mg Fz/kg feed. The microscopic picture of the testes of Fz fed quails also became similar to that of control group. The Fz fed group also exhibited significant decrease in body weight, testes weight, testes weight and volume compared with control. Microscopically the seminiferous tubules had decreased population of germinal epithelial cells, however, no abnormal morphology of spermatids was observed. After increae in feed consumption all parameters of pair-fed group became nonsignificant from control group earlier than Fz fed groups. This observation suggested that Fz induced decreased intake was not the sole cause of changes in testes of Fz fed quails.

One hundred day -old broiler chicks kept in five equal groups (A-E) wee given formalin (37% formaldehyde) at dose levels of 20, 10,5,2,5, and 0 ml / kg feed for 7 weeks. Body weight and feed intake of the birds fed 2.5 ml formalin / kg feed was non-significantly different from control whereas higher formalin levels groups had significantly lower values. Formalin at 2.5 and 5.0 ml /kg feed level did not produce clinical signs in the birds but Higher doses of formalin resulted in depression., somnolence and a staggering gait. Necrotic and ulcerative areas on the mucosa of crop, proventriculus and petechial hemorrhages were observed on the mucosa of small intestine. Liver and kidneys did not show any specific microscopic changes. The no observed effect level (NOAEL) of formalin appeared to lie between 2.5 and 5 ml kg feed.

The beneficial and toxic effects of chromium chloride alone and in combination with copper sulfate were investigated, on health and immunity of the broiler chicken. One hundred and seventy five day-old broiler chicks were procured and randomly divided into seven groups viz. A, B, C, D, E, F and G each having 25

chicks. Group G served as control receiving no treatment. Groups A, B and F received chromium chloride at the rate of 2g/kg and nicotinic acid 150 mg/kg, while C, D and E received chromium chloride 8mg/kg and nicotinic acid 150 mg/kg. Boilers of groups A and C received copper sulfate at the rate of 200 mg/kg and groups B and D received 400 mg/kg feed in the feed. Parameters used to assess the health included clinical signs, body weight, carcass weight, feed conversion ratio and fecal examination. Parameter used to assess the immune system includes indices of lymphoid organ, leukogram and antibody liter against Newcastle disease and infectious bursaldisease. During the experiment trials no clinical signs were observed in broiler receiving chromium chloride 2g and 8g /kg feed, nicotinic acid 150mg/kg feed and copper sulfate 200 and 400 mg/kg feed. There was non-significant effect of chromium chloride alone and in combination with copper sulfate on body weight and carcass weight of broiler but an increasing trend was observed up to the age of 5 weeks. During the withdrawal period the significant increase in bodyweight and carcass weight was observed in both experimental trial.

The primary organs of immune system of the chicken consist of bursa of Fabricius and thymus. In both trials, effect of chromium chloride (2 and 8g/kg), nicotinic acid and copper sulfate was (200, 400 mg/kg) non- significant on index of bursa of Fabricius in the beginning but it was suppressed in growing period and afterwards it became non-significant up to the age of 45 days. During the experimental trials indices of thymus and spleen were not affected in broilers receiving chromium chloride, nicotinic acid and copper sulfate and also chromium chloride in feed, it was decreased in broilers receiving various treatments in growing phase. After this age the difference became non-significant. During the trials grossly and histologically lymphoid organs showed no pathological changes. In present study, total leukocytic count of broiler receiving chromium chloride, nicotinic acid and copper sulfate showed an increasing trend through out the trials. In present study the heterophil and lymphocyte count in experimental broilers did not differ significantly, but increasing trend in lymphocyte and decreasing trend in heterophil count was oberved during the both experimental trials and in the withdrawal period. In present study chromium chloride alone enhanced the antibody titer against NDV while it remained unaffected by the combination of chromium chloride and copper sulfate in the beginning. GMT was suppressed by the combination of chromium chloride. nicotinic acid and copper sulfate, while it remained unaffected by alone supplementation of chromium chloride in growing period. During the present study, antibody titer against Infectious Bursal Disease was higher in broiler receiving combination of chromium chloride, nicotinic acid and copper sulfate and alone chromium chloride and nicotinic acid through out the trials. From these experiments it can be concluded that chromium chloride at the dose of (2 and 8g/kg) of feed improves the body, carcass weight and feed conversion ratio while lymphoid organ indices were not affected. The immune response against NDV and IBDV, chromium chloride helped in improving the immune response but the combination of chromium chloride and copper sulfate had no beneficial effect on immunity.

A survey study was conducted on urea concentration in poultry feed ingredients. Feed ingredients, when analysed, revealed in order that 68.72 per cent samples of fish meal, 54.29 per cent samples of meat meal, 52.00 per cent samples of poultry by-product meal and 45.71 per cent samples of blood meal contained up to 3.0 per cent urea. While analysis of commercial poultry rations revealed in order that 72.00 per cent samples of broiler finisher ration, 65.00 per cent samples of layer mash, 56.00 per cent samples of chick starter ration, 54.00 per cent samples of chick grower ration and 48.00 per cent samples of broiler starter ration contained less than 1.0 per cent urea. It suggests widespread adulteration of poultry feed ingredients and commercial rations with urea in Pakistan.

Effects of 0.25, 0.5, 1.0 and 2.0 per cent urea supplementation in feed was studied in 1-60 days old layer chicks, 50 weeks old laying hens, 1-30 days old broiler chicks and 31-60 days old broilers. No clinical signs were observed with urea-treatment at any concentration of urea in any stock of poultry, furthermore, mortality between treatments did not differ in any stock of poultry. However, body weight was generally decreased in urea-treated layer chicks ($P<0.001$), laying hens ($P<0.05$), broiler chicks ($P<0.01$) and broilers ($P<0.01$). The decrease in weight gain was consistently dose-related. Of the visceral organs, urea treatment exerted no effect on heart index, kidney index or gizzard index in any stock of poultry under

study. Nevertheless, the liver index was significantly increased in the layer chicks in response to 0.25- 2.0 per cent urea concentration (P<0.001), whereas, liver index was increased in broiler chicks only with 1.0 per cent and 2.0 per cent urea treatment. However, any of the urea concentration in feed inflicted no effect, whatsoever, on liver index of adult broilers. Proventricular index was increased with urea treatment in layer chicks and broiler chicks but remained un-affected in adult broilers. Intestinal length and weight were greater in urea- treated layer chicks, broiler chicks and adult broilers than those of their control counterparts (P<0.001).

Of the lymphoid organs in experimental birds, bursa index was not affected with urea-treatment. Thymus index was not affected with urea- treatment in layer chicks and adult broilers but significantly increased in broiler chicks (P<0.05). Spleen index was not affected with urea-treatment in layer chicks and broiler chicks but was significantly decreased in adult broilers (P<0.05). Erythrocyte count changes were inconsistent in layer chicks, decreased significantly in hens (P<0.05) and broiler chicks (P<0.001) but increased in adult broilers (P<0.001) when subjected to the urea- treatment. Haemoglobin concentration was not affected with urea- treatment in layer chicks and adult broilers but was significantly decreased in hens (P<0.05) and broiler chicks (P<0.01). Packed cell volume was not affected with urea-treatment. Total leucocyte count (TLC) was significantly decreased with urea- treatment in layer chicks (P<0.001), hens (P<0.001) and adult broilers (P<0.001). In broiler chicks, a waning trend of TLC was witnessed when compared with the values in control broiler chicks. Absolute heterophil values were un-affeclcd but absolute lymphocyte, monocyte, and eosinophil counts were decreased with the urea-treatment.

Serum total proteins were significantly increased (P<0.001) with urea-treatment in all types of birds under study. This increase was mainly due to the increase in albumin (P<0.001). Globulins were not affected in layer chicks, hens and adult broilers but were significantly decreased in broiler chicks (P<0.001). Serum total bilirubin, serum aspartate transaminase, serum alanine transaminase and blood urea were significantly increased in all types of birds under study (P<0.001). Serum creatinine was significantly increased in layer chicks and hens (P<0.001) but not in broiler chicks and adult broilers.

Immunoassay studies indicated that antibody production against Newcastle Disease Vaccine Virus and Sheep Red Blood Cells was significantly decreased in all stocks of poultry under study but antibody synthesis against Brucella abortus antigen was significantly decreased in layer chicks and hens but not in broiler chicks or adult broilers. Cutaneous hypersensitivity reaction as a measure of cell-mediated immunity assessed by Wattle reaction to Mallein exhibited significant decrease of it in layer chicks, hens, broiler chicks and broilers. Egg production (% HD) recorded was significantly lesser in urea-treated laying hens than in control hens (P<0.001). Total egg production during 39 day experiment also decreased with the urea-treatment. Egg weight was not affected with urea treatment anyway.

The study was planned to compare the adverse effects of formalin administered by two different methods. Formalin mixed with the feed (2.5, 5.0, and 10 ml/kg) was given to 10 weeks old White Leghorn cockerels for a period of 8 weeks. Simultaneously in other groups 3 % solution of formalin was administered into the crops (5, 10, 15 and 20 ml/bird/day). Total amount of formalin utilized during the experiment in the feed of individual bird of groups given 2.5, 5 and 10 ml /kg was 6.25, 3.9 and 1.6 percent higher than those administered 5, 10 and 20 ml of 3 % formalin into crop. Body mass and feed intake in all feed mixed groups and those given 5 and 10 ml formalin (3 %) into crop were not significantly different from control. Administration of 15 and 20 ml formalin (3 %) into crop resulted in depression, delayed onset of crowing, significantly decreased feed intake, lower body mass, decreased mass and volume of testes, ulceration in crops, sloughing of mucosa and petechial hemorrhages in proventriculus. All the groups given formalin had significantly smaller diameters of seminiferous tubules. Kidneys of the birds administered formalin into crop exhibited pyknotic nuclei of epithelial cells in proximal tubules. Non significant differences in different parameters and lesser degree of pathological changes in birds given formalin-mixed feed than their corresponding crop-administered groups suggested that formalin present in the feed had partially evaporated and therefore, bird ingested less amount of formalin than that originally mixed in the feed.

Two experiments were conducted to study the pathological effects of various dose levels of gentamicin administered intramuscularly into day-old broiler chicks. In experiment 1, day-old, broiler chicks were kept in 15 groups (A - O) of ten birds each. Gentamicin was administered intramuscularly at the rate of 0, 10, 20, 30, 40, 50, 60,70, 80, 90, 100, 120,140,160,and 180 mg per kg body weight.. Following administration, birds were observed for five weeks. Clinical signs, gross and microscopic pathology, mortality, feed intake and body weights were recorded. In experiment 2, day-old broiler chicks were kept in six groups (A1, B1, D1, E1, F1 and H1) of 10 birds each. These groups were administered gentamicin intramuscularly at rate of 0, 10, 30, 40, 50, and 70 mg per kg body weight. Birds were slaughtered at weeks 1 and 4 of the experiment. Gross and histopathological alterations in different organs, hematological parameters, serum albumin, total protein, creatinine and ALT levels were determined.. Birds administered up to 30 mg gentamicin / kg b.wt. did not show clinical signs. These birds showed no variation from control birds in respect of grass and microscopic lesions and serum biochemical changes. However, decreased feed intake and lower body weight were observed at 30 mg / kg. Birds administered 50 mg and higher levels of gentamicin resulted in mortality, anorexia, depression, increased water intake and diarrhea. These birds showed swollen and congested kidneys, enlarged livers and hemorrhages on the heart and other organs of the body. Microscopically kidneys showed tubular necrosis and livers had fatty change and necrotic aresas. There was a decrease in serum proteins and albumin concentration and an elevation in ALT and creatinine. Severity of all the morphological and biochemical changes increased with an increase in dose level of gentamicin suggesting a dose related effect.

A total of 84 male Japanese quails (Coturnix coturnix japonioca) of 40 days of age were divided in seven groups having 12 birds in each group. Four of these groups were fed CSM at 0, 13, 27 and 41 % levels in the feed. Other three groups were fed same levels of CSM with ferrous sulphate. Birds receiving 27% and 41% CSM in the feed had poor weight gain. Attraction towards feed was also less in groups receiving 27% and 41% CSM. Frequency of crowing and mounting remained unaltered in control and 13 % CSM while these gradually decreased in 27 % and 41% CSM groups. A decrease in testicular weight and volume were observed in quails fed 27 and 41 % CSM. Testes also showed degenerative changes at microscopic level. Decrease in testes weight and volume did not occur in quails administered ferrous sulfate concurrently with CSM. Liver size increased in the groups that were offered 27 and 41% CSM and microscopically liver showed lesions of degeneration, necrosis, cellular infiltration and bile duct proliferation. Level of serum total proteins and serum albumin decreased in quails fed 27 and 41 % CSM. Heamtocrit and hemoglobin were found decreased in quails fed 27 and 41 % CSM. The result sof the present study suggested that CSM had toxic and degenerative changes in the reproductive performance of the quails. Ferrous sulphate had a partial ameliorative effect upon the toxic effects of CSM in the feed of male Japanese quails.

Two experiments were conducted to study the pathological effects of gentamicin. In experiment 1, four weeks old, broiler chicks was kept in 12 groups (A – L) of ten birds each. Gentamicin was administered intramuscularly at the rate of 0, 10, 20, 30, 40, 50, 60,70, 80, 90, 100, and 120 mg / kg body weight. Duration of experiment was four weeks. Clinical signs, pathology, mortality, feed intake and body weights were recorded. In experiment 2, four weeks old broiler chicks were kept in six groups (A1, B1, D1, E1, F1 and H1) of 10 birds each. These groups were administered gentamicin intramuscularly at rate of 0, 10, 30, 40, 50, and 70 mg /kg body weight. Birds were slaughtered at weeks 1 and 4 of the experiment. Gross and histopathology of different organs, hematological parameters, serum albumin, total protein, creatinine and ALT levels were determined. Birds administered up tp 20 mg gentamicin / kg did not show clinical signs, weight loss and decrease in feed intake. These birds also showed no variation from control birds in respect of grass and microscopic lesions and serum biochemical changes. Birds administered 30 and 40 mg / kg and higher levels of gentamicin resulted in depression for a variable period and recovered. Those administered 50 and higher doses resulted in clinical signs and mortality. These birds showed swollen and congested kidneys, enlarged livers and hemorrhages on the heart and other organs of the body. A significant decrease occurred in serum proteins and albumin concentration

and an elevation observed in ALT and creatinine. Severity of all the morphological and biochemical changes increased with an increase in dose level of gentamicin suggesting a dose related effect.

A total of 84 male Japanese quails (Coturnix coturnix japonioca) of 40 day of age were divided in seven groups having 12 birds in each group. Four of these groups were fed CSM at 0, 13, 27 and 41 % levels in the feed. Other three groups were fed same levels of CSM with 2% lysine. Birds receiving 27% and 41% CSM in the feed had poor weight. Attraction towards feed was also less in groups receiving 27% and 41% CSM. Crowing and mounting gradually decreased in 27 % and 41% CSM groups. A decrease in testicular weight and volume was observed in quails fed 27 and 41 % CSM. Testes also showed degenerative changes at microscopic level. Decrease in testes weight and volume did not occur in quails administered lysine concurrently with CSM. Liver size increased in the groups offered 27 and 41% CSM and microscopically liver showed lesions of degeneration, necrosis, cellular infiltration and bile duct proliferation. Level of serum total proteins and serum albumin decreased in quails fed 27 and 41 % CSM. Hematocrit values and hemoglobin were found decreased in quails fed 27 and 41 % CSM. The results of the present study showed a partial ameliorative effect of lysine upon the toxic effects of CSM in the feed of Japanese quails.

Forty eight Japanese quails of 40 day of age were divided in equal four groups kept at ambient temperature. These groups were offered feeds containing 0, 13, 27 and 41 cottonseed meals (CSM) for 42 days. Birds in different groups did not showed variation in body weight and feed intake. No difference was observed in the frequency of crowing , mounting and foaminess in dropping in groups fed 0, 13 and 27 percent CSM but decreased in 41 CSM group.Slaughtering at day 21 and 42 of the experiment showed that testicular weight and volume decreased 41% CSM fed group. Hematological parameters did not show any variation whereas serum totoal proteins and albumin were decreased suggesting hypoproteinemia and hypoalbuminemia. Microscopic observation revealed that spermatogenic activity was normal in birds of control group. All stages of spermatogenesis were observed .In birds receiving different levels of CSM exhibited degenerated and necrotic spermatocytes, and spermatids in seminiferous tubules. The changes in testes suggested a partial spermatogenic arrest in the birds fed cottonseed meal in the feed.

One hundred and twenty female japanese quails (Coturnix coturnix japonica) of pre-pubertal age were randomly divided into six groups viz; A, B, C, D, E and F. These groups were administered Thiodan® (endosulfan) at different dose levels mixed in feed. The dose rates were 0, 5, 25, 50, 100 and 500 mg/kg feed respectively. Neuronal excitability, reduced feed intake and reduced egg production of birds were observed in endosulfan treated groups.In hematological parameters, in which there was a significant change was observed in most of the cases in endosulfan treated birds. The changes were including erythrocyte count, leucocyte count, hematocrit value and hemoglobin concentration. Egg production hatchability and infertility was also studied which was significantly decreased. Serum biochemistry revealed the non significant differences in serum total proteins and serum albumin concentration. Histopathological findings revealed the decrease in the height of superficial epithelium, pyknotic nuclei ,foamy cytoplasm with large vacules ,folds of the epithelium wide apart ,atrophy of the glands with scarce amount of secretions in the lumen. Observations of the present study suggest that endosulfan has toxicopathological effects on female japanese quails.

A total of ninety-day-old broiler chicks were procured and randomly divided into five groups viz. A, B, C, D and E each having 18 chicks. Groups A, B and C received ethanol (40%v/v) through crop route at the dose rate of 6, 4 and 2ml respectively. Group D received 6ml of water through crop route and served as positive control and Group E served as negative control. The data showed a significant decrease in the live body weight of broilers throughout the treatment trial. Overall a significant decrease in the carcass weight of the treated broilers was also observed during the treatment trial. There was a significant decrease in relative weights of various organs including heart, kidneys, proventriculus, gizzard, were observed through out the treatment trial. The heart ventricular volume also showed decrease in treated

birds throughout the treatment period. However intestinal weight showed increase. FCR was better in ethanol fed birds. There was a significant decrease in intestinal diameter throughout the treatment period. Serum enzyme studied (alkaline phosphatase) also showed decrease in treated birds while creatinine and urea showed an overall increase.

The effects of ethanol were investigated in broilers and quails at different dose level through various routes. Three experiments were conducted, two on broilers and one on quails. Total of two hundred and forty day-old broiler chicks, and one hundred and twenty Japanese quails of 39 days old were purchased from local market. Experiment 1 included 150 broiler chicks which were randomly divided in to five groups of 30 chicks each (1, 2, 3, 4 and 5). Group 5 served as control receiving no treatment. Ethanol at dose rates 2, 4, 8 and 16% was offered to first four groups, respectively through drinking water from days 8 to 42 of age. Experiment 2 included 90 broiler chicks randomly divided into 5 groups of 18 birds each (1 , 2 and 3) and 40% ethanol was given through the crop route at dose rates 2, 4, 6ml, respectively from days 21 to 42 of age. Group 4 received 6 ml water through crop as positive control, while group 5 served as negative control. All the birds in both experiments were vaccinated against the Newcastle Disease and Infectious Bursal disease. In the third experiment 120 quails were randomly divided in to five groups of 24 each (Groups 1, 2, 3, 4 and 5). They were offered ethanol at dose rates 2, 4, 8 and 16%, respectively, while group 5 served as control. During the experiments, the birds received 8 and 16 % ethanol through drinking water showed signs of anaesthesia, loss of appetite, emaciation, dullness and deep sleep for 2 to 6 hours, while birds received 2 and 4 % ethanol were having staggering gait and decreased responsiveness for 2 to 4 hours. Broilers given 6 mL ethanol (40%) were highly depressed with staggering gait, convulsion, comma, and were anaesthetized after the ethanol administration. Broilers given 4 mL ethanol showed loss of coordination, decreased responsiveness and staggering gait, while broilers given 2 mL showed no signs and symptoms. Quails offered 8 and 16 % ethanol through drinking water showed dullness, depression and staggering gait, while those given 2 and 4 % ethanol showed decreased responsiveness for 2 to 3 hours. In all the experiments, the brain weight decreased significantly in all treated groups, while there was significant increase in relative weight of pancreas. Brain volume in all treated birds was also decreased significantly. In all experiments, sodium and potassium level in serum decreased significantly. In 3rd experiment, erythrocyte and leukocyte count increased significantly in quails treated with ethanol than control. The results of differential leukocyte count were non-significant.

Effects of ethanol were investigated on various body organs of broiler chicken. These included heart, kidney, intestine, proventiculus, gizzard and some biochemical parameters like enzyme alkaline phosphatase, serum urea and creatinine. One hundred and fifty, day-old, broiler chicks were purchased form commercial hatchery and kept under optimum conditions of brooding and management for one week. After one week, chicks were divided in to five groups having thirty birds in each (1, 2, 3, 4 and 5). All the birds were kept under optimum managemental conditions in cages where feed and drinking water was provided ad libitum. Different dose levels of ethanol were offered from 8th day up to 42nd day of age for 5 weeks. Six birds including control (group 5) were slaughtered weekly after the start of ethanol administration, i.e., at 8, 14, 21, 28, 35 and 42 days of age. Live body weight of each bird was recorded before slaughtering. The organs including proventriculus, gizzard, heart, kidneys and intestine were colleted and were weighed and preserved in 10% neutral bufferd formalin. Serum was collected for the determination of urea nitrogen, serum creatinine and enzyme Alkaline Phosphatase. Various observations including ventricular volumes and intestinal diameter were measured. These organs were also examined for gross lesions/changes and histopathological studies. A significant decrease in live body weight and carcass weight was observed in a dose related manner. A non-significant difference in relative weights of intestine & provetriculus was observed, while kidney and gizzard showed an increase in relative weights at higher doses. Duodenum & jejunum diameter was significantly decreased at higher doses of ethanol. Intestine also showed serosal and mucosal haemorrhages at different doses of ethanol during the experimental periods. A non-significant difference in ventricular volume was observed in ethanol treated broilers compared with control. A significant increase in urea concentration was observed

in broilers feed 1 and 4% ethanol at the end of the 1st week of treatment, while creatinine showed a higher concentration at 1, 2, 4 and 16% during 1st week and a lower concentration at 1, 2, and 4% at 3rd week of treatment as compare with control. The result obtained in present study suggested that ethanol produce untoward effects on various body organs and is not useful to broilers if given for longer periods.

The effects of ethanol through drinking water on haematology, lymphoid organs and immune response in broilers were investigated. One hundred and fifty day-old broiler chicks were procured and randomly divided into five groups viz. A, B, C, D and E each having 30 chicks. Group E served as control receiving no treatment. Groups A, B, C, and D received ethanol through drinking water at the dose rate of 2, 4, 8 and 16% V/V respectively. In the present study a significant or relative increase ($P< 0.05$) in the erythrocyte count of all treatment groups was observed, while packed cell volume and erythrocyte sedimentation rate showed non significant difference in treatment groups as compared with control. However Haemoglobin concentration showed a decrease in the treated broilers. A significant decrease ($P< 0.05$) in live weight of broilers received different dose levels of ethanol up to the age of 42 days was observed with a gradual decreasing trend in the live body weight. A significant decrease ($P< 0.05$) in relative weights of lymphoid organs including spleen, bursa of Fabricius and thymus were observed through out the treatment trial. However, no gross pathological changes were observed in the lymphoid organs. There was a comparable decrease in the cellular density in the treated groups at histological examination under light microscope in all the treatment groups. Total leukocyte count of broilers received ethanol showed an overall decrease while hetrophil percentage showed an increase throughout the treatment trial. Similarly lymphocyte percentage was lower in treatment groups during the experimental trials. However, other cells including eosinophils and monocytes showed non-significant difference between the treatment groups and control. Serum antibody titers against NDV, IBDV and washed sheep red blood cells were lower in broilers received ethanol as compared with the control. Similarly there was a significant decrease in the cell mediated immune response in the broilers against the mallein antigen in treated groups.

120 quails of Thirtynine-day-old were procured and randomly divided into five groups viz. A, B, C, D and E each having 24 quails. Groups A, B, C and D received ethanol (40%v/v) through drinking water route at the dose rate of 2, 4, 8 and 16ml respectively. Group E served as control. The data showed a significant decrease in the live body weight,intestine wt., proventiculus wt. And kidney weight in 1st week of quails during the treatment trial. Overall a significant increase in the carcass weight of the treated quails was also observed during the treatment trial. There was a significant increase in relative weights of various organs including heart, kidneys, lungs, spleen, thymus, bursa gizzard, were observed through out the treatment trial. The heart ventricular volume showed non-significant change throughout the treatment period. FCR was better in ethanol fed birds.

The effects of ethanol through crop route on haematology, lymphoid organs and immune response in broilers were investigated. A total of ninety day-old broiler chicks were procured and randomly divided into five groups viz. A, B, C, D and E each having 18 chicks. Groups A, B and C received ethanol (40%) through crop route at the dose rate of 6mL, 4mL and 2mL, respectively. Group D was administered 6 mL of tap water through crop route and served as positive control while group E served as negative control receiving no treatment. Present study showed a dose dependent decrease in erythrocyte count, ESR and haemoglobin levels in ethanol treated broilers. PCV showed non-significant difference between treatment groups and control groups. Similar non-significant effect of ethanol was observed on total leukocyte count, differential leukocyte count and live body weight. However, the values of haemoglobin concentration and live body weight were relatively lower in treatment groups. The increase in relative weight of spleen in treatment groups and positive control suggested no effect of ethanol as no gross and histological changes were seen. Bursal changes were also similar to those of spleen; however, epithelial height showed decrease in groups administered ethanol, while diameter remained unchanged. Thymus weight showed significant decrease in ethanol administered birds. The GMT against ND, IBD and SRBC in birds given 6mL of ethanol was low, while a non-significant difference in swelling amplitude against the

mallein antigen was observed between the treatment group and control.

The effects of ethanol through crop tube and through drinking water on some biochemical parameters, liver and lungs in broiler chicks were investigated. Two experiments were conducted in the 1st experiment a total of ninety day-old broiler chicks were randomly divided into five groups viz. A, B, C, D and E each having 18 chicks. Groups A, B and C received ethanol (40%) through crop route at the dose rate of 6mL, 4mL and 2mL, respectively. Group D was administered 6mL of tap water through crop route and served as positive control, while group E served as negative control receiving no treatment. In the 2nd experiment one hundred and fifty day-old broiler chicks were randomly divided into five groups viz. A, B, C, D and E each having 30 chicks. Group E served as control receiving no treatment. Groups A, B, C, and D received ethanol through drinking water at the dose rate of 2, 4, 8 and 16%, respectively. In both experiments, non-significant difference in the relative weight of liver was observed in all treatment groups given ethanol. A significant increase in the relative weight of lungs was observed in group A in experiment 1 during 3rd week of trial. A significant ($P<0.05$) decrease in plasma fibrinogen concentration in groups A & B the treatment trial was observed as compared with both control during 3rd week of trial. Similarly a non-significant difference was observed in Serum total proteins, albumin, globulins and serum enzymes (Aspartate Aminotransferase and Alanin Aminotransferase) in all treatment groups through out the treatment trial in both experiments. In second experiment, a significant increase in the relative weight of lungs was observed in all treatment groups. A non-significant difference in plasma fibrinogen concentration in all treatment groups was observed in experiment 2.

11.3. Misc. Diseases

The study was carried out on 27 broiler farms located in and around Faisalabad, during the months of November 1996 to March 1997. Overall, morbidity and mortality due to ascites syndrome were 0.60 and 4.46%, respectively. At 71.00% of the farms with ascites syndrome, age of birds ranged between 5 to 7 weeks. Maximum mortality (5.95%) due to this syndrome was observed during 7th week of age. The mortality in different strains broilers observed during present study was 5.01%, 3.07% and 3.09% in Hubbard, Arbor Acres and Avian respectively. Ascitic broilers showed listlessness, dullness, and depression, cyanosis of comb, open mouth breathing, loose faeces, white pasting of the : 3 pm'i ana Na (89.1.014 ± 80,8 vent and distended abdomen. 75 of Na. On postmortem examinations heart was found flabby and cone shaped with right ventricular dilation.The liver showed congestion and induration. Microscopically in liver, there was coagulative necrosis with proliferation of fibrous connective tissue and congestion. There was inflammatory foci present involving portal areas and distributed in other parenchymal places. Kidneys were swollen and congested. Microscopically, congestion of renal tubules was frequently observed. Renal tubules showed degenerative changes. Lungs appeared congested and consolidated. Microscopically, pneumonic changes comprising of congestion, thickening of alveolar septa and heterophilic infiltration was seen. Biochemical studies revaled higher levels of Lactate dehydrogenase (962.62 ± 601.9 lU/lit) low serum total proteins (4.017 ± 1.502 G%), serum globulins (2.1286 ± 0.85 G%) and serum albumin (1.8893 ± 0.7720 G%). The serum K (78.937 ± 14.13 ppm) and Na (891.014 ± 80.8 ppm) revealed higher values in ascites affected broiles. The concentration of Na, K, total proteins, albumin and globulins was (189.24 + 14.53 ppm, 77.40 ± 8.703 ppm, 2.390 ± 1.297 G%, 1.5038 ± 0.7723 G%, 0.7600 + 0.5757) respectively in ascitic fluid. Level of sodium in feeds used at broiler farms having ascites syndrome was 5766.6 + 304.0 ppm, while in underground water it was 82.74 ± 21.48. The total dissolved solids were 1746.35 ± 374.0 ppm in underground water at farms having ascites syndrome.

12. Toxico-pathological studies

One hundred and sixty two mature male Japanese quails were randomly divided into nine groups mainly Al, A2, A3, Bl, B2, B3, Cl, C2 and C3 having 18 birds in each. Birds of groups Al, A2 and A3 were fed 0 mg aflatoxin Bl along with endosulfan at the dose rate of 0, 500, 1000 mg per kg, respectively. Birds in

groups Bl, B2 and B3 were fed 3 mg aflatoxin B 1 along with 0, 500, and 1000 mg endosulfan per kg respectively. Birds of groups Cl, C2 and C3 were fed 9 mg aflatoxin Bl along with 0, 500 and 1000 mg endosulfan per kg, respectively. Nervous excitability reduced feed intake and reduced body weights of birds were observed in all treated groups. Hematological parameters determined on day 15, 30 and 45 suggested a significant decrease all treated groups compare with control. A significant decrease was observed in testosterone level in all treated groups compare with control group (A 1). Histopamologically testes showed a decreased in diameter of seminiferous tubules, decreased height of germinal epithelial layer of the tubules and presence of necrotic spermatids in tubules. A concurrent fed of both endosulfan and AFB1 resulted in potentiation of toxic reaction, which included a severity of nervous signs, high mortality, and a decreased feed intake, diameter of seminiferous tubules, height of germinal epithelial layer of seminiferous tubules and presence of more necrotic spermatids in tubules compare with fed substances alone. Observation of present study suggests that endosulfan and aflatoxin Bl both have toxicopathological effects on testes of male Japanese quails and these effects become positive and there is interaction of aflatoxin Bl and endosulfan.

Fluoroquinolone antibiotics have been used widely in humans and domestic animals, including horses, because of their broad-spectrum bactericidal activity, and relative safety. The use of fluoroquinolones, however, is not without risk. Tendonitis and spontaneous tendon rupture have been reported in people during or following therapy with fluoroquinolones. We have studied the effects of enrofloxacin, a fluoroquinolone antibiotic used commonly in domestic animals, on tendon cell cultures established from equine superficial digital flexor tendons. Effects on cell proliferation and morphology were studied using cell counting and scanning electron microscopy. Monosaccharide content and composition was determined by gas chromatography-mass spectrometry analysis. Western and Northern blot analyses were utilized to evaluate the synthesis and expression of two proteoglycans, biglycan and decorin. Our data demonstrate that enrofloxacin inhibits cell proliferation, induces morphological changes, decreases total monosacharide content and alters small proteoglycan synthesis at the glycosylation level in .equine tendon cell cultures. These effects are more pronounced in juvenile tendon cells than in adult equine tendon cells.We hypothesize that morphological changes and inhibition of cell proliferation are a result of impaired production of biglycan and decorin, proteoglycans involved in fibrillogenesis of collagen, the most important structural component of the tendon of enrofloxacin-treated tendon cells. Our findings suggest that fluoroquinolones should be used with caution in horses, especially in foals.

Lambda-cyhalothrin (LCT) is a potent, synthetic, type II pyrethroid and used to control a wide range of pests, insects in agriculture and external parasites in different animals. Synthetic pyrethroid has the advantage to be slowly degraded by the light and have wide margin of safety to mammals that makes these compounds ideal insecticides in agriculture, veterinary and public health programmes. In spite of wide margin of safety, these compounds are not free from hazardous effects. Therefore, the present study had been executed to explore effects on haemotological and histopathological parameters along with to know genotoxic effects in rabbits with low and high doses of LCT.

The present study was carried out on 30 rabbits divided into five equal groups. Three groups were treated with different levels of the LCT at the dose rate of 1.0, 4.0 and 8.0 mg/kg b.wt intraperitoneally (I/P) while other two groups i.e. D and E were kept as positive and negative control, respectively. Positive control group was treated with a single dose of Mitomycin-C (2 mg/kg b.wt I/P) whereas negative control group was administered normal saline (1 ml/kg b.wt I/P).

Clinical sings exhibited by all the rabbits in each group were monitored twice daily. Blood samples were collected with EDTA for haemotological studies. Haemotological parameters included were red blood cell (RBC) counts, haemoglobin (Hb) concentration, packed cell volume (PCV), erythrocyte indices: mean corpuscular Volume (MCV), mean corpuscular haemoglobin concentration (MCHC) and Mean corpuscular haemoglobin (MCH), white blood cell (WBC) counts and differential leukocyte counts (DLC). At the end of the experiment, gross lesions were noted and morbid tissues of liver, lungs, spleen and

brain colleted for histopathological study and bone marrow samples were collected from all rabbits from both femora to explore the genotoxic effects of LCT.

Clinical signs exhibited by rabbits treated with LCT were salivation, licking of different body parts, muscular tremors, ataxia and convulsions. Haemotological studies revealed significant ($P<0.05$) decrease in RBC, PCV, Hb, and WBC of all treated groups as compared with control groups. MCV and MCH were increased significantly ($P<0.05$) in all treated groups as compared with control group while MCHC was significantly ($P<0.05$) decreased in treated groups as compared with control groups. Differential leukocyte counts revealed significant ($P<0.05$) increase in neutrophils, eosinophils and monocytes while lymphocyte and total leukocytes counts decreased significantly ($P<0.05$) in all treated groups as compared to control groups.

All gross and histopathological lesions observed in rabbits were having less severity in low (1 mg/kg b. wt) LCT dose where as much severe lesions were noted in high dose (8 mg/kg b. wt) group. Liver of the treated rabbits exhibited extensive perihepatitis, pale colour, fibrosis, hyperplasia of bile duct arrested cell division, condensed nuclei, necrotic foci, hemorrhages and congestion. There were hemorrhages, congestion, atelactasis, collapsed alveoli and accumulation of extensive inflammatory cells around the bronchus and bronchioles in lungs. Thickened alveolar walls, bronchioles filled with blood, edema fluid and blood in some alveoli and sloughing of columnar epithelium from the bronchioles were also observed in lungs. In brain arrested cell division was observed in the molecular layer of cerebellum. Dose dependent hemosidrin deposition and atrophy of the red pulp was observed in the in the spleen.

A dose dependent increase in the incidence of micronucleated polychromatic erythrocyte was observed in all treated groups as compared with negative control group. In group D (positive control), the frequency of micronucleated erythrocyte was pronounced as compared to middle and high dose of lambda-cyhalothrin.

Cypermethrin is one of the photostable synthetic pyrethroid, which is extracted from the pyrethrum flowers. Synthetic pyrethroids have the advantage that they are slowly degraded by the light. They have wide margin of safety to mammals that makes these compounds ideal insecticides in agriculture, veterinary and public health programmes. In spite of wide margin of safety, these compounds are not free from side effects. Therefore, the present study has been designed in a way to explore haematological and histopathological alterations in male dwarf goats treated with low and high doses of cypermethrin. This study was carried out on 30 healthy male dwarf goats maintained at Livestock Experimental Station Allah -Dad Farm, Tehsil Jahanian, District Khanewal. Cypermethrin, member of pyrethroid group was used in four different concentrations (0.1, 0.4, 0.8, and 1.6 %) for dipping of animals. Blood samples were collected from all the treated and non treated (control) group of animals with anticoagulant (EDTA) for haematological studies. The different haematological parameters includes: red blood cell (RBC) counts, haemoglobin (Hb) concentration, packed cell volume (PCV), erythrocyte sedimentation rate (ESR) and white blood cell (WBC) counts along with plasma proteins and fibrinogen. Gross and histopathological lesions present in kidneys, heart and intestines were studied to see the possible effects of CY on cell morphology.

In haematological studies RBC and PCV was decreased significantly in all treated groups as compared with control group. The Hb was non significantly decreased as compared with control group. In ESR non significant difference was observed in treated and non treated groups. In WBC significant increase was observed in all treated groups as compared with control group. In plasma protein and fibrinogen non significant decrease was observed in treated and non treated groups. PCV was found to be positively correlated with Hb, RBC and fibrinogen in groups C, D and E, while with plasma proteins in groups A, B and D. PCV was negatively correlated with ESR in groups A, C, D and E and with WBC in group B. Hb was found to be positively correlated with RBC, fibrinogen and plasma proteins in groups D and E, while with fibrinogen and plasma proteins in groups B and C respectively. Hb was negatively correlated with WBC in groups C and D. RBC was positively correlated with plasma proteins and fibrinogen in groups A

and D and negatively correlated with WBC in groups B and C. WBC was positively correlated with fibrinogen in group A. WBC was found to be negatively correlated with ESR and plasma proteins in groups C and D. Fibrinogen was positively correlated with plasma proteins in groups A, B, D and E. On histopathological examination necrosis of myofibril and proliferation of fibrous connective tissue was observed in heart and in kidneys there was massive necrosis of tubular lining cells resulting in desquamation of cells in the lumen of proximal and distil convoluted tubules There was shrinkage of glomerulus leaving proteinecious material in between Bowman's capsules and glumerulus while in intestines, there was necrosis of villus epithelial lining along with massive infiltration of polymorph nuclear cells in the lamina propria.

VETERINARY PARASITOLOGY

1. TREMATODES

Studies on the incidence and ecological aspests of trematodes in different species of animals were conducted. The incidence of various trematodes recorded was as follows:

1.1. Sheep/goat

Fasciola gigantica (14%), *Fasciola hepatica* (10%) *Paramphistomum cervi* (8.4%), *Paramphistomum iexplanatum* (4.4%) and *Cotylophoron cotylophorum* (6.8%).

1.2. Buffalo

Paramphistomum cervi (1.8%), *Carmyerius spatiosus* (3.36%) and Schistosoma spp. The studies on ecological aspects of Schistosoma revealed that incidence of Schistosomiasis was higher in those animals which were kept on daily grazing and had stagnent river water as their drinking source, whereas incidence was minimum in the group of animals which were kept on stall feeding and running water as drinking source. It was also found that Schistosomiasis was accompanied with other trematode infections such as Pasciola, Amphistomes and Fischoederius. The observations on molluscan intermediate hosts indicated that snails of Lymnaea, Indoplanorbis and planorbis acted as intermediate hosts. The percentage of prevalence of the snails was encouraged by the presence of weeds and vegetations arround the water areas. Studies on effect of starvation on the recovery of total number of *Cotylophoran cotylophorum* cercaria in infected *Indoplanorbis exustus* snails was also conducted. It was generally observed in these studies that fed snails revealed a greater , number of rediae and cercarieae than the starved snails. This was also observed that size of the snail did not play any role in the recovery of different number of cercariae.

2. CESTODES

Studies on the incidence, taxonomy, life cycle and bionomics of different cestodes were conducted. The incidence and species of tapeworms recorded in various species of animals was as follows:-

2.1. Sheep

Moniezia expansa (8%), Moniezia benedeni (4.4.%), Moniezia Lyallpurienesis (New spp.), Moniezia denticulata, Stilesia spp. (48.8X), Avitellina centripunctata (2%), Avitellina Lahorea, Avitellina sudanea and Avitellina woodlandi.

2.2. Goat

Moniezia expansa *(7.6%),* Moniezia benedeni *(4%) and* Avitellina centripunctata *(1.6%).*

2.3. Buffalo

Moniezia benedeni (5.45%), *Moniezia expansa*

2.4. Wild birds

Cotugnea cuneata (from pigeons), *Choanotaenia parina* (from sparrows) and *Railliotina polychalix* (from parrots).

2.5. Domestic fowl

Raillietina tetragons, Raillietina cesticillus, Raillietina echinobothrida, Raillietina pseudoechinobothrida. An overall incidence of Raillietina species was recorded to be 48.73%.

2.6. Human beings

Hymenolepis nana (3.5%), *Taenia saginata* (0.3%). The incidence of hydatid cysts was also recorded in sheep, goat, cattle and buffaloes to be 24%, 8%, 33% and 49.02%, respectively. Studies on chracterization of cyst fluid and histopathology of hydatid infected organs were also conducted. The chemical characterization of cyst fluid revealed total protein 19.99 and 18.019 mg/100 ml in liver nd lungs, respectively. Glucose contents were 14.063 and 13.432 mg/100 ml in fertile and sterile cyst fluid from liver. The values of potassium in fertile and sterile cyst fluid of liver and lungs were 12.55, 13.13, 12.17 and 9.92 mEq/litre, respectively.

This difference in the protein, glucose and potassium concentrations of cyst fludis of different organs has made the basis for further studies. Histopathological studies of hydatid infected lungs showed cellular infiltration, bronchial hyperplasia and denudation of epithelial cells. In livor, the changes wore biliary hyperplasia and passive venousucongestion. Taxononuc studies on Avitellina, Moniezia, Stilesia, Raillietina, and Ostertagia involved morphological observations. New species of some of above genera were also recorded. Bionomics and life cycle of Heterakis, Raillietina and Moniezia were also studied.

3. NEMATODES

3.1. Sheep

Haemonchus contortus (12.%), *Oesophaqostomum venulosum* (3.32X), *Dunostomum trigonocephalum* (2.4%), *Chabertia ovina* (1.2%), *Cooperia cruticoi* (0.8%), *Trichuris ovis* (1.6%), *Ostertagia ostortaqi* (0.8%), *Ostertaqia circuoicincta* (1.2%), *Dictyocaulus filaria* (3%), *Protostrongylus rufescen.s* (2%), and *Mucllorius capillaris* (0.6%).

3.2. Goat

All the species of nematodes except lungworms recorded in sheep were also recovered from goats.

3.3. Buffalo/cattle

Nooafscan'R vituJorum (1.8%), *Trichuris glohulosa* (5.45%), *Trichuris ovis* (1.8%), *Bunostomum phlobotomum* (3.63%), *OesophaqoRtomum radiatui.i* (76.36%) and *Strongyloides papillosus.*

3.4. Dogs

Spirocerca lupi (20%)

3.5. Birds

Ascaridia coJumbae (from pigeons), *Ascaridm galli* (27.1%) *Eeterakis gallinae* and *subulura brampti.*

3.6. Human beings

Ascaris lumbricoidea (0.4"%), *Enterobius vermicularis* (0.5%) and species of hookworms (5.3%). Studies on the bionomics of the larvae of *Dictyocaulus filaria, Protostrongylus rufescens* and *Dictyocaulus viviparus* were conducted. A significant effoct of temperature and humidity on hatchability of eggs and moulting of these worms was observed. Taxonomic and life cycle studies on Ostertagia spp. and *Protostrongylus rufescens* were also undertaken. It was found that snails of genus Helicella act as intermediate host for *Protostrongylus rufescens.* The life cycle of Helicella was also studied. This was observed that, of several hundred snails kept in captivity only a few deposited ova. The hatchability percentage was also found very low, which suggests that tho fertility and the hatchability of Helicella species is severely affected when kept in captivity, probably because, natural environmental conditions cannot be duplicated in laboratories. The migratory pattern of larvae of *Neoascaris vitulorum* revealed that these larvae migrated through liver and lungs and finally reached intestine of the host. Effect of *Ascridia galli* on the blood parameters viz; RBC count, WBC count, ULC, blood glucose, total protein and serum electrolyte was seen. It was observed that total serum protein was much lowered while other parameters were non-significantly affected.

Studies on the lambs experimentally infected with different degrees of haemonchosis showed that the level of haemoglobin decreases with increase in the degree of haemonchosis. It was also observed that lambs with haemonchosis had microcytic hypochromic type of anaemia and there was decrease in RBC counts and increase in TLC. Studies on bionomics of the larvae of *IIaemonchu/f contortus* revealed that optimum temperature for development of egg and larvae is 27 °C. The optimum humidity was found to be 75.1%. The relationship of different levels of nutrition to the development of *Haemonchus contortus* infestation in lambs was studied. It was observed that the experimental lambs kept on ration containing 9.9% crude protein exhibited better feed utilization, weight gain and wool production as compared to the experimental lambs kept on ration containing 13.6% and 8.1% crude protein. It was concluded that a ration containing 9.9% crude protein had an optimum level of nutrition and exerted a profound influence on the degree of *Haemonchus contortus* infected animals. There was an improvement in the digestibility of crude protein as compared to non-infected animals. A case of bottle jaw was seen and it was confirmed that this was caused by hypoproteinemia due to the infection with *Haemonchus* contortus. In another study migration of ascarids in abnormal host was experimentally observed. Two experiments were performed in lambs to observe the effect of *Ascsris suum* and *Toxocara canis* migration. They were infected per as wsith 1,00,000 to 5,00,000 eggs of *Ascaris suum* and *Toxocara canis.* They were necropsied after 2, 4, 8, 16,32 and 64 days. Larvae of *Ascaris suum* underwent a complete migration reaching intestine in which third and fourth stage larvae were recovered. During migration they caused pathological changes in the lungs and slight blood eosinophilia. *Toxocara canis larvae* did not undergo a complete migration, none reached the intestine and remained at second stage. Damage was more pronounced in liver with formation of "white spots". These larvae induced a severe tissue and blood oosinophilia.

Studies on the pathology of *Spirocerca lupi* reaveled that death due to the rupture of blood vessels caused by this parasite could not bo ascertained. Of the twelve infected dogs, the youngest was one year and the oldest was six years of age. Four were pedegree dogs and the eight were non-descript stray dogs. The sex ratio was four males to eight females. An acute violent inflammation in recent parasitic invasion and granule matous proliferation of tissues with osteoid bone formation in chronic cases was observed.

4. ANTHELMINTIC TRIALS

Comparative trials of Rametin, Nemafax and Nilverm against *Haemonchus contortus* w?re conducted. The results showed that Nilverm was the most effective product against haemonchosis and then Nemafcx and Rametin in order of efficacy. Studies on efficacy of Morantel tartrate (Banminth IT) against gastrointestinal nematodoa of buffalo calves revealed that Banminth II reduced the nematodo ogg counts

by 97 per cent. Ninety per cent animals stopped passing eggs in their faeces. The effect of *Ascaridia galli* on the serum protein and electrolytes levels of chicken before and after treatment with Oxfendazole was also seen. This was observed that effect of infection on serum electrolytes viz; sodium, potassium and chloride values on day 3rd and 7th post-treatment with oxfendazole was non-significantly different than the chickens of control group, although the levels of sodium and potassium are diturbed during diarrhoea and dehydration.

5. PROTOZOA

The following species of protozoa were recorded from various species of animals:

5.1. Sheep

Eimeria parva, Eimeria intricata, Eimeria arloingi, Eimeria faurei.

5.2. Human beings

Rntamoeba coli *(6.5%),* Trichomonas hommis *(0.6%),* Giardia Imbilia *(0.4%) and* Balantidium coli *(0.3%)*

5.3. Dogs

Ehrlichia canis

5.4. *Isospora locazii* (from wild birds), *Eimeria ascervulina, Eimoria mitis, Eimeria maxima, Eimeria tenella, Eimeria nocatrix, Eimeria praecox*

Studies on the pathogenecity of coccidia in chicken showed highest mortality with mixed species of coccidia. Lesions were found in caeca and intestine, severe haemorrhage and loss of epithelial tissues was also observed. Ilistopathological studies presented hyperplasial changes, laceration and haemorrhages in caeca. Studies on diurnal periodicity of production of *Eimoria tenella* oocysts showed that their number increased markedly from 3 p.m to 9 p.m., declined at any other hours of the day irrespective of the time of inoculation of infective agent. Immunogonic efficacy of infective cocysts of *Kimeria tenella* after attenuation with gamma rays against coccidiosis was studied. This was found that the infective oocysts, whether irradiated with gamma rays or not, induced the same lovcl of immunity but the mortality rate was very low in former casn. Comparative studios on immune response in Post and Foreign breeds of chickens against *Eimeria tenella* revealed that the Uesi breed acquired immunity faster than foreign breeds of poultry viz. Rhode island Red, White leghorn. White cornish and Lyallpur silver black. This was observed in a study that mortality was reduced and less blood was lost in droppings of chicks fed on ration supplemented with antlcoccidials like sulphaquinoxaline and Vitamin A. Better weight gain in these birds was also observed. This was also observed thsit coccidiosis increases the requirement of vitamin A of birds. The role of chemotherapeutic agents in establishing immunity against caecal coccidiosis in chickens was observed. Studies revealed that immunity against *Eimoria tenella* was best developed when infective oocysts were administered alongwith 0.1% sulphaquinoxaline as compared to the birds which were not treated.

In another study *Ehrlichia* cam's was recorded from dogs with epistaxis problem. A new species of *Ehrlichia canis* (Neutrophilic isolate) was also recorded. Throe experiments were performed to compare the effects of two isolates of *Ehrlichia* cam's viz. lymphocytic and neutrophilic isolate and thrombocyte counts decreased to 21,000/cmm. Thrombocytopenia persisted throughout the study. Most of the thrombocytes in principals exposed to neutrophilic isolate decreased and the lowest level reached 29-31 days after exposure. The values then returned to pre-exposure level. In no case did the thrombocyte counts of either principals or controls approached the subnormal range. No increase in the size of

thrombocytes occurred in the principals exposed to neutrophilic isolate as compared to those inoculated with lymphocytic isolate in which there was a definite increase in size. The increase in size was first observed in the principals. 10-15 days post-exposure and persisted throughout the remainder period of the experiment.

6. ARTHROPODS

A systematic survey of various species of ectoparasites viz; ticks, lice, mites and warbles parasitizing buffaloes, cattle, sheep and poultry was conducted. Following spp. were recorded.

6.1. Buffalo

Hyalomma aegyptium, Hyalomma anatolicum anatolicum, Boophilus microplus, Haematopinus eurysternus *and* Psoroptes mites.

6.2. Cattle

Hyalomma aegyptium, Hyalomma anatolicum anatolicum, Boophilus microplus, linognathus vituli and *Hypoderma lineatum.*

6.3. Sheep

Hyalomma aegyptium

6.4. Poultry

Argas persicuB, Argaa abdussalami, Menacanthus stramineus and *Lipeuris caponis*

The economic losses due to ectoparasites in these animals were estimated to million of ruppees due to blood loss, poor weight gain caused by these ectoparasites. For the control of these parasites, various drugs were tried i.e. gammaxene, toxaphene, aldrin, dieldrin, asuntol and neguvan. Gammaxene was found to be highly effective insecticide. Studies on the taxonomy and bionomics of genera Hyaloroma, Rhipicophulus, Boopphilus and Argas were also conducted. These studies involved morphological observations, seasonal activity, life-cycle and breeding babbits of the species of above mentioned genra.

Comparative study of indirect haemagglutination test with traditional diagnostic method for *Trypanosoma evansi* infection in horses
Saeed, K., 1986. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The efficacy of indirect haemagglutination test (IHA) was evaluated against wet preparation and stained thin blood smear method for the diagnosis of surra in horses. Blood samples were collected from 100 suspected horses on the basis of history and clinical symptoms. These blood samples were examined by wet preparation and after staining the thin blood smear by Giemsa stain. These methods gave 5 and 11% positive animals for *Trypanosoma evansi* infection. The positive blood was inoculated into albino mice and at the peak of parasitaemia, these mice were bled under ether anaesthesia and blood was collected in heparin. The fractionation of the infected mice blood was carried out by DEAE-Cellulose in phosphate-saline-glucose buffer (PGS) pH 8.0 in burrettes. Blood cells and platelets were trapped and eluting motile trypanosomes were collected, centrifuged, sediments pooled and washed twice with PGS. Finally, the sediment was ultrasonically disrupted, which constituted the crude antigen and diluted in phosphate buffered saline pH 6.4 for sensitizing sheep erythrocytes. Blood from a healthy sheep was collected and 3.8% cell suspension was prepared in PBS. These sheep erythrocytes were tanned in 1:20000 working dilution of tannic acid and these tanned erythrocytes were sensitized by *Trypanosoma* antigen.

Suspected sera were inactivated and prediluted 10 times and serial two fold serum dilutions were prepared by micropipettes in microtitre U plates and sensitized erythrocytes were added to the plates and incubated at room temperature in humid chamber for 16 hours. A titer of 1:40 and above was considered as positive. In positive reactions, the cells agglutinated like carpet at the bottom of the wells; whereas, in negative reactions the cells settled as a compact mass in the centre of the wells. By the IHA test 13 horses were found positive for surra.

A study on biochemical composition of hydatid cyst fluid obtained from sheep and goats slaughtered at Faisalabad abattoir and its correlation with their fertility
Haq, A.U., 1986. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The studies were carried out to determine biochemical composition of hydatid cyst fluid obtained from sheep and goats slaughtered at Faisalabad abattoir. The prevalence of hydatidosis among these animals was also observed. During this study, a total of 8573 sheep and 28965 goats of different age and sex were examined. In adult animals, the *Echinococcus* cysts were present in 2.834% sheep and 0.432% goats while it was nil in lambs and kids. A reasonably high percentage of hydatid cysts was observed in female sheep as compared to males while slightly higher percentage of infection was noted in male goats than in females. The percentage of fertile cysts found in the current study was 80.95 in sheep and 65.49 in goats. Organ specificity has shown that in every speices lungs were the organ most commonly infected while no cyst was detected in spleen. The size of hydatid cysts recovered from lungs was found ranging from 0.51 cm to 10.42 cms while in liver cyst size ranged from 0.77 to 3.79 cms. The number of cysts was found ranging from 1 to 11 in lungs while in liver number of cysts ranged form 1 to 4. The glucose concentration was found ranging form 40.0 to 51.4 mg per 100 ml. There was no significant difference between the hydatid cyst fluid of fertile and sterile cysts. The glucose values in hydatid fluid obtained from sheep and goats were significantly different form each other. The chemical characterization of the cyst fluid obtained from sheep and goats revealed total protein contents ranging form 158.357 to 375.179 mg per 100 ml. The total protein concentrations in hydatid cyst fluid were variable depending upon the nature of cysts, their location and species of the animal host. The difference between the total protein contents of liver and lung cyst fluid was significant. The total lipid contents in hydatid cyst fluid were found ranging from 31.99 to 72.24 mg per 100 ml. The total lipid contents of hydatid cyst fluid differed significantly between fertile and sterile cyst fluid with respect of their species and locations and also within the species. Hydatid cyst fluid was found to contain varied concentrations of chloride ranging from 399.17 to 505.28 mg per 100 ml. The concentrations of chloride in hydatid cyst fluid depends upon the nature of the cyst, its location and the host species. The fluid obtained from hydatid cyst revealed iron ranging 0.043 to 0.105 mg per 100 ml. The iron contents in the fertile cyst fluid was found to be significantly different from that of sterile cyst fluid. Hydatid cyst fluid was found to contain inorganic phosphorous contents ranging form 0.684 to 1.127 mg per 100 ml. No significant difference of phosphorous contents was found between fertile and sterile cyst fluid with respect of their location and animals host. This micro-nutrient has been estimated for the first time in cyst fluid of sheep and goats. Hydatid cyst fluid found to contain magnesium contents ranging from 0.830 to 0.851 mg per 100 ml. A variation in magnesium contents was observed in the fluid of fertile and sterile cysts recovered from infected liver and lungs. The copper contents were found ranging from 0.061 to 0.116 mg per 100 ml. The copper contents of fertile hydatid cyst fluid obtained from sheep and goats were somewhat lower than that of sterile cyst fluid of both the species. It was also observed that liver hydatid cyst fluid contained more copper as compared to pulmonary cyst fluid. The pH values of lung cyst fluid were found ranging from 5.4 to 8.4 whereas pH values of liver cyst fluid were found ranging form 6.3 to 8.6. The pH values of the lung cyst fluid were significantly different from that of the liver cyst fluid.

Effects of natural haemonchosis on various blood parameters in sheep
Muhammad, S., 1986. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present study was conducted to find out the effect of natural haemonchosis on various blood

parameters of sheep. Thirty healthy dewormed sheep were kept in the control group, 30 sheep having subclinical infection in the second group, while the third group comprised of sheep showing clinical signs of haemonchosis. It was concluded that there was a decline in the erythrocyte count, haemoglobin level and packed cell volume of infected sheep, and a significantly negative correlation existed between these parameters and the number of eggs per gram of faeces. An increased erythrocyte sedimentation rate was noted and, thus, a normocytic hypochromic to microcytic hypochromic anaemia was detected. Total leukocyte count revealed that a significantly negative correlation existed between the total leukocyte count and the number of eggs per gram of faeces. It was found that percentage of neutrophils increased with the increase in the number of eggs per gram of faeces. A decrease in the lymphocyte count with the increase of infection was also evident. No significant change occurred in the monocyte percentage. Eosinophil percentage was found to be low in heavy infections while in light infections it was higher as compared to that of the non-infected animals. A correlation existed between the number of basophils in the blood and the number of eggs per gram of faeces.

Study of gastro-intestinal nematodes and taxonomy of the species of the genus *Haemonchus* in sheep and goats
Naseem, A., 1986. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

A survey of 100 guts, comprising of 50 each from sheep and goats was conducted between July to October 1986, to study the incidence of various species of gastro-intestinal nematodes in sheep and goats. The taxonomy of the species of the genus Haemonchus was also studied. The overall incidence of various species of gastro-intestinal nematodes was found to be 72 and 54% in sheep and goats, respectively. The following eight species of nematodes were recorded: *Haemonchus contortus, Ostertagia circumcincta, O. ostertagi, Bunostomum trigonocephalum, Cooperia cruticei, Oesophagostomum venulosum, Trichuris ovis* and *Chabertia ovina.* The only species of genus *Haemonchus* recorded in sheep and goats was *H. contortus*. Two types of vulvular flaps viz linguiform and knobbed were observed in the females of *H. contortus* during the present study.

Studies on the identification, incidence and epizootiology of blood protozoan and helminth parasites of indigenous chickens in Lahore district
Bhatti, S.B., 1987. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present work was planned to study the incidence and epizootiology of various species of helminth and blood protozoan parasites in indigenous chickens. For this purpose, 300 each of guts, tracheas and blood smears were studied. The overall incidence of gastro-intestinal helminths, *Syngamus trachea*, and blood protozoa was 85, 12 and 8.99%, respectively while 39% of the birds had mixed infection. The following species of helminths and blood protozoa were identified: *Raillietina tetragona*, *R. cesticillus, R. echinobothrida Cotugnia digonopora, Choanotaenia infundibulum* and *Amoebotaenia sphenoides*, were the intestinal cestodes, *Ascaridia galli, Heterakis gallinae* and *Subulura brumpti* were the intestinal nematodes, while the only species of respiratory tract nematode recorded was *S. trachea*. Among the helminths recorded, nematodes were found predominating as compared with cestodes. *A. galli* was the most common nematode species (49%) while *R. tetragona* (56%) predominated the cestode species. Respiratory tract helminth *S. trachea* was rare in occurrence (12%).

Application of indirect haemagglutination test for the confirmation of natural hydatidosis in cattle
Farooqui, R.H., 1987. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore)

A study was under taken to find out the incidence of hydatidosis and to evaluate the efficacy of indirect haemagglutination (IHA) test for the confirmation of natural hydatidosis in aged cattle slaughtered at Lahore Municipal abattoirs. Blood samples from 100 cattle were randomly collected during the antimortem examination. The serum from each sample was separated and stored at 20ºC, labelled as “hydatid positive” and ‘hydatid Negative’. For the preparation of antigen, crude cyst fluid was aspirated

aspectically from hydatid cysts. Blood from healthy sheep was collected in 3.8% sodium citrate solution and red blood cells were separated by centrifugation. A 2.5% red cell suspension was prepared in Phosphate Buffered Saline (PBS). The sheep erythrocytes were tanned in 1:20000 tannic acid solution and these tanned erythrocytes were sensitized by hydatid fluid antigen. Optimal dilution of antigen used was 1:16 in PBS pH 6.4 for sensitizing the sheep erythrocytes. All the sera were inactivated at 56ºC for half an hour and serial two fold serum dilutions were prepared by micropipettes in microtitre U plates and sensitized erythrocytes were added to the plates and incubated at room temperature in a humid chamber for 2 or 3 hours. A titre of 1:32 and above was considered as positive. In positive reactions, the cells agglutinated like a carpet at the bottom of the wells where as in negative cases the cells settled as a compact mass in the centre of the wells. By the indirect IHA, 44 cattle were found positive for hydatidosis. Out of 44 samples, 40 (65.57%) were confirmed positive on postmortem while 4 out of 39(10.26%) negative samples gave positive results with IHA test.

Characterization of *Theileria* species, its vector as well as haematological observations of *Theileria* infected cattle
Khalid, M., 1987. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

Theileria annulata was identified in the erythrocytes of infected crossbred cattle alongwith panting, temperature (103.8-105.8^{o}F), swelling of superficial lymph nodes, salivation and decrease in milk production. Ticks of *Hyalomma* species are the principal biological vectors of *Theileria* as only the impression smears of *Hyalomma* spp. revealed the sporont stage of this parasite. No sporont stage was observed in the smears of *Rhipicephalus* spp. and *Boophilus* spp. There were significant differences in haematological findings in infected cattle as compared with non-infected crossbred animals. There was decrease in total erythrocytic count (18.94%), haemoglobin concentration (24.65%), packed cell volume (25.05%), total leukocytic count (21.36%) and an increase in erythrocytic sedimentation rate (43.8%). Giemsa's stain performed better for the identification of parasite than Leishman's and Wright's stains.

Identification of various species of genus *Eimeria* in naturally infected buffaloes and cattle in Lahore
Murtaza, G., 1988. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

Investigations were conducted to find out the identification of various species of genus *Eimeria* responsible for coccidiosis in buffaloes and cattle. For this purpose, 828 animals (724 clinical cases and 104 apparently healthy animals) were examined from various sources. The species of genus *Eimeria* recorded were: *E. zuernii, E. bovis and E. cylindrica.* Of 828 animals, 200 (24.15%) were found to be suffering from various species of genus *Eimeria*. The examination of 200 positive samples of faecal material revealed that 88 (44%) animals were harbouring mixed infection of coccidial occysts. The oocyst count per gram of faeces in calves up to six months of age ranged from 4,000 to 9,000 but in above six months of age, it was 300-1200 per gram of faeces. The disease incidence was higher in young animals and it decreased with age. It was observed that *E. zuernii* was the most prevalent amongst total faecal samples examined during research work, from March to June 1988. *E. zeurnii* was very pathogenic in the young animals and a few occysts may cause pathogenic effects.

Comparative efficacy and safety of oral albendazole, morantel and parenteral ivermectin and levamisole in sheep infected with gastrointestinal nematodes
Ali, S., 1987. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

Seventy five sheep parasitized naturally with *Haemonchus, Tricnostrongylus, Oesophagostomum* and *Ostertagia* spp. of nematodes and 12 sheep experimentally infected with *Haemonchus, Trichostrongylus* and *Oesophagostomum* spp. were used to evaluate the efficacy of different anthelmintics in two different trial studies. Seventy five naturally parasitized sheep were randomly divided into five groups comprising 15 animals each. Group A, B, C, D, were given recommended doses of Ivermectin (Ivomec), Levamisole

(Anthelmin), Albendazole (Valbazen) and Morantel tartrate (Banminth), respectively. Group "E" was kept as infected unmedicated control. Anthelmintic study against naturally infected animals revealed that the Levamisole, Albendazole, Ivermectin and Morantel tartrate were 100, 98.82 97.02 and 76.50% effective, respectively. Levamisole proved to be the most effective drug while morantel tartrate had the lowest efficacy in removing gastrointestinal nematodes of sheep. A higher gain in body weight was recorded in levamisole treated group as compared to Albendazole, Ivermectin and Morantel tartrate treated groups. All treated groups showed significant increase in weight gain when compared with infected untreated control group. No side effects were observed in Levamisole, Ivermectin and Albendazole treated groups while diarrhoea was observed in group receiving Morantel tartrate treatment. Levamisole (Injectable) and Albendazole (oral) were picked up as drugs of choice of different routes of administration on the basis of results achieved through the studies conducted on naturally parasitized sheep. Twelve sheep experimentally infected with *Haemonchus, Oesophagostomum* and *Trichostrongylus* spp. were divided into three groups viz. A, B and C randomly. Group A was treated with Levamisole and group B with Albendazole while group C remained unmedicated control. Levamisole gave almost similar results being 99.57% effective in eliminating the worm burden; whereas, Albendazole cleared 98.29% experimental infection. The body weight gain and infection clearence percentage was almost similar to those observations recorded in naturally parasitized animals. It is, therefore, recommended that levamisole can be safely used to achieve optimum parasitic worm burden control in sheep without any side effects.

Studies on the identification, incidence and epizootiology of blood protozoan and helminth parasites of indigenous chickens in Lahore district
Bhatti, S.B., 1987. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present work was planned to study the incidence and epizootiology of various species of helminth and blood protozoan parasites in indigenous chickens. For this purpose, 300 each of guts, tracheas and blood smears were studied. The overall incidence of gastro-intestinal helminths, *Syngamus trachea*, and blood protozoa was 85, 12 and 8.99%, respectively while 39% of the birds had mixed infection. Two species of blood protozoa recovered were *Aegyptianella pullorum* and *Haemoproteus columbae*. *Aegyptianella pullorum* was more common blood protozoan followed by *Haemoproteus columbae*. Bacterial organism *Borrelia anserina* (19%) was also observed in the present work.

A study on the taxonomy and incidence of the species of genus *Psoroptese* in buffalo and cattle in Lahore
Ali, A., 1988. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A systematic survey on the incidence and taxonomy of *Psoroptes* mange mites infesting cattle and buffaloes in Lahore was carried out. Out of 250 suspected buffaloes, 50 were found positive (6 calves and 44 adults) for Psoroptic mange. The average number of mites recovered from infested animals were 1267 per animal; whereas, the total number of mites isolated were 63 and 350 from calves and buffaloes, respectively. Similarly out of 250 suspected cattle, 23 were found positive (2 calves and 21 adults) for *Psoroptes* mange. The percent infection recorded was 6.25 and 9.63 for calves and adults, respectively. The average number of mites recorded per infected animal was 721 and total number of mites isolated was 16,583. The species identified were *Psoroptes bovis, P. natalensis* in cattle and buffaloes; whereas, *P. ovis* was recorded only in cattle. The incidence of species in buffaloes was *P. bovis* 56% and *P. natalensis* 44%; whereas, in cattle incidence recorded was *P. bovis* 30.43%, *P. ovis* 21.74% and *P. natalensis* 47.83%.

Study of hydatidosis and chemcial characterization of cyst fluid in camels slaughtered at Lahore abattoir
Hussain, A., 1988. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The study was conducted at Lahore abattoir to record the occurrence of hydatidosis in camels. The

chemical composition of the fertile cyst fluid obtained from liver, lungs and spleen was also determined. Three hundred camels of different age and sex were examined. The overall incidence of hydatidosis recorded was 60.67%. Organ specificity noted in the current study was, lungs 100%, liver and spleen 56.04 and 11.53%, respectively. The diameter of the hydatid cysts recovered from lungs was found, ranging from 2 to 30 cms an average of 15.73 cms while the size of liver cysts ranged from 1 to 29.5 cms and diameter, with an average of 14.5 cms. In spleen the cysts measured between 1.5 cm to 25 cms with an average of 11.85 cms.in diameter. The average number of cysts recorded from liver lungs, and spleen were 7.9 and 2, respectively. Out of 350 cysts randomly obtained from liver lungs and spleen 262 (74.86%) were found to be fertile. The total protein contents of fertile cysts fluid from liver, lungs and spleen were 3.203, 3.183 and 3.208 gm/dl, respectively. There was no significant difference between these values. The lipid contents recorded were 11.738, 13.855 and 10.849 gm/litre of cyst fluid from liver, lungs and spleen, respectively. These values did not differ significantly. The glucose contents of the fertile cyst fluid from liver, lungs and spleen, recorded during the current study were 24.912, 21.66 and 22.017 mg/dl, respectively. Statistically there was no significant difference between these values. The average sodium contents were 84.94, 70.102 and 60.36 mmol per litre of cyst fluid from liver, lungs and spleen, respectively. There was no significant difference between the values. The average potassium contents were 4.046, 4.18 and 4.726 mmol per litre of cysts on liver, lungs and spleen, respectively. The difference in value was statistically significant. The average chloride contents obtained during this study were 0.489, 0.456 and 0.430 gm/dl of cyst fluid from liver, lungs and spleen, respectively. The specific gravity of the cyst fluid collected from hydatid cysts of all these organs was 0.010.

Comparative efficacy of anticoccidial drugs against experimentally infected sheep
Omar, M., 1988. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The present experiment was planned to study the comparative efficacy of commonly used anticoccidials against experimentally infected sheep. Twenty sheep were divided into two groups, A and B having 16 and 4 animals, respectively. Group A was further divided into A1, A2, A3, and A4, each group having 4 sheep. All animals in group A were infected with mixed coccidial infection while animals in group B served as uninfected controls. Animals in group A1, A2, and A3 were treated orally with amprolium powder (50 mg/kg body weight), clopidol powder (50 mg/kg body weight), respectively, daily for 7 days. Animals in group B served as uninfected controls. The initial body weight and oocyst counts per gram of faeces were compared before treatment and 7the day after treatment. After 7 days the animals in groups A1, A2, A3, A4 and B gained 1.30, 0.95, 0.85, 0.10 and 1.60 kg body weight, respectively. The analysis of variance revealed significant differences between different groups at 1% level. The comparison of mean differences revealed that among the treated sheep, amprolium treated animals gained significantly higher weight than clopidol and nitrofurazone treated animals. The group B having uninfected control animals gained highly significant weight than either treated or infected untreated animals. The oocyst count was reduced in group A1, A2, and A3 by 99.2, 96.6 and 95.7%, respectively. The oocyst count in infected untreated groups A4 increased by 80.68%. All the three anticoccidials tested gave appreciable response in oocyst count reduction against coccidiosis in sheep, but amprolium was found to be better than the other two drugs. Sheep in uninfected control group remained healthy during the experimental period. They gained weight better when compared with the infected untreated or infected treated animals. Their feed intake was also higher.

A study on the prevalence, taxonomy and bionomics of species of genus *Oesophagostomum* in sheep and goats
Rana, A.S.Z., 1988. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A study of 200 guts, comprising 100, each from sheep and goats was carried out from January to March 1988, to note the prevalence of *Oesophagostomum* species in sheep and goats. The taxonomy and bionomics of the species of genus *Oesophagostomum* was also carried out. The total prevalence of *Oesophagostomum* recorded in sheep and goats was 40 and 17%, respectively. The following species

were recorded: *Oesophagostomum columbianum* and *O. venulosum.* Taxonomy and bionomics of genus *Oesophagostomum* have also been described.

Comparative study on the prevalence of gastro-intestinal parasitic fauna of indigenous and exotic chicken layer in and around Faisalabad
Hadayat, S., 1989. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The species of coccidia identified from indigenous and exotic chickens were *Eimeria tenella, E. acervulina* and *E. necatrix.* However, *E. acervulina* was not recorded in indigenous layer. Coccidia infection was also recorded from indigenous (4.0%) and exotic (2.2%) layers. *Eimeria tenella* and *E. necatrix* infection in indigenous and exotic layers was 2.4 and 1.6; 1.4 and 0.6%, respectively with additional *E. acervulina* (0.2%) infection in exotic layers. The incidence of coccidia was the lowest during June in indigenous and exotic layer.

A study on nematode parasites and taxonomy of different species of the genus *Capillaria* in indigenous chickens in Lahore district
Saleem, M., 1989. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present study was undertaken to have an up to date knowledge of the prevalence and intensity of various nematode species infesting indigenous chickens. For this purpose 200 samples of guts, crop, oesophagus and trachea of indigenous chickens were collected from various chicken, shops, where these chickens are brought for sale and slaughter from different Tehsils of Lahore district. The study was conducted from among the nematode species recorded *Ascaridia galli* was the most prevailing species (57%) followed by *Heterakis gallinarum* (22.50%), *Subulura brumpti* (17.50%) while the respiratory tract nematode *Syngamus trachea* was very rare and present only in 2.5% of the tracheas.

Comparative study on the prevalence of gastro-intestinal parasitic fauna of indigenous and exotic chicken layer in and around Faisalabad
Hadayat, S., 1989. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The species identified from indigenous (74.6%) and exotic (66.8%) chickens were *Ascaridia galli, Heterakis gallinarum, Subulura brumpti, Raillietina tetragona, R. cesticillus, R. echinobothrida, Cotugnia digonopora, Choantaenia infundibulum* and *Hymenolepis carioca.* The incidence of nematodes was 17.8 and 40.8% in indigenous and exotic layer, respectively. The most prevalent nematode species was *Ascaridia galli* in indigenous (8.2%) and exotic (15%) layers. The incidence of *Heterakis gallinarum* and *Subulura brumpti* in indigenous and exotic layers was 5 and 13.2; 4.6 and 12.6%, respectively. The cestode incidence in indigenous and exotic layers was 40.0 and 11.2%, respectively. The incidence of *R. tetragona, R. cesticillus, R. echinobothridia, Cotugnia dignopora, Choantaenia infundibulum* and *Hymenolepis carioca* in indigenous layers was 17.2, 10.8, 2.4, 5.6, 3.2 and 2.8%, respectively. No trematode was isolated. The nematodes infection was highest in April in indigenous and exotic layers while cestodes infection was lowest in April.

A study of gastric trematodes in buffaloes and taxonomy of the species of the genus Paramphistomum
Akbar, M., 1989. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present study was carried out to determine the incidence of various gastric trematodes of the species of the genus Paramphistomum in buffaloes. Two hundred compound stomachs of slaughtered buffaloes were examined at Lahore abattoirs. The buffaloes were selected at random irrespective of the age, sex, and breed. The overall incidence was found to be 79.50%. The various species of gastric trematodes identified were: *Paramphistomum cervi, Cotylophoron cotylophoron, Gastrothylax crumenifer and Carmyerius spatiosus*. The incidence of *P. cervi* infection was higher (56.50%) as compared with the

other species of the family Paramphistomatidae. The incidence rate of *C. cotylophoron* was 52.50%, that of *Gastrothylax crumenifer* 35.50% and *Carmyerius spatiosus* was 24.50%.

A study on blood parameters and comparative efficacy of different fasciolicidal drugs against fascioliasis in cattle
Hussain, S.M., 1990. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present study was aimed to see the extent and effect of the disease on various blood parameters and to confirm the efficacy of Trodax and Ranide against fascioliasis in naturally infected cattle. Sixty animals suffering from fascioliasis were randomly divided into 3 groups A, B, and C comprising of 20 animals each. Group A and B were treated with Trodax 34% and Ranide at manufacturer's recommended dose rates, while group C was kept as untreated control. Egg counts were made on 3rd, 7th, 14th and 18th day post medication. At the end of the experiment, the efficacies recorded were 82.05 and 87.50% for Trodax and Ranide, respectively. Statistically there was no significant difference between the drugs but a significant difference between Trodax and control group and between Ranide and control group. Significantly lower values were obtained for estimates of packed cell volume, haemoglobin and total erythrocyte counts while higher values were obtained for eosinophil counts in infected cattle. However, fascioliasis produced no significant change in the lymphocyte, neutrophil monocyte and basophil counts. Results revealed that haemoglobin values had the highest correlation with worm burdens (4= -0.84) while the least correlation was noted for eosinophil counts (r=-0.30).

A study on the prevalence and pathogenicity of tick infestation with taxonomy of the genus *Rhipicephalus* in dogs
Sultana, A., 1990. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A study was conducted for finding out the incidence of tick infestation in dogs. One hundred infested dogs were examined, ticks were collected and identified. Only one species i.e. *Rhipicephalus sanguineus* was recorded. It was observed that ticks started appearing on dogs in the month of March. The tick population was heaviest in he month of June when the climate was warm and humid. The infestation declined by the end of humid. The infestation declined by the end of September and was lowest in November. No tick was noticed from December till later February. Haematological study of infested dogs was made. A decrease in haemoglobin concentration, packed cell volume and erythrocytic count was recorded. The incidence of ticks and the degree of anaemia was higher in younger dogs which declined in older dogs. No blood protozoan parasite was seen in any of the blood smears stained with Giemsa's stain.

Effect of parasitic nematodes on productivity and haematology of sheep
Hussain, S.M., 1990. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The present experiment was conducted to find out the effect of mixed species of nematode parasites on productivity and haematology of sheep. The experiment was conducted on 18 sheep divided into three groups viz., A, B and C. Each group had six animals. Animals in group A and B were infected with 10,000 and 15,000 infective larvae of *Haemonchus contortus* and *Trichostrongylus colubriformis*, respectively, whereas group C served as uninfected control. All the animals were weighted and blood smples were taken on day 0, 10, 20, 30, 40, 50 and 60, postinoculation. It was concluded that nematode infection significantly decreased body weight of infected animals as compared to uninfected control. There was a decline in total erythrocyte count, haemoglobin concentratioin and packed cell volume of infected sheep. An increase in erythrocyte sedimentation rate was noted. Normocytic normochromic anaemia was recorded in infected group A, and microcytic hypochromic anaemia was detected, in infected group B. Total leukocyte count in infected groups A and B increased slightly during the first three weeks of infection and then decreased, but overall group means of infested and control animals had not significant difference. All the animals were shorn at the start of the experiment and on day 90 postinfection to observe the effect of nematode parasites on wool production. It was concluded that nematode parasites

significantly decrease the fleece weight, fibre diameter and staple length in infected groups compared with those of controls, indicating that nematodes affect both the quality and quantity of wool.

Effects of addition of vitamin A and K on anticoccidial activity of Esb_3 in broiler chicks
Nawaz, G., 1990. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The experiment was conducted to evaluate the efficacy of supplementation of vitamin A and vitamin K alongwith Esb_3 (Ciba-Giegy), a sulpha drug in treating experimentally produced coccidiosis. One hundred and fifty broiler chicks at the age of 5 weeks were experimentally infected with 50,000 sporulated coccidial oocysts per bird. After the establishment of clinical infection, the birds were medicated twice with a discontinual period of two days (3-2-3) for two weeks with Esb_3 alone or with supplementation with vitamin A and K. The birds were weighed weekly during the experimental period upto the age of 7 weeks and average daily weight gain and feed conversion ratio (F.C.R.) were calculated. At the age of 7 weeks all the birds were slaughtered, the organs were examined for the presence of lesions and the average weight of liver in each group was recorded. The clinical symptoms observed were dullness, depression with anorexia low intake of feed and water and bloody diarrhoea. The symptoms were more pronounced in birds which were treated with Esb_3 without any supplementation of vitamin A and K than those birds which received an additional supplementation of vitamin A and vitamin K, respectively. The mortality rate amongst the birds of groups which received an additional supplementation of vitamin A and K with Esb_3 was significantly lower than the birds of the group which were treated with Esb_3 only. The F.C.R. and average daily weight gain of the birds was significantly improved by the addition of vitamin A and K than of the birds which were medicated without any supplementation of vitamins. The gross pathological changes which includes petechiation and haemorrhages of various sizes, with necrotic foci in visceral organs and muscles were more pronounced in birds treated with Esb3 alone, than the birds which received supplementation of vitamin A and K. This addition of vitamin A and K also resulted in slight increase in average liver weight of the birds.

Monitoring coccidia in commercial poultry farms
Saleem, M.S., 1991. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

For monitoring of coccidiosis in commercial poultry farms, 204 samples of poultry litter; comprising 102 each from broiler and layer farms in and around Faisalabad were examined. An overall prevalence of coccidiosis in poultry litter was 28.92%. Of 102 samples, each from broiler and layer farms, 35 (34.31%) and 24 (23.52%) were positive for coccidiosis, respectively. Prevalence of coccidiosis was higher in samples of litter from broiler farms as compared to those of layer farms in all the age groups. In the litter of broiler and layer under flocks below three weeks of age, the prevalence was 23.52% and 20.58%, respectively. The prevalence was 64.70 and 38.23%; 14.70 and 11.76% in the flocks between three to six and above six weeks of age in litter of broiler and layer farms, respectively. The prevalence was highest (64.70%) in the litter under broiler flocks of three to six weeks of age, whereas minimum (11.76%) in the litter under layer flocks of more than six weeks of age. The species of coccidia identified from litter samples of both broiler and layer farms included *Eimeria tenella, E. acervulina, E. necatrix, E. maxima, E. praecox* and *E. mitis*. All these species of coccidia were identified from litter samples of broiler and layer farms of all age groups except *E. mitis* which was not found in litter samples of broiler under three weeks of age. *E. tenella* was the highely prevalent species of coccidia in poultry litter, whereas, *E. mitis* was the least prevalent species of coccidia in poultry litter. Moreover, prevalence of coccidiosis, in general, was high in the litter of flocks of both broiler and layer farms between 3-6 weeks of age. It was observed that the management conditions of the farm and physical conditions of litter were not up to the mark in most of the farms which resulted in higher prevalence of the disease reflects that management conditions of the farms and physical conditions of the litter used for bedding are directly related with the rate of prevalence of coccidiosis and the oocyst burden.

Taxonomic and therapeutic studies of natural and experimental coccidiosis in commercial quails

Iqbal, A., 1991. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

Taxonomic and therapeutic studies of natural and experimental coccidiosis in commercial quails were undertaken. Total 500 gut samples were examined microscopically to study the incidence of coccidiosis, which was recorded as 69%. By making taxonomic study based on size, morphological characteristics, sporulation time and post-mortem lesions it was concluded that the causal coccidia was *E. bateri*. Average size of the oocyst recorded was 21.42 u x 14.28u while sporulation time recorded was 24 hours at 27ºC. The oocysts were double walled and 1.2 u in thickness. Oocysts production per gram of faeces in natural infection ranged between 31-350 oocysts. While average number of oocysts per gram of faeces recorded was 220. To study effects of ESB_3 and Darvisul AK plan on experimental infection one hundred and sixty day old quail chicks were reared upto 3 weeks of age in coccidia free environment. They were then randomly divided into four groups A, B, C and D. comprising of 40 birds each these groups were sub-divided into four replicates each comprising of 10 birds. Birds of group B, C and D were infected with 50,000 sporulated oocysts given directly into crop. On fourth day post infection birds of all infected groups showed disease symptoms and at that time groups C and D were treated with Darvisul AK plus and ESB_3, respectively; while group B was kept as infected and un-medicated group. At the end of experimental period in 6^{th} week, maximum weight was gained by group "A" and minimum by group "B". Group D which was treated with ESB_3 gained less weight than group C which was treated with Darvisul AK plus. Best feed conversion ratio was seen in group A and among the medicated groups group D revealed better feed conversion ratio than group C, while group B showed the worst feed conversion ratio. Highest mortality of 40% was recorded in group B, 10% in group C and least in group D i.e. 2.5%.

Identification of different species of *Eimeria* and effects of natural infections on various blood parameters in sheep

Sherazi, S.A.A., 1991. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

Study was conducted to find out the incidence of various species of *Eimeria* responsible for coccidiosis in lambs of 4-6 month of age. For this purpose, 100 lambs were examined. The species of *Eimeria* found were *Eimeria ovina, E. intricata, E. parva, E. faurei* and *E. ninakohlyakimovae*. All lambs had mixed infection with 2 to 3 species of *Eimeria*. The oocyst count per gram of faeces in positive cases ranged from 6,000 to 50,000. The disease incidence was higher in young animals and it decreased with age. It was observed that *E. ninakohlyakimovae* was the most prevalent (30%) amongst the faecal samples examined. For haematological purposes, 60 blood samples of lambs 4-6 months of age were used. A significant decrease in total erythrocyte count was observed in infected lambs. A negative correlation existed between the average oocyst count and number of erythrocytes per micro litre of blood. There was 13.25% decrease in average leukocyte count in clinically sick animals; whereas, 7.23% decrease in the animal showing sub-clinical form of disease. The coccidiosis caused 7.62% decrease in lymphocytes in infected lambs. The results also showed that in clinical cases of coccidiosis, the monocyte count increased by 10%. The results revealed a decrease in the eosinophil count.

Gastrointestinal helminths in desi (indigenous) and commercial layers with taxonomy of the isolates

Khan, M.S., 1991. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present project was designed to estimate and compare the extent of helminth infestation in Desi (indigenous) and commercial (W.L.H) poultry layers along with taxonomic study of the isolated species. A total 600 gut samples of adult layers i.e. 300 each of desi (indigenous) and commercial (W.L.H) were examined. The overall prevalence of helminth parasite (nematodes and cestodes) was 80.3% in desi and 32.6% in commercial (W.H.L) birds. *Ascaridia galli* was the most prevailing species 167 (55.6%) followed by *Heterakis gallinae* 38(12.6%), *Subulura brumpti* 45 (15.0%); while *Syngamus trachea* was very rare and was present only in 5 (1.6%) of desi (indigenous) birds. In commercial (W.L.H) layers the nematodes singly and/or on multiple basis were recorded in 98(32.61%) of birds *Ascardia galli* alone infected

49(16.3%) of birds while *Syngamus tracheae* was very rare and present only in 2 (0.6%) of the tracheas. The overall incidence of cestodes was higher than those of nematodes parasites. It was found to be 65.0% and 22.6% in desi (indigenous) and commercial (W.L.H) layers, respectively. The species of cestodes recorded from desi (indigenous) birds were: Raillietina (58.0%), *Raillietina cesticillus* (12.6%), *Raillietina echinobothrida* (14.0%), *Cotugnia digonopora* (10.6%),*Choanotaenia infundibulum* (20.0%), *Amoebotaenia sphenoides* (3.3%); While in commercial (W.L.H) layers the species recorded were: *R. tetragona* (22.0%), *R. cesticillus* (1.0%), *R.echinobothrida* (3.0%), *C. digonopora* (1.0%), *C. infundibulum* (4.3%) and *A. sphenoides*(2.0%).No trematode parasite was however recovered both in desi (indigenous) and commercial (W.L.H.) birds during the present study.

Studies on the epidemiology and control of hydatidosis
Iqbal, Z., 1991. *Ph.D. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The present studies were conducted on the epidemiology and control of hydatid disease in the Faisalabad division (Pakistan). Studies included assessment of prevalence of echinococcosis in dogs and jackals and hydatidosis in sheep, goats, cattle, buffaloes, camels and wild boars. The second part of the study comprised of investigations on strain differences in *Echinococcus granulosus* in study area and chemotherapeutic control of echinococcosis in dogs. Socio-cultural factors contributing towards spread of hydatid disease were also studied. Prevalence of echinococcosis was recorded as 16% (16/100), 13% (13/100), 18% (18/100) and 9% (9/100) in stray dogs, pet dogs, shepherd dogs and jackals, respectively. Hydatidosis was recorded in 15.9% (476/3000) sheep; 7.7% (232/3000) goats; 32.4% (809/2500) cattle; 51.8% (1295/2500) buffaloes, 53.2% (133/250) camels and 4% (4/100) wild boars. Investigations on strain differentces in *E. granulosus* included morphological, growth and developmental studies on the worms recovered from naturally and experimentally infected dogs and jackals. These studies also included the morphological observatioins on protoscoleces of hydatid cysts from different animal origins. These studies revealed two distinct populations of *E. granulosus* from the area of study. It was observed that one of these two populations of *E. granulosus* infect sheep and goats and other to cattle and buffaloes. *E. granulosus* of camel-origin shared characteristies with worms of both above origins. Both populations of *E. granulosus* differed from each other in respect of rostellar hooks and strobilar morphology and growth and development of the worms. All the populations of *E. granulosus* recovered from experimentally infected dogs and jackals were also recovered from naturally infected dogs and jackals. The protoscoleces of all animal origins except those of sheep and goat origin were found growing more rapidly in jackals compared within dogs. The jackals in the area were proved as potential definitive hosts for *E. granulosus* as far as growth and development of the worms is concerned. It was also noted that the worms of all origins developed to maturity by day 35 of the ingestion of protoscoleces. Chemotherapeutic studies included trial of praziquantel against *E. granulosus* at different stages of development in dogs. Praziquantel was found 94.3, 97.8 and 100% effective against 6, 20 and 35-day-old worms, respectively. Socio-cultural factors studied included awareness of local people about hydatid disease, extent of association of dogs with livestock and human beings, legal and illegal (within and outside the abattoir) slaughter practices, hygienic and unhygienic disposal of carcasses/offals and practice of feeding dogs. It was observed that all these factors were conducive towards spread of hydatid disease. Very few people (40%) were aware of the disease and dogs were closely associated with livestock and human beings. No abattoirs were availabale in villages, therefore, animals were slaughtered in the houses or fields, particularly on occasions of feasts like Eid-ul-Azha. Disposal of the carcasses/offals was not satisfactory and dogs were found having easy access to these offals. It was concluded from the current studies that both dogs and jackals play important role in the epidemiology of hydatid disease and domestic ruminants as well as wild boars help in perpetuation of the life cycle of *E. granulosus*. It was also concluded that the possibility of occurrence of sylvatic strain of *E. granulosus* in Pakistan cannot be ruled out but it needs further studies including biochemical and cross-infection experiments. Moreover, the factors of socio-cultural system in Pakistan comprising awareness of the people about hydatid disease, slaughter practices, unhygienic disposal of carcasses and absence of an anti-hydatid campaign help in maintenance of hydatid disease.

Effects of natural dicrocoelliasis on different blood parameters and serum billirubin level in sheep
Bano, A., 1991. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present study was planned to investigate the effects of natural dicrocoeliasis on various blood parameters and serum bilirubin level in sheep. For this purpose, 40 out of 1200 animals were confirmed positive for dicrocoeliasis on the basis of post mortem identification of adult flukes. An over all incidence of 3.3% was recorded in sheep. The results showed that mostly the infection was in animals from one year to three years of age. The incidence of infection was highest in months of September and October i.e. 3.8 and 4.2, respectively. It was the lowest in July and August i.e. 2.3 and 2.9, respectively. Significantly lower values of packed cell volume, haemoglobin and total erythrocyte count were estimated while higher values were obtained for eosinophil counts in infected sheep resulting in an increased total leukocyte count.

Identification and pathology of lungworms of sheep
Basraa, M.T., 1991. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

Two hundred suspected lungs for verminous pneumonia were collected from Lahore abattoir and subjected to isolation of lungworms and their pathological study. Twelve % were found with verminous pneumonia, out of which 25% were *Dictyocaulus filaria,* 8.33% with *Protostrongylus rufescens* and 66.67% were infected with mixed type of lungworms, containing *Dictyocaulus filaria* and *Protostrongylus rufescens*. Grossly the affected lungs showed area of consolidation. The color varied from red to grey. The affected parts were usually wedge shaped showing areas of hepatization and emphysema. After dissection it was observed that the lungworms were found almost obstructing the lumen of bronchi and were in all cases confined to the bronchi only. In almost all cases, the dorsal portion of the diaphragmatic lobes was affected. The verminous nodules were deeply embedded in the parenchyma and could not be separated and showed emphysemic lesions. Microscopically, the focal areas of consolidation surrounded by emphysema were seen. In some cases bronchial epithelial hyperplasia were also prominent that it caused blocking of bronchioles. In some cases, peribronchial muscles were markedly hyperplastic and in some lungs neutrophils and eosinophils were infiltrated in the alveoli and bronchioles. In some cases intra-alveolar septa were enlarged due to infiltration of inflammatory cells. Blood vessels were congested.

Epidemiological studies on trematodes infestation in buffaloes in district Gujrat
Bhatti, C.I.H., 1991. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The study was designed to find out the prevalence and intensity of trematodes infestation in Buffaloes in Distt. Gujrat. For this purpose, 20 villages out of 1516 were randomly selected. The study period was from January to May, 1991. Data collected from Veterinary Hospitals indicated that 1252 (19.39%) out of 6554 buffaloes were positive for trematode infection. Information collected from owners of the buffaloes of 20 villages showed that 133 (17.52%) out of 746 young buffaloes and 689 (21.92%) out of 3143 adult buffaloes were affected with trematodes. Five hundred faecal samples were tested by fresh smear and sedimentation method from 20 villages and found that 144 (28.8%) buffaloes were suffering from trematodes in District Gujrat. In order to determine the intensity of fluke disease in the infected animals, quantitative faecal examination was done and it ranged from 30-87.6 epg indicating that the disease is likely to be pathogenic. Overall incidence of trematodes recorded in slaughtered buffaloes was 76.5%. It was concluded from the findings of the study that trematodal infestation in buffaloes in District Gujrat are quite prevalent necessitating to adopt appropriate measures to control these infestations

Taxonomical study of ectoparasites of indigenous poultry and effect of fowl tick (*Argas persicus*) on different blood parameters
Ahmad, S.M., 1991. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A study was conducted to see the incidence and to identify the species of ectoparasites (tick, lice, mites) in indigenous poultry. Samples were collected from different areas in Lahore. Out of 1500 indigenous birds examined, 826 were found infested with ectoparasites, showing an overall infestation rate 55.07%. The infestation rate of ticks, lice, mites and mixed infestation (ticks + lice) was recorded as 14.47, 32.93, 0.33 and 7.34%, respectively. The species of ectoparasites identified were: *Argas persicus* (fowl tick), *Menopon gallinae*, *Menacanthus stramineus, Lipeurus caponis, Goniodes gigas* (lice) and *Cnemidocoptes mutans* (scaly leg mite). The infestation percentage of the above mentioned species was: 14.47, 15.47, 7.86, 5.87, 3.73 and 0.33%, respectively. The results of haematological examinations showed a significant decrease in haemoglobin and total erythrocytic count, whereas a rise in Erythrocyte Sedimentation Rate of fowl tick infested birds as compared to healthy birds.

A study on the prevalence, chemotherapy and taxonomy of the species of the genus *Sarcoptes* affecting camels in D.I. Khan district of NWFP
Khan, T.M., 1991. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A study was carried out to find out the prevalence, taxonomy and chemotherapy of the different species of Genus *Sarcoptes* infesting camels in D.I. Khan (N.W.F.P.). Fourteen hundred camels from 25 herds were surveyed from local and nomadic camels. Out of these 100 suspected camels were thoroughly examined and 32 were found positive (10 local and 22 nomadic) having mange. The average number of mites recovered from infested camels were 1245 and 2061 per animal, whereas the overall average number of mites isolated were 249 and 900 from local and nomadic camels, respectively. Out of 50 local camels suspected to be suffering from mange, 10 were found positive. (3 below two years and seven above two years of age) and 22 out of 50 were found positive in nomadic camels (4 below 2 years and 18 above 2 years) for mange mites. The percent infection recorded was 13.04 and 22.22% in animals of local and nomadic herds, respectively. Whereas the incidence of mange mites was found to be 25.92 and 56.25% in animals above two years in local versus nomadic herds. The overall average number of mites recorded per animal was 249 and total number of mites isolated was 12450 for local and 900 and 45348 mites for nomadic camels. For the identification of different species of sarcoptic mites, microscopic examination was carried out and the mites were first seen under low power and then under high power of magnification. Three genera identified were *Sarcoptes, Psoroptes* and *Chorioptes* in camels. The prevalence of mange was 20% in local and 44% in nomadic camels. While Sarcoptes species was 18 and 34% in both groups. Neguvon was found effective against mange.

On the diagnosis of *Echinococcus granulosus* by indirect haemagglutination test in dogs
Danso, P., 1991. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

To determine the haemagglutinating antibodies against experimentally induced *Echinococcus granulosus* infection in 18 pups (8-12 weeks), 60,000 (0.5 ml) protoscoleces in a gelatin capsule concealed in a ball of minced beef were given. Two types of antigens were specially prepared for the IHA test using crude extract of sheep hydatid cyst fluid with or without sonication. Serum samples were taken weekly from both the groups before and after the experimental infection. All the eighteen pups were euthanised after the fifth week of infection and the small intestine examined for the presence of adult *E. granulosus*. Results of faecal examination were negative throughtout the experimental period. In treated and control groups, the two antigens gave negative results in IHA test during the first two weeks post-infection. Haemagglutinating antibodies were detectable in all experimentally infected pups. In the third week post-infection, a geomean titre (GMT) of 13.929 was recorded with both the antigens. On the fourth week, the GMT for crude antigen was 22.628 and that of sonicated antigen 24.25. At the fifth week, the GMT was 25.99 with both crude and sonicated antigens. It was concluded that IHA test can be of diagnostic value in experimental *E. granulosus* infection of pups.

Identification of various species of coccidia and effects of natural infection on various blood parameters and total serum proteins in teddy goats

Ahmad, A., 1992. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

Study was conducted to find out the incidence of various species of *Eimeria* responsible for coccidiosis in kids of 4-6 month of age. The species of *Eimeria* found were *Eimeria arloingi, E. intricata, E. parva, E. faurei* and *E. ninakohlyakimovae*. All samples showed mixed infection with 2 to 3 species of *Eimeria*. The oocyst count per gram of faeces in positive cases ranged from 5,000 to 50,000. The disease incidence was higher in young animals and it decreased with age. It was observed tha *Eimeria arloingi* was the most prevalent (81.25%) amongst the faecal samples examined. A significant decrease in total erythrocyte count was observed in infected animals. A negative correlation existed between the average oocyst count and number of erythrocytes per micro litre of blood. The results also indicated that a 36.34% increase in total leukocyte count of kids having clinical coccidiosis and 5.02% increase in the animal suffering from sub-clinical form of disease. The coccidiosis caused 7.62% decrease in lymphocytes in infected kids. The result indicated a significant decrease in lymphocyte count due to coccidiosis. The result showed that the coccidiosis produced no significant change in the monocyte component of blood of infected kids. Decrease in total serum protein occurred due to coccidiosis.

A study on the taxonomy and prevalence of the species of genus *Ancylostoma* and effects of natural infections on various blood parameters in dogs
Ashraf, K., 1992. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The study was conducted to determine the prevalence of ancylostomes (Hookworms) in dogs, taxonomy of the species of the genus *Ancylostoma* and their effects on various blood parameters of the infected canines. Samples were collected from dog hospital, College of Veterinary Science and different pet clinics in the city. Only those dogs which had high prevalence in ancylostomes were examined by different faecal examination methods, were selected to get mature ancylostomes, after killing the dogs. Preservation and staining of ancylostomes was carried out by adopting the prescribed methods. The over all prevalence of different types of ancylostomes recorded in stray and pet dogs was 28%. The species of ancylostomes identified in the area was: *Ancylostoma caninum, A. braziliense and A. duodenale .* The percentage of the above mentioned species were 19.9, 33 and 2.5%, respectively. The results of haematological examination showed a significant decrease in haemoglobin, total erythrocyte count, packed cell volume and total serum protein level; whereas, a significant increase in erythrocyte sedimentation rate and differential leukocyte counts, like neutrophils, eosinophils and very little increase in basophils were also seen.

Studies on the prevalence of ectoparasites of the dromedary in Faisalabad division
Rahim, M.A., 1992. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The prevalence and identification of different species of ectoparasites (mites, ticks and lice) parasitizing camels at Faisalabad division was determined from July to November 1993. Of 500 camels examined, 285 (57%) were found infested. The infestation rate of mites, ticks, lice and mixed infestation (mites and ticks) were 13.4, 38.8, 3.2 and 1.6%, respectively. The species of ectoparasites identified were *Sarcoptes scabiei var cameli, Hyalomma (H) dromedarii, H. anato licum anatolicum, H. aegyptium* and *Haematopinus cameli*.

A study on the taxonomy and bionomics of genus *Haemaphysalis* in domestic animals
Durrani, H.Z., 1992. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

During this study numerous ticks from sheep, goat, cattle and buffaloes each were collected from Lahore and Sheikhupura districts. One species of genus *Haemaphysalis* i.e. *Haemaphysalis brunati* was recorded. Other species of same genus did not occur in these districts. This species was recorded from Lahore only. The incidence was 3.87%. In the year three generations of *Haemaphysalis brunati* occurred in Lahore district. The ticks appeared on livestock in March and gradually increased during following

months and reached its peak level in June. Then the population graph fell, until in last week of September when a minor peak was recorded. Subsequently the infestation recorded considerably amongst livestock during October and was lowest in the end of November. No incidences were recorded from early December through late February. The ticks mostly started depositing egg 19 days and 7 days after dropping in autumn. The ovipositor period under natural conditions was found to be 12 days in spring, 11 days in summer and 11 days in autumn. The average number of eggs laid by a single female tick in different seasons was not constant. In spring season, average number of eggs deposited by single female tick was 3819 in summer 2786 and in autumn 2514. The eggs were oval in shape and measured 0.470 x 0.420 mm in size and weighed 0.041 mg on average. The incubation period of ova was found to vary in different season. In spring it was 20 days, 16 days in summer and 15 days in autumn. The larvae survived without food and water for 56 days in spring. The larvae fully engorged in 9 days during spring, 7 days in summer and 6 days in autumn. The weight of unfed larvae was found to be 0.129 mg. The fully engorged larvae moulted in 16 days during spring, 11 days during summer and 10 days during autumn. The newly moulted unfed nymph lived for 65 days in spring. The nymph engorged in 7 days during spring, in 6 days during summer and autumn. The weight of unfed nymph was found to be 0.114 mg and that of engorged nymph was round to be 1.094 mg. The nymph moulted in 17 days during spring and in 9 days during summer and autumn. The newly moulted female engorged within 9 days in spring, 8 days in summer and 4 days in autumn. The weight of unfed female was 1.695 mg and of engorged female 210.0 mg. The amount of blood sucked by a single female tick was estimated to be 208.36 mg. Amount of blood sucked by a single female during her entire life span was found to be 221.549 mg. Influence to temperature and humidity on the rate of development of *Haemaphysalis brunati* on preoviposition period, oviposition period, number of eggs laid, incubation period and percentage of hatchability were studied and it was observed that constant temperature and varying humidities had no significant effect on the said parameters; whereas, constant humidity and varying temperatures had significant effect on the rate of development, preoviposition period, oviposition period, number of eggs laid, incubation period and percentage of hatchability.

Some biochemical and haematological disturbances associated with ovine haemonchosis
Chaudhry, G.R., 1992. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The present study was conducted on some biochemical and haematological disturbances associated with ovine haemonchosis. Twelve, one-year-old Lohi sheep of either sex with almost same age and body weight were used in this experiment. The animals were divided into two groups A and B, each consisting of six animals. The group A was infected with 15,000 L, of *Haemonchus contortus* while group B was kept as uninfected control. The blood samples were taken from both groups at day 0, 7, 14, 21, 35 and 56 post infection and were subjected to biochemical and haematological study. Serum concentrations of enzymes, SGOT and SGPT; and urea, inorganic phosphorus and potassium significantly increased with the severity of infection from day 7 to day 56 post infection in infected animals. Whereas, glucose, protein, zinc, copper, iron and chloride continuously decreased form day 7 to 56 post infection in infected animals. Cholesterol and calcium decreased from day 21 to day 56 post infection. Total erythrocyte count, packed cell volume, mean corpuscular volume and mean corpuscular haemoglobin remained constant upto the day 14 post infection and decreased significantly from day 21 to day 56 in infected animals. The values of haemoglobin and lymphocyte counts remained constant upto day 7 post infection and decreased significantly from day 14 to 56 post infection; whereas, erythrocyte sedimentation rate and total leukocyte counts increased significantly form day 14 to day 56 post infection in infected animals. The values of neutrophils and those of eosinophils increased from day 7 to day 56 post infection in infected animals. The values of basophils and monocytes remained unaffected during the experiment. The present study led to the conclusion that haemonchosis is a dreadly disease of sheep which results in rapid down fall in the health of animals. Moreover, it deprives the animals from essential nutrients and severaly disturbs body metabolism by affecting the enzyme systems of the body of the animals. Therefore, it is strongly recommended that the animals be dewormed regularly for *H. contortus* and if at all, infection is established, the diet of infected animals must be supplemented with essential body

nutrients like iron, phosphorus, copper, zinc, chlorides, magnesium and glucose along with proteinaceous ration. Supplementation of diet along with proper medication will help the animals in their rapid recovery and will save the owners from the losses due to lowered productivity.

Prevalence of haemonchosis in sheep and goats at Faisalabad and histopathology of infected abomasa

Maqsood, M., 1992. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

Abomasal contents of 1000 sheep and 1000 goats, slaughtered at Faisalabad abattoir, were examined for the presence of *Haemonchus contortus*. A complete record of breed, sex and age of the host and sex and number of worms was maintained. The prevalence of haemonchosis was 65.2% in sheep and 47.1% in goats. Breed wise distribution of haemonchosis revealed non-significant differences in the prevalence between different breeds of sheep and goats. Prevalence was 04.0, 00.9 and 04.04% in Lohi, Kajli and Buchi breeds of sheep and 46.8 and 47.8% in Teddy and Beetal goats, respectively. Results of the sex-wise prevalence revealed higher rate of infection in female than that in male sheep. Whereas, there was no difference in the prevalence between male and female goats. Prevalence was 59.1% in male and 74.6% in female sheep and 44.8% in male and 50.3% in female goats. The prevalence of haemonchosis was higher in sheep (67.1%) and goats (47.8%) less than two years of age; whereas, it was lower being 40.4 and 33.3%, respectively in those of above two years. Worm burden was categorized into four types i.e. light (up to 100), mild (101-200), moderate (201-300) and severe (above 300). Of the total infected sheep and goats, 88.5:93.0; 7.7:5.7; 3.2:1.1 and 0.6:0.2% had light, mild, moderate and severe worm burden, respectively. The worm load on sex basis was also categorized in four types. Of the total infected male and females 91.9:84.2; 5.6:10.3; 2.2:4.5 and 10.3:1.0% and 96.2:89.0; 3.4:8.6; 0.4:1.9 and 0:0.5% had light, mild, moderate and severe worm load in sheep and goats, respectively. The results on the female to male ratio was 1.3 female/male. Histopathology of infected and un-infected sheep and goats was performed. In worm free sheep and goats, the abomasal mucosa consisted of a columnar mucus-secreting surface epithelium which extended into gastric glands. The lamina propria contained mast cells, eosinophils, lymphocytes and plasma cells. These cells occurred both in mucosa and submucosa. The microscopic lesions in infected animals were nearly same in both sheep and goats. There was marked cellular infiltration to submucosa and mucosa. Eosinophils and neutrophils were abundant. The submucosal and mucosal oedema, mucosal haemorrhage and depressed lesions in the mucosa were noted. It was concluded that; 1) Prevalence of haemonchosis was higher in sheep compared with goats, 2) Prevalence of haemonchosis was not associated with any particular breed of sheep and goats, 3) Female sheep and goats were more affected with haemonchosis compared with their male counter parts, 4. Young sheep and goats (upto two years) were more affected with haemonchosis compared with those of above two years of age, 5) No significant difference was observed in worm burden between sheep and goats however, females harboured more number of worms in both spp. of animals, and 6) abomasal histopathological changes, induced by *H. contortus* were recorded in both sheep and goats. It was recommended that; 1) Work on various nutritional plans leading to development of good resistance against *Haemonchus* spp. and an establisment of regular deworming schedules is suggested, and 2. Attention be focused on application of immunological procedures for early diagnosis of haemonchosis and its control.

A study of intestinal nematodes with taxonomy of the species of genus *Trichostrongylus* in sheep in district Bahawalpur

Afzal, M., 1992. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

Study of intestinal nematodes with taxonomy of the species of genus *Trichostrongylus* in sheep in district Bahawalpur was conducted. For this purpose two hundred guts of sheep were collected from Bahawalpur Abattoir and adjacent areas of Cholistan. The overall incidences of gastro-intestinal nematodes was 63% in sheep. The species of nematodes observed during the study were: *Oesophagostomum venulosum* (62%), *O. columbianum* (52%), *Trichuris ovis* (38.5%), *T. globulosa* (24%), *Nematodirus spathiger* (25%),

Haemonchus contortus (14%), *Trichostrongylus colubriformis* (24%), *T. axei* (13.5%). The highest infection rate was 84% during the months of April and 68% during the month of March. In February, the infection was 56%. The lowest incidence was recorded as 44% during the month of January. The taxonomy of the species of genus *Trichostrongylus* was studied.

A study on the chemotherapy and taxonomy of mange mites in ovine and their effect on different blood parameters
Rana, M.R., 1993. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A study was carried out to find out the taxonomy, chemotherapy of mange mites in sheep and its effect on different blood parameters. A total of 30 flocks comprising of 1500 sheep of different age and sexes were examined in the city and village around Lahore. Out of 200 suspected sheep, 30 (15%) were found positive for mange mites infestation. Species of three genera namely *Sarcoptes, Psoroptes* and *Chorioptes* were found infesting these animals. The average number of mites recovered from the species of each genera were recorded as 851, 825 and 815 for *Psoroptes, Sarcoptes* and *Chorioptes*, respectively. Chemotherapeutic trials were carried out in suspected sheep by using two concentrations of neguvon solution i.e. 0.10% and 0.15% at ten days intervals. It was noticed that 0.15% neguvon was highly effective against mange mites infestation when it was applied twice after ten days interval.

Taxonomical study of ticks of genus *Rhipicephalus* and their relation to the incidence of haemoparasites and comparative efficacy of different acaricides on ticks in sheep and goats in Kaghan valley
Khan, M.I., 1993. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

Present study was conducted in the areas of Tehsil Balakot of District Mansehra to find out the species of the genus *Rhipicephalus*, infesting sheep and goats, efficacy of three acaricides and to identify the haemoparasites carried by *Rhipicephalus*. One species was recovered i.e. *Rhipicephalus sanguineus sanguineus*. Ectopar provided on average 93.6% control on sheep and 85% control on goats and Neocidol provided 89.5% control on sheep and 92% control on goats. Asuntol on sheep and goats was less effective than the other two acaricides. Very small number of ticks were positive for *Babesia ovis*.

Enzymatic study on hydatid cyst fluid in cattle, buffalo and sheep
Shah, A.U. 1993. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

Enzymology of hydatid cyst (n=120) fluid of infected liver and lungs from cattle, buffalo and sheep for the detection of glutamate pyruvate transaminase (GPT) and alkaline phosphatase(AP) was processed by kit method. The average GOT values of fertile and sterile cyst fluid from liver and lungs of cattle and buffaloes was 49.20 and 47.40; 45.90 and 44.50; 41.60 and 40.10; 62.90 and 60.80 u/l. The Total GOT concentration in cystic fluid from liver and lungs of sheep was 49.90 and 4740; 58.90 and 57.40 u/l. The average GPT values of fertile and sterile cystic fluid from liver and lungs of cattle and buffaloes was 34.90 and 34.00; 45.20 and 45.10; 31.90 and 29.40; 47.70 and 46.00 U/1. The GPT values in fertile and sterile cystic fluid from liver and lungs of sheep were 65.50 and 62.10; 63.90 and 64.60 U/1. Alkaline phosphatase values in fertile and sterile cystic fluid from liver and lungs of cattle and buffaloes were 12.00 and 11.30; 19.40 and 19.00; 14.70 and 14.60; 14.90 and 14.00 U/1. Of sheep livers, the average alkaline phosphatase values were 12.20 and 13.90 U/1 and of lungs were 16.30 and 16.20 U/1. The concentration of the GPT and AP was variable in the fertile and sterile cyst fluid of cattle, buffaloes and sheep.

Efficacy of Coxeva in experimental caecal coccidisis and its effects on body weight in broiler chicks
Malik, M.Y., 1993. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The study was conducted to evaluate the efficacy of anticoccidial drug coxeva (a mixture of 80%

sulphadimidine and 8% diaveridine) and its effects on body weight, growth rate and feed conversion ratio. For this purpose, 120 days old broiler chicks were reared upto the age of 4 weeks. At the end of 4 weeks, the birds were randomly divided into four groups A, B, C and D, each group containing 30 chicks. The birds of each group were weighed. The group B, C and D were infected with 50,000 sporulated oocysts of *Eimeria tenella,* while the group A was left uninfected and kept as control. On the 6th day after the appearance of clinical symptoms of caecal coccidisos, the group C and D were medicated with coxeva (the group C for five continuous days and group D for three days with one day break after two days), the group B was left as infected control. The daily oocysts count per gram of faeces were taken upto the end of experiment which was zero in group C on 10th day and in group D on 13th day the oocysts were at their peak (5,20,000) on 15th day of inoculation. The body weight was recorded at the end of each week throughout the experiment which showed significant difference in group B and groups A, C and D. The feed consumed by each group was recorded on daily basis and growth rate was recorded at the end of each week. The analysis of variance revealed significant difference in feed consumption and growth rate in group B and other groups. The feed conversion ratio was recorded for each group at the end of each week which showed non significant difference among group A, B, C and D. The drug was also evaluated for its modes of administration (continuous and intermittent) and found no significant difference in both modes of administration. The mortality was recorded which was five birds (17%) in group B. The drug proved 100% effective against caecal coccidiosis in broiler chicks.

Serodiagnosis of ovine hydatidosis
Javaid, M., 1993. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A study was undertaken to find out the incidence of hydatidosis and to evaluate the efficacy of indirect haemagglutination (IHA) test for the confirmation of natural hydatidosis in sheep slaughtered at Lahore municipal abattoir. Blood samples from 200 sheep (50 each from hydatidosis affected and free sheep on the basis of postmortem findings and 100 blood samples selected randomly without considering postmortem finding). The serum from each sample was separated, properly labelled and stored at –20ºC. For the preparation of antigen, crude cyst fluid was aspirated aseptically from hydatid cysts. Blood from healthy sheep was collected in 3.8% sodium citrate solution and blood cells were separated by centrifugation. A 2.5% red cell suspension was prepared in Phosphate Buffered Saline (PBS). The sheep erythrocytes were sensitized by Hydatid fluid antigen. Optimal dilution of antigen 1:16 was used in PBS (pH 6.4) for sensitizing the sheep erythrocytes. All the sera were inactivated at 56ºC for half an hour and serial two fold serum dilutions were prepared by micropipettes in microtitre U plates and sensitized erythrocytes were added to the plates and incubated at room temperature in a humid chamber for 3 hours. A titre of 1:32 and above was considered as positive. In positive reactions, the cells agglutinated like a carpet at the bottom of the wells; whereas, in negative cases the cells settled as a compact mass in the centre of the wells. By the IHA test 92% sheep were found positive for hydatidosis. Out of 50 serum samples (Group A_2) 46(92%) were confirmed positive on postmortem while 3 out of 50 (6%) hydatid free samples (Group A_3) gave false positive results with IHA test. The hydatid cysts did not affect the blood values of the host significantly. However, only 28% of hydatid positive animals showed eosinophilia ranging from 7 to 23% which was non pathognomonic.

A study of gastro-intestinal nematodes of camels slaughtered at metropolitan corporation abattoir Lahore with taxonomy of the isolated species
Ali, S.A., 1993. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present study was carried out to determine the incidence of gastro-intestinal nematodes of camels, with the taxonomy of the isolated species. Sixty guts were examined randomly. The five species of nematodes representing different genera were isolated and identified *Haemonchus longistipes, H. contortus, Camelostrongylus mentulatus, Nemataodirus spathiger* and *Trichuris globulosa.* The overall incidence recorded from camels during the present study was 65%.

Comparative efficacy of trypanocidal drugs and their effects on some blood parameters in camels naturally infected with surra
Nizami, F.J., 1993. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present study was designed to find out the prevalence and treatment of *Trypanosoma evansi* infection by using Naganol (Bayer) and Trypacide (M & B) in camels in District Layyah. For this purpose, 1000 suspected camels were examined and 75 (7.5%) were found positive for *T. evansi* infection. Out of these, 45 positive cases were randomly divided into 3 equal groups comprising 15 animals each. Two of the groups were kept as untreated infected control; while a 4th group of 15 camels was kept as non-infected and untreated control. Naganol (Bayer) was found to be 60% trypanocidal on day 5 and 100% on day 10 and 21 post treatment. Trypacide (M & B) was found to be 53% trypanocidal on day 5 and 50% on day 10 and 21 post treatment. There was marked neutropenia with lymphocytosis before the treatment in infected versus non infected ones. The average values of neutrophils were 38±0.62, 39±0.02, 36±0.47 and 52±0.48 in the 4 groups, respectively. But on day 21 post treatment, the number of neutrophils increased in group Nos. I and II with an average of 51±0.33 and 49±1.41 while the group No. III and IV revealed no difference in their count. The mean values of lymphocytes prior to and after the treatment were 51±0.33, 52±0.71, 56±0.46 and 41±0.36, 42±0.40, 45.3±1.09, 56±0.46 and 39±0.23, respectively. There was 41.66% increase in eosinophils of group I, II and III before the treatment, the average being 7±0.22, 5±0.48 and 5±0.48, respectively, while the group No. IV possessed 4±0.19% neutrophils. The eosinophilia tended to become normal with 33.33% decrease, average being 4±0.40 and 3±0.45 in group No. I and II, respectively on day 21 post treatment; while the neutophils count remained nearly the same in group No III and IV average being 6±0.24 and 4±0.19, respectively on day 21 post treatment. The basophils and monocytes count remained unchanged before and after the treatment in all the 4 groups.

Taxonomical studies of genus strongylus by coprological examination in horses and their effects on various blood parameters
Mengal, M.A., 1993. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The work was designed to study the taxonomy of the genus *Strongylus* and its effect on the haematological parameters of horses. Of 100 horses examined during November, December and January, only 28 showed single infection of genus *Strongylus*; *S. vulgaris* (56.73%), *S. edentatus* (16.63%) and *S. equinus* (26.86%). Mixed infections along with *Strongylus* species were found in 54 horses whereas only nine horses had mixed infections without *Strongylus* species. Other species observed in mixed infections were *Triodontophorus, Trichonema, Trichostrongylus, Parascaris* and *Fasciola*. Overall 82 horses were found to be positive for single and mixed infections. Haematological parameters witnessed significant reduction ($P<0.01$) in RBC, WBC counts, neutrophils percent, Hb gm/dl and PCV% whereas lymphocytes and eosinophils were significantly increased in single and/or mixed infections with or without *Strongylus* species

The host reaction to experimentally induced *Eimeria* infections in broiler chicks
Awan, A.U.R., 1994. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The experiment was designed to study the host reaction to the experimentally induced *Eimeria* species in broiler chicks. For this purpose, 220, day-old chicks were reared. At the age of day 3, they were divided randomly into four groups each comprising 55 birds. They were named as A, B, C and D. The group A was kept control, while group B, C and D, at the age of day 3, received a primary dose of 1000 virulent sporulated oocysts, through oral, intraperitoneal and subcutaneous routes, respectively. The challenge doses of 50,000 virulent sporulated oocysts each were administered to the members of each group B, C and D on days 13, 28 and 43 of age. The OPG counts in group A remained nil throughout the experiment. The maximum OPG counts 65,500 were recorded in group B by day 21. On the same day, OPG counts of group C and D were also on the peak found to be 40,500 and 54,500, respectively. Three mortalities occurred in group B, 4 in C and 6 in group D. Similarly, the maximum weight was attained by the

members of group A (control) i.e. 1750 gm, secondly by group B (oral) i.e. 1530 gm, thirdly group D (S/C) i.e. 1410 gm and fourthly group C (I/P) i.e. 1280 gm. The difference in B was of 220 gm, in C 470 gm, and in D 340 gm lesser as compared to group A.

The effects of induced coccidiosis on growth and blood parameters in commercail quails (*Coturnix coturnix japonica*)
Ashraf, M., 1994. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The study was designed to see the effects of experimentally induced coccidiosis on growth and blood parameters in commercial quails (*Coturnix coturnix japonica*). For this purpose, 200 day old quail chicks were obtained from a local hatchery and raised under standard, controlled coccidia free conditions. A commercial coccidiostat free feed was provided. At the age of 21 days, birds were divided into 2 groups A and B each comprising 100 birds. Birds of group 'A' were kept as non infected control and birds of group 'B' were infected with 50,000 sporulated oocysts given directly into crop. After the infection, the OPG of the both groups was recorded. Weekly weight gain/bird of both A and B group was recorded. Meanwhile the morbidity, mortality clinical finding and post-mortem findings were also observed. At the end of experimental period of 42 days, 20 birds from each group were slaughtered and blood sample were collected for haematology. The weight of birds in group 'B' was significantly lower than that of group 'A' birds. The morbidity and mortality rate in group B were 100 and 38%, respectively.

Studies on the prevalence, taxonomy and chemotherapy of mites in cattle and buffaloes in Faisalabad district
Qudoos, A., 1994. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The prevalence, taxonomy and chemotherapy of mite infestation in cattle (n=600) and buffaloes (n=300) in Faisalabad district were determined. The overall prevalence of mite infestation was 27.3% being 9.3 and 45.3% on cattle and buffaloes, respectively. The highest rate of mite infestation was recorded in tehsil Faisalabad (34%), followed by tehsil Samundri (26.5%) and Jaranwala (21.5%). Mite infestation was more on adult cattle (9.3%) than buffaloes (6.6%). In contrast, buffalo calves has higher prevalence (38.6%) of mite infestation than cow calves (0%). Two species of mites, *Sarcoptes scabiei var. bovis* and *Psoroptes ovis* were identified from infested cattle and buffaloes. Ivermectin has the highest acaricidal effect followed by Diazinon and Trichlorphon against mite infestation.

Experimental induction of coccidiosis in broiler chicks with *Eimeria tenella* and comparative efficacy of different prophylactic measures against the disease
Issot, N.J., 1994. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The study was designed to look into the immunogenic properties of *Eimeria tenella*. Two hundred and twenty five day old broiler chickens were reared under controlled conditions. They wee equally divided into five group i.e. A, B, C, D and E. Group "A" was kept as uninfected control. Group 'B' acted as infected control, which was infected with 50,000 sporulated oocysts at day 15, 25 and 35 of age. Group 'C' acted as infected and treated, which received sporulated oocysts on day 15, 25 and 35 alongwith 5 days treatment with salinomycin (60 ppm in finished feed) after 3 days of each primary and challenge dose. To group 'D' 1000 live sporulated oocysts were administered orally at day 3 and 10. Similarly, 'E' group received formalin treated 1000 sporulated oocysts orally at day 3 and 10 of age of chickens. Subsequently the members of group D and E received challenge infections of 50,000 *Eimeria tenella* sporulated oocysts at day 15, 25 and 35. Immunogenicity was measured by the passage of oocysts per gm of faeces and by comparative weight gains amongst different groups. It was noticed that no coccidiosis could be established in groups A, C and E and the OPG counts remained nil throughout the period of experiment. Group B showed high counts and group 'D' showed moderate counts but towards the completion of experiment the OPG counts gradually reduced to 8400 and 6100 respectively, in both groups. Weight gains recorded were 473, 393, 316 and 310 gm. Greater in A, E, D and C, respectively,

as compared with group B. Group E depicted 100% protection and remained second to the uninfected control group A in respect of weight gains. Group 'D' although developed infection was placed 3rd in weigh gain. Inspite of complete protection in group C due to Salinomycin treatment, the weight gain remained lower than group D and E.

Study of gastro-intestinal helminths and taxonomy of species of the genus *Paramphistomum* in camels
Khan, S.A., 1994. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The study was undertaken with the aim to determine the prevalence of gastro-intestinal helminths and to record the intensity of infection along with special emphasis on taxonomy of species of the genus *Paramphistomum* in camels. Two hundred gastro-intestinal tracts of slaughtered camels were examined. The animals awaiting slaughter were also examined at random irrespective of age, breed, sex and state of health. Out of 200 guts examined, 15 guts (7.5%) were found infected with trematodes, 50 guts (25%) were infected with cestodes and 60 guts (30%) were having nematode infection respectively. Two species of gastric trematodes were recorded having the incidence of 5% in case of *Paramphistomum cervi* and 2.5% in *Gastrothylax crumenifer*. Two species of cestodes were isolated, i.e, *Moniezia expansa* and *M. benedeni*, showing an incidence of 17.5% and 7.5%, respectively. As regards the nematodes, three species were isolated, i.e., *Haemonchus longistipes, H. contortus* and *Trichuris globulosa* with an incidence of 13, 10 and 7%, respectively. The only species of this genus in camel was *P. cervi*. Morphology of the recorded species of the genus *Paramphistomum* has been described. The month wise prevalence of trematodes during the month of July, August, September and October was 6, 10, 8, and 6%, respectively. In case of cestodes, in the month of July, August, September and October, it was 16, 24, 30, and 30%, respectively. For nematodes, the month wise prevalence during the same months was 20, 24, 36 and 40%, respectively. Data revealed a significant difference among prevalence of different parasites. Moreover, no significant difference was found among different months.

A study on the taxonomy of sheep cestodes and the efficacy of albendazole and niclosamide against natural infections
Ashraf, M., 1994. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A study of cestodal infections in sheep with taxonomy of the prevalent cestode species affecting different age groups in and around Lahore was conducted. For this purpose, 200 guts (100 each from below six month and above six month of sheep) were collected from Lahore Abattoir. The over all incidence of cestodes infection in sheep was 64.5%. The species of various genera of cestodes observed during the present study were: *Moniezia expansa* (64%), *M. benedeni* (60%), *Avitellina centripunctata* (49.50%), *A. lahorea* (40%), *A. sudanea* (30%), *Stilesia vittata* (30%), *S. globipunctata* (50%) and *Thysanosoma actinioides* (6%). The infection rate was 76% during August and 66.25% during September. The lowest incidence was recorded as 57.14% during October. The taxonomy of the prevalent cestode species was carried out. The efficacy of two commonly available anthelmintics namely albendazole (Valbazen) and niclosamide (Mansonil), in naturally infected sheep with gastrointestinal cestodes was also studied. Both the drugs revealed a progressive decrease in the faecal egg/segment counts. The efficacy of albendazole on 3rd and 21st day was 96.02 and 99.23%, respectively while the efficacy of niclosamide (mansonil) was 100% on 3rd and 21st day.

Taxonomical studies of endo-parasites and their sequence of prevalence at different ages of layers
Haq, A.U., 1994. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

In the present study the infection of gastro-intesntinal parasites was studied in commercial layers, maintained at various poultry farms located in and around Lahore. About 930 faecal samples were collected from those birds which were dewormed at least one month before. Birds were divided into six

age groups starting from Week-1 to 48. Out of 930 faecal samples, 689 (74%) were positive for parasitic infection. *Ascaridia galli* was found in 432 (46.4%) faecal samples, *Heterakis gallinarum* 326 (35%) and coccidiosis in 237 (25.4%) of the total faecal samples examined. The age wise incidence of parasites in group A (17-48 wks) was 81.2% i.e. ascending order of infection. In case of seasonal prevalence of infection, the occurrence of nematodes in June was 27.7%, in July 24.8%, in August 16.1% and in September 28.5%. In general low body weight gain and low Egg production (30-40%) in the parasitised birds as compared with non-parasitised birds were noted.

Studies on the incidence of gastrointestinal helminths and comparative efficacy of anthelmintics in buffalo calves
Amir, M.I., 1994. M.Sc. Thesis, Faculty of Veterinary Science, University of Agriculture, Faisalabad

Of 500 faecal samples of buffalo calves, gastrointestinal helminthiasis was recorded as 63.8%. The species identified were *Strongyloides papillosus*, *Toxocara vitulorum, Trichostrongylus spp, Ostertagia ostertagi, Oesophagostomum radiatum, Cooperia* spp*., Moniezia benedeni, Bunostomum phlebotomum, Moniezia expansa* and *Nematodirus* spp. Comparative efficacy of Albendazole (Valbazen), Levamisole (Nilverm) and Mebandazole (Chanazole) against gastrointestinal nematodes revealed marked reduction in egg per gram counts with Albendazole (97.62%) followed by Levamisole (95.62%) and Mebendazole (90.53%). It is recommended that Albendazole can be used as drug of choice being cost effective against gastrointestinal parasitic infections.

A comparative study of lungworms in sheep and goats and effect of mixed nematode infection on certain blood parameters
Sherazi, I.A., 1994. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present study was conducted to find out the incidence of lungworm infestation and effect of mixed nematode infections on certain blood parameters in sheep and goats. For this purpose, sheep and goats brought to Lahore abattoirs for slaughtering were closely examined before and after slaughter and animals suspected for lungworms were selected for collection of blood and tissue samples. Two hundred samples of lungs and blood (100 each from sheep and goats) were collected for parasitological and haematological examination, respectively. The results revealed that incidence of lungworms infestation in sheep and goats was 31 and 11%, respectively. It was observed that *Dictyocaulus filaria*, *Protostrongylus rufescens* and *Muellerius capillaris* infection in lung of sheep was in the order of 22, 8, and 1%, respectively; whereas, the incidence of lungworm infestation in lungs of goats caused by the same species was 8, 3 and 0%, respectively. The highest incidence of lungworm infection observed was that of *D. filaria* in both the sheep and goats, while *M. capillaris* was found only in lungs of one sheep and infection by this species could not be detected in goats. The findings of this study showed that average red blood cell count, heamoglobin level and packed cell volume were reduced due to nematode infection in sheep and goats. The results have also indicated that nematode infection in sheep and goats enhanced erythrocyte sedimentation rate.

Comparative studies on the prevalence and pathology of cestode infection in indigenous and exotic layers at Faisalabad
Shah, A.H., 1995. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The prevalence of cestodes in indigenous (59.4%) and exotic (16%) layers was determined. The species of cestodes identified from indigenous layers were *Raillietina echinobothrida, R. tetragona, R. cesticillus, Choanotaenia infundibulum, Amoebotaenia cuneata, Hymenolepis carioca* and *H. cantaniana* and of exotic layers, *R. echinobothrida, R. tetragona, R. cesticillus, C. infundibulum* and *H. carioca.* Two species of cestodes *Amoebotaenia cuneata* and *Hymenolepis cantaniana* were not found in exotic layers. Most prevalent cestodes in indigenous and exotic layers were *R. echinobothrida* (13.2%) and *R. cesticillus* (3.6%), respectively. The prevalence of *R. echinobothrida*, *R. tetragona*, *R. cesticillus*, *C. infundibulum, H.*

carioca, H. cantaniana and *A. cuneata* was 13.2, 10.6, 12.8, 6.8, 9, 5.2 and 1.8% in indigenous layers, respectively. In exotic layers, the prevalence of *R. echinobothrida*, *R. tetragona*, *R. cesticillus*, *C. infundibulum* and *H. carioca* was 2, 3.6, 3, 3.4 and 4%, respectively. Gross lesions in the infected guts were nodules formation on intestinal mucosa, thickening, ulceration, pale and rough mucosa of intestines in both indigenous and exotic layers. Histopathological lesions included villous atrophy, catarrhal entritis, granuloma formation in duodenum, desquamation of villi and submucosal glands, congestion, inflammatory reaction and vacuolation of epithelial cells.

A study of gastro-intestinal helminthiasis and the effects of natural infection on various blood parameters in the buffaloes
Ahmad, I., 1995. M.Sc. Thesis, College of Veterinary Sciences, Lahore

A total of 76 buffaloes brought to the Lahore Metropolitan Slaughter house were studied for helminthiasis. Out of which 50 (65.79%) were found positive. The helminthiasis positive guts were examined for the presence of helminthes and the following species were identified *Haemonchus contortus* (11.84%), *H. placei* (10.53%), *Ostertagia ostertagi* (7.89%), *Trichostrongylus axei* (3.9%), *Mecistocirrus digitatus* (2.63%), *T. colubriformis* (7.89%), *Cooperia onchophora* (9.21%), *C. punctata* (5.26%), *C. pectinata* (6.58%), *Nematodirus helvetianus* (2.63%), *Bunostomum phlebotomum* (2.63%), *Paramphistomum cervi* (3.95%), *Paramphistomum microbothrium* (2.63%) and *Moniezia benedeni* (2.63%). The effect of helminthiasis on blood parameters like, total erythrocytic count, total leuikocytic count, packed cell volume, erythrocytic sedimentation rate, haemoglobin concentration was investigated and the values recorded were 5.840±0.110x10^6 cumm, 5.447±0.07x10^3 cumm, 32,858±0.230%, 38.004±0.217 mm/hr. and 10.368±0.096 gm/100ml, respectively. The differential leucocytic count values for neutrophils, lymphocytes, eosinophils, monocytes and basophils were 43.16±0.531%, 43.82±0.718%, 6.40±0.187%, 5.620±0.241% and 1.040±0.124%, respectively. The respective values in helminth free (control) animals 7.38±0.068x10^6 cumm, 6.321±x10^3 cumm, 38.927±0.286%, 28.213±0.148 mm/hr. and 11.892±0.286 gm/100ml. The differential leukocytic count values for neutrophils, lymphocytes, eosinophils, monocytes and basophils were 29.15±0.365%, 56.0±0.513%, 8.12410.28%, 5.852410.264% and 0.90±0.191%, respectively.

A study on the prevalence and taxonomy of biting and sucking lice infestation in sheep with their effect on different blood parameters
Nasir, J.A., 1995. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The study was planned to determine the prevalence and taxonomy of biting and sucking lice infestation in sheep with their effect on various parameters. For this purpose specimen were collected from Outdoor Hospital College of Veterinary Sciences, Lahore and various private clinics in the city. Two species of lice i.e. *Damalina ovis* (biting lice; 10.5%) and *Linognathus pedalis* (sucking lice; 1%) were recorded. The infestation recorded was highest during spring and autumn and lowest during the summer. Haematological examination showed a significant decrease in haemoglobin, total erythrocyte count and packed cell volume; whereas, a significant rise in leukocytic count and D.L.C. of infested sheep as compared to healthy sheep was observed.

A comparative study of helminth and haemoparasites of domestic and wild pigeons
Hussain, A., 1995. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present work was planned for the comparative study of helminths and haemoparasites of domestic and wild pigeons. For this purpose, 300 each of guts and blood smears were studied. The overall incidence of gastro-intestinal helminths and blood protozoans was 77.33 and 31.99%, respectively, while 36% of birds had mixed infection. The incidence of gastro-intestinal helminths and blood protozoa in wild pigeons was 89.33 and 20.66%, respectively and in domestic pigeons it was 65.33 and 11.33%, respectively. Whereas mixed infections were 22 and 14%, respectively. The following species of

helminths and blood protozoa were recorded: *Raillietina tetragona, R. cesticillus, Choanotaenia infundibulum, Ascaridia columbae and Capillaria obsignata.* Among the helminths recorded, cestodes were found predominating as compared with nematodes in both wild and domestic pigeons. *R. cesticillus* was the most common cestode species in both wild and domestic pigeons i.e. 51 and 33%, respectively; while *Ascaridia columbae* predominated the nematode species i.e. 18 and 15%, respectively. The incidence was higher in wild pigeons.

Comparative efficacy of anthelmintics against gastro-intestinal parasites of buffalo calves and their effects on blood parameters
Humayun, T., 1995. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

Coprological examination revealed *Toxocara vitulorum* (412.22%) as single infection and 31.11% as mixed infection. *Strongyloides papillosus* as 21.11% as single infection and 20% mixed infection. *Nematodirus* spp. 1.11% as single. *Haemonchus* spp., 2.22% as single and 1.11% mixed infection and *Moniezia* spp. 3% as single. Intensity of infection of gastro-intestinal parasites in buffalo calves was determined as 41.1% of calves upto 500 eggs per gm of faeces, in 22.22% calves from 501 to 1000 epg, in 16.66% calves from 1001 to 1500 epg and in 20% calves greater than 1500 epg of faeces. Oxfendazole and Albendazole, both the anthelmintics were 100% effective on day 14 post treatment. Coprological examination revealed *Eimeria* spp., in 21% animals as single and 13.33% as mixed infection.

A comparative study of helminth and haemoparasites of domestic and wild pigeons
Hussain, A., 1995. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present work was planned for the comparative study of helminths and haemoparasites of domestic and wild pigeons. For this purpose, 300 each of guts and blood smears were studied. The two species of blood protozoa recovered were: *Aegyptianella pullorum* and *Haemoproteus columbae. Aegyptianella pullorum* was more common blood protozoan i.e. 22 and 11%, respectively in wild and domestic pigeons. The incidence of *Haemoproteus columbae* was 9 and 11%, respectively.

Evaluation of vaccines against ticks developed from different parts of ticks
Akhtar, M., 1996. *Ph.D. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

Studies were conducted to establish optimum conditions for the laboratory rearing of ticks, *in vitro* propagation of midgut cells; and determination of immunogenic and protective effects of whole tick, midgut, midgut cell culture, protein and lipopolysaccharides subunit vaccines against *Boophilus (B) microplus*. *B. microplus* were reared in the laboratory. Larvae, nymphs and adults were successfully fed on rabbits. The optimum temperature and relative humidity for maintaining different developmental stages of the tick were 30-35^{o}C and 80-90 %, respectively. The total number of eggs laid and blood sucked by a single female tick ranged from 1800-2600 and 165 µL, respectively. Midgut cells of *B. microplus* were grown successfully on cell culture media. The best growth was seen on Grace's insect medium at 28^{o}C. Media supplemented with five percent foetal calf serum gave better growth compared with that without serum. The number of cells per mL in serum supplemented cultures was 2.5 x 10^{7}, 2.0 x 10^{7} and 1.9 x 10^{7} for Grace's insect, Minimum essential and RPMI-1640 media, respectively. However, viability of cells was reduced by 4-6 % in serum supplemented culture. It was observed that growth was observed after 12-15 hours at 28^{o}C but there was no inconvenience of frequent change of the medium. Addition of antibiotics and fungizone did not affect the growth of cultures. The viable midgut cells adhered to the flask's surface and started proliferating after 4-87 hours of cultivation. Microscopic observations of cultures revealed small, rounded, flattened and epithelial like cells. The cells gradually died after 12 hours of cultivation.

All the vaccines were evaluated on the basis of cellular, humoral and challenge responses. There was a

significant difference (P<0.05) in cellular response among all vaccines, best being to lipopolysaccharides complex subunit (LPCS) followed by protein subunit (PS), midgut cell culture (MGCC), midgut (MG), whole tick supernatant plus pellet (WTSP), whole tick pellet (WTP), and whole tick supernatant (WTS). Significantly higher (P<0.05) humoral response was also recorded in LPCS, PS and MGCC compared to WTSP, WTP and WTS. However, the response to MG was similar to MGCC; and WTSP to WTP as indicated by IHA and/or SRH, respectively. The boosting dose of all vaccines significantly increased (P<0.05) both cellular and humoral responses. The results of the humoral and cellular responses were consistent with the challenge response.

It was observed that all the vaccines were effective in protecting buffaloes from *B. microplus*. The level of protection, however, varied from lower to higher from crude to subunit vaccines. The results of the current study confirm the role of carbohydrates as protective antigen or as a factor for specificity of these antigen. The best protection against *B. microplus* was provided by LPCS followed by PS, MGCC, MG, WTSP, WTP and WTS. The vaccines with adjuvant gave significantly higher (P<0.05) cellular, humoral and challenge responses compared to those without adjuvant.

The effects of piroplasmosis on hematology in equines
Salva, 1996. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The present study wad conducted to find out the effect of natural piroplasmosis on various blood parameters of equines. A total of forty horses (Group A including 20 uninfected horses and Group B included 20 horses showing clinical symptoms of the disease and confirmed positive for piroplasmosis through blood examination were used in the study. Haematological examination revealed a significant decrease (P<0.05) in the erythrocyte count, hemoglobin level and packed cell volume of the infected horses. Normocytic and hypochromic type of anemia was observed. Total leukocyte count was also decreased. A decrease in the number of neutrophils, eosinophils, basophils, monocytes and lymphocytes was also observed in the infected horses. Out of the 20 infected horses, 4 had *P. equi* and 16 had *B. caballi* infection.

A study of gastro-intestinal parasitism and haematological disturbances associated with single or multiple infection in sheep
Hafeez, M., 1996. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A study of gastro-intestinal parasitism with isolation and identification of the parasite species affecting sheep at different age groups in and around Lahore was conducted. For this purpose, 200 G.I. tracts of sheep (100 each from below six months and above six months of age) were collected from Lahore Metropolitan Corporation, Abattoir. The overall incidence of gastro-intestinal parasitism in sheep was found to be 68.5%. Age wise incidence was found to be 71% and 66% in sheep below and above six months of age, respectively. The sporozoans were recorded in 51% animals. The following species of parasites were recorded: *Eimeria arloingi, E. ninakohlyakimovae, E. parva, E. intricata* and *E. faurei.*

Taxonomy and prevalence of *Eimeria* species infecting young buffalo and cattle calves and their effect on various blood components
Afzal, M., 1996. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

This study was contemplated to evaluate some aspects of prevalent species including taxonomy of *Eimeria* infections in young cattle and buffalo calves. In addition, the effects of *Eimeria* infections on various haematological parameters were also studied. For this purpose, the animals (Buffaloe and Cattle calves) were divided into two groups. Firstly those having diarrhoea and secondly those which were apparently healthy. The buffalo and cattle calves were divided into four groups (A, B, C and D) on the basis of the age in days under the maximum age of 120 days. A group ranged from 1-30 days, B ranged 31-60 days, C ranged 61-90 and D ranged 91-120 days. The haematological observations were recorded

from both the groups formulated upon the basis of age as A, B, C and D in both cattle and buffalo group A, B, C and D having the same age range. Results revealed that out of 816 animals (442 cattle and 374 buffalo calves), 167 (84 cattle and 83 buffalo calves) were found to be positive (20.46%) for *Eimeria* species infection. Whereas, 62 out of 250 (24.80%) suffering from diarrhoea and 22 out of 192 (11%) apparently healthy cattle calves showed coccidial infections. For buffaloes, 63 out of 220 cases (29%) were positive from animals showing diarrhoea and 20 out of 154 (13%) were found positive for coccidiosis from apparently healthy group. Four species of *Eimeria* namely, *Eimeria zuernii, E. bovis, E. cylindrica* and *E. ellipsoidalis* were found in the above mentioned calves. *E.zuernii* was the most prevalent species found (48%) followed by *E. bovis* (27%), *E. cylindrica* (16%) and *E. ellipsoidalis* (10%), respectively. Ova counts per gram of faeces carried out ranged from 500-70,000 oocyst per gram of faeces. Haematological observations showed anaemia, which was a feature of the diarrhoeic calves and not found in apparently healthy animals although some of them had been harbouring *Eimeria* infection. The PCV decreased proportionately with haemoglobin; whereas, erythrocyte count also showed decrease in positive cases. On the other hand, ESR of the above referred calves increased. There was neutrophilia in the infected animals versus control animals and lymphocytes decreased in infected animals. There was no significant change in eosinophil and monocyte counts.

Studies on the incidence, taxonomy and seats of predilection of various species of paramphistomes in buffaloes
Zar, M.A., 1996. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

The incidence, taxonomy and seat of predilection of various species of Paramphistomes were determined in buffaloes (n=500). During the examination, 192 animals were found infested with paramphistomes. The overall incidence was 38.4%. The incidence of Paramphistomes in rumen was the highest (38.4%) while the lowest in the gall bladder (0.2%). The flukes were recovered from rumen, reticulum, abomasum, duodenum caecum, colon, bile ducts and gall bladder. The species identified were *Paramphistomum cervi* (55.0%), *Cotylophoron cotylophoron* (27.0%), *Gastrothylax crumenifer* (15.0%) and *Gigantocotyle explanatum* (3.0%).

A study on the epidemiological aspects of fascioliasis in buffaloes in Lahore district
Sahar, R., 1996. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

The study was designed to find the prevalence and intensity of liver fluke infection in buffaloes in Lahore District. The data were collected from four Veterinary Hospitals in Lahore District namely Herbenspura, R.A. Bazar, Shamkey Bhattiana and Rukh Chandra. A total of 2184 buffaloes were treated for different diseases in these hospitals. Based on history, clinical symptoms and response to treatment, 229 (10.48%) buffaloes were positive for fascioliasis. Information collected from Municipal Corporation, Lahore abattoirs regarding economic losses revealed that one hundred eight million rupees were lost annually due to damage and condemnation of liver fluke infected livers. Two hundred faecal samples collected directly from the rectum of buffaloes from various localities at Lahore were examined microscopically by fresh smear and sedimentation methods, which revealed that 75 (37.5%) buffaloes were suffering from fascioliasis. In order to determine the intensity of fascioliasis in infected animals, quantitative faecal examination was done (and it ranged from 32.6 to 45.6 EPG indicating that the disease is likely to be pathogenic). Overall liver fluke infection was recorded by examining 40 livers along with their bile ducts collected from slaughtered buffaloes and it was found that 16 (40%) had liver fluke infection. Identification of liver flukes from the infected livers revealed that 8(50%) had mixed infection of *Fasciola hepatica* and *F. gigantica*, 5(31.25%) had only *F. gigantica* infection; while 3 (18.75%) had only *F. hepatica* infection.

A study of gastro-intestinal parasitism and haematological disturbances associated with single or multiple infection in sheep
Hafeez, M., 1996. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

A study of gastro-intestinal parasitism with isolation and identification of the parasite species affecting sheep at different age groups in and around Lahore was conducted. For this purpose, 200 G.I. tracts of sheep (100 each from below six months and above six months of age) were collected from Lahore Metropolitan Corporation, Abattoir. The overall incidence of gastro-intestinal parasitism in sheep was found to be 68.5%. Age wise incidence was found to be 71% and 66% in sheep below and above six months of age, respectively. Class wise overall incidence was found to be sporozoan (51%), trematodes (21%), cestodes (62%) and nematodes (68%). The prevalence was higher in the month of August and lowest in the month of October. The following species of parasites were recorded: *Paramphistomum cervi, Cotylophoron cotylophoron, Moniezia expansa, M. benedeni, Avitellina centripunctata, Haemonchus contortus, Oesophagostomum columbianum, O. venulosum, Trichuris ovis, Ostertagia circumcincta, O. ostertagi, Chabertia ovina, Trichostrongylus colubriformis* and *Nematodirus spathiger.* There was decrease in haemoglobin, total erythrocytic count, packed cell volume, total leukocytic count and increase in erythrocyte sedimentation rate in both sheep below and above six months of age under the effect of single or multiple gastro-intestinal parasitism. The values of differential leukocytic count were variable in both the age groups.

Taxonomical study of trematode infections and their effect on blood picture in sheep and goats
Hameed, S., 1996. *M.Sc. Thesis,* College of Veterinary Sciences, Lahore

In the present study, 200 each sheep goats both above one and below one year age were examined after their slaughtering at abattoirs of Lahore for the presence of gastrointestinal trematodes. Three species of trematodes i.e. *Paramphistomum cervi*, *Fasciola hepatica* and *Dicrocoleium dendriticum* were recorded. It was observed that the infection increased gradually and reached peak in the month of July and then declined. An overall incidence of 64.25% of trematodes was recorded in both the species. The parasitic incidence was as *P. cervi* 2.75%, *F. hepatica* (29.75%) and *D. dendriticum* (10.75). The rate of infection was on the peak in the month of July in *P. cervi, F. hepatica* and *D. dendriticum*. The hematological values of sheep and goats infected with trematodes were total Erythrocytic count 12.013±0.096 million/cubic microliter, Haemoglobin level 8.037±0.242 mm/24 hours and total Erythrocytic count 10.973±0.094 mm/24 hour, respectively for sheep and goats. It was observed that the infection with trematode had an adverse effect on total erythrocyte count, haemoglobin level and packed cell volume.

Prevalence and taxonomy of gastrointestinal helminths of sheep
Sajid, M.S., 1999. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad–38040, Pakistan

The present study was conducted to get an explicit picture of the gastrointestinal helminth infections in sheep based on the taxonomy of the worms and also to know the seasonal trends of their prevalence in Faisalabad. A total of 500 gastrointestinal tracts of sheep were collected at random from Faisalabad abattoir in one year. A total of 376 (75.2%), 240 (48%) and 135 (27%) gastrointestinal tracts were found positive for nematodes, trematodes and cestodes, respectively. The species of nematodes identified included *Haemonchus (H.) contortus* (68%), *Trichostrongylus (T.) colubriformis* (42.2%), *Trichiuris (Tr.) ovis* (36.4%), *T. axei* (34.8%), *Oesophagostomum (Oe.) columbianum* (22%), *Tr. globulosa* (21.6%), *Ostertagia (O.) circumcincta* (18%), *O. trifurcata* (14.4%), *Bunostomum (B.) trigonocephalum* (13%) and *Oe. venulosum* (7.4%). The species of trematodes identified included: *Paramphistomum (P.) cervi* (18%), *P. explanatum* (10%), *Cotylophoron (C.) cotylophoron, Dicrocoelium (D.) dendriticum, Fasciola (F.) hepatica* and *F. gigantica. P. cervi* was the highest (18%) in prevalence followed by *Cotylophoron cotylophoron* (12%), *Paramphistomum explanatum* and *Fasciola hepatica* (10%), *Dicrocoelium dendriticum* (8%) and *Fasciola gigantica* (7%). One hundred and thirty five (27%; 135/500) gastrointestinal tracts were found positive for one or the other cestode species. The species of cestodes identified included *Moniezia expansa* (13%), *Moniezia benedeni* (8%) and *Avitellina centripunctata* (10%). The highest and lowest prevalence of *H. contortus*, *T. colubriformis, Tr. ovis, T. axei, O.*

circumcincta, Tr. globulosa, Oe. columbianum, O. trifurcata, B. trigonocephalum and *Oe. venulosum* was in the months of July (92.9%) and January (26.7%); December (65.2%) and June (26.2%) ; July (76.2%) and February (5.0%); December (50.0%) and March (21.4%) ; August (50.0%) and February (7.5%); August (36.8%) and May (12.0%); November (31.0%) and May (14.0%); September (25.0%) and April (5.0%); September (17.5%) and April (7.5%); and August (13.2%) and February (2.5%), respectively. The highest and lowest prevalence of *P. cervi, P. explanatum, C. cotylophoron, D. dendriticum, F. hepatica* and *F. gigantica* was in the months of September (32.5%) and May (10%); August (24.9%) and June (4.2%) ; September (20%) and January (6.7%); August (20.1%) and January (0%) ; September (20%) and June (2.1%); and August (14.2%) and January (0%), respectively. The highest and lowest prevalence of *M. expansa, M. benedeni* and *A. centripunctata* was in the months of January (26.7%) and May (2%); November (14.4%) and May (2%); and January (16.8%) and May (4%). The highest and lowest prevalence of parasites was recorded in the animals < 1 year and > 2 years of age, respectively for nematodes; whereas, *vice versa* for trematodes and cestodes. The data on sex-wise prevalence revealed highest and lowest rate of infection in females and males, respectively for all types of helminths.

Effect of some chemical and biological agents on development and survival of *Haemonchus contortus* eggs and larvae

Munir, M.A., 1999. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad

Effect of urea, NaCl, $CaCO_3$, sorghum, bakain and biocontrol on hatching, moulting and survival of eggs and larvae of *Haemonchus contortus* was studied. In 2.5% concentrations, the egg hatching was observed on day 2 post-treatment (PT) when L1 were identified from the culture aliquots. The percentage of hatched L1 was, however, much lower in urea treated groups compared with control (70%) on day 2 PT. No hatching of *Haemonchus* eggs took place on higher concentrations i.e. 5.0, 7.5 and 10.0%. L2 and L3 started appearing in cultures from day 4 and 6 PT, respectively; whereas, in control L2 and L3 started appearing in cultures from day 2 and 4 PT, respectively. It was found that urea in addition to causing reduction in the number of hatched eggs, also delayed hatching of eggs and moulting from L2 to L3. This conclusion was further strengthened when hatching of the eggs was totally stopped in higher concentrations of urea. The eggs of *H. contortus* hatched to L1, L2 and L3 in 2.5% urea solution. However, the % hatching and subsequent moulting to L2 and L3 was lower as compared to control. It was found that only 6.4% eggs hatched and consequently developed to L3 by day 8 PT compared with 49.2% in control group. There was no hatching of the eggs on 5, 7.5 and 10% urea concentrations as observed for a period of eight days after treatment. The egg hatching as evident from presence of L1 in cultures started from day 2 PT at all concentrations of NaCl. However, there was a gradual decrease in hatching with increasing concentrations of NaCl and the total number of eggs hatched was lower in treated groups compared with control. These findings suggested adverse effects of increasing salinity on hatching as well as moulting of larvae. The eggs of *H. contortus* hatched to L1, L2 and L3 in 2.5, 5.0, 7.5 and 10% NaCl solution. However, the % hatching and subsequent moulting to L2 and L3 was lower as compared to control. It was found that 8.4, 6.4, 4.2 and 4.2% eggs hatched and consequently developed to L3 by day 6-8 PT compared with 43.8, 43.0, 36.4 and 43.0% in control group in 2.5, 5.0, 7.5 and 10.0% NaCl concentrations, respectively. Lower percentage (7.8%) of eggs hatched in $CaCO_3$ solutions compared with the control (72.4%) on day 2 PT. Moreover, hatching was also delayed due to $CaCO_3$ effects as indicated by the presence of higher number of unhatched eggs in cultures compared with control on day 4 PT. In 2.5% concentrations, the egg hatching was observed on day 2 PT when L1 were identified from the culture aliquots. The percentage of hatched L1 was, however, much lower in urea treated groups compared with control (70%) on day 2 PT. Rare eggs hatched to L1 in 10.0% $CaCO_3$ concentrations. This indicated destructive effects of $CaCO_3$ on eggs and larvae of *H. contortus*. The eggs of *H. contortus* hatched to L1, L2 and L3 in 2.5% $CaCO_3$ solution. However, the % hatching and subsequent moulting to L2 and L3 was lower (4.8%) as compared to control (47.2%). In 5.0% $CaCO_3$ concentrations, however, only 4.4% L2 were found and only rare L3 were recorded. Likwise, in 7.5 and 10% $CaCO_3$ rare eggs hatched and developed to L3 by day 8 PT in contrast to the hatching and development in control groups which ranged from 45.0 to 48.6% in control groups. The hatching of eggs was delayed in bakain treated

cultures compared with control. L1 were found in cultures on day 4 PT, whereas in control L1 were found on day 2 PT. Only rare L3 were found on day 6 and 8 PT in bakain treated cultures compared with 48.0% L3 in control groups. Hatching of eggs, although low numerically, started on day 2 PT in both sorghum treated (5.8%) and control (69.8%) groups. However, only rare L1 moulted to L3 in contrast to control where 45% eggs developed to L3. The cultures treated with bio-control remained almost unaffected and a slight delay in hatching of the eggs and reduction in the percentage of L1, L2 and L3 was noted compared with control. The % of L3 on day 8 PT was 39.2 and 45.0% on in bio-control treated and control groups.

Epidemiology and chemotherapy of fascioliasis in buffaloes and cattle
Maqbool, A., 2000. *Ph.D. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad–38040, Pakistan)

An epidemiological study of fascioliasis in buffaloes and cattle and its chemotherapy with different indigenous drugs was conducted during January 1996 to December 1996. The results are presented in four parts. Part 1 deals with the monthwise, seasonal, age and sex wise prevalence of fascioliasis in buffaloes and cattle in slaughtered animals, at livestock farm, household animals and in various veterinary hospitals of different districts of the Punjab province. The prevalence was the highest at farms followed by slaughtered animals, veterinary hospitals and the lowest in household animals. The prevalence was higher in older animals than youngsters. Sex had no bearing effect on the prevalence of disease. Animals of both sex are nearly equally affected. The prevalence was the highest at Gujranwala, Jhang and while it was lowest at Faisalabad. The highest prevalence was noted during autumn followed by spring then winter and the lowest during summer. Higher prevalence was reported in buffaloes than cattle. Part II deals with the prevalence of various genera of snails in different districts of Punjab. The snails of seven genera including *Lymnaea, Indoplanorbis, Bulinus, Physa, Gyraulus, Bellamaya* and *Oncomelonia* were identified. Their highest prevalence was recorded at Gujranwala followed by Lahore, Sheikhupura, Sargodha, Jhang and Faisalabad. *Lymnaea* snails were more prevalent and were responsible for the transmission of fascioliasis. Their prevalence was the highest during summer followed by autumn, winter and the lowest during spring. Their prevalence was highest at Gujranwala followed by Lahore, Sheikhupura, Sargodha and Faisalabad. Part III deals with meterological data including temperature, relative humidity and rainfall. It was noted that an optimal temperature ranged from 15-25°C where significant multiplication of snails and fluke larval stage were ensured. Relative humidty from 50-65% was found to be favourable. Rainfall during summer months helps the miracidia for searching of snails and for dispersal of cercariae shed from snails. Part IV deals with chemotherapeutic trials by using *Nigella sativa, Fumaria parviflora, Caesalpinia crista, Saussurea lappa* and triclabendazole (treated control group). All these drugs were effective at one dose level and highly effective at two dose levels. Among herbal drugs *Fumaria parviflora* at dose rate of 60 mg/kg body weight was equally effective as that of triclabendazole. This drug was much cheaper than triclabendazole and other allopathic drugs.

Humoral response of chicken against sonicated coccidial oocysts
Sultan, A., 2000. *M.Sc. Thesis,* Department of Veterinary Parasitology, University of Agriculture, Faisalabad

Humoral immune response of Vaccine-I (supernatant from sonicated sporulated oocyst) Vaccine-II (sediment from sonicated sporulated oocyst) and Vaccine-III (un-sonicated sporulated oocyst) against coccidiosis in chickens was determined by indirect haemagglutination (IHA) test. IHA antibody titre was significantly higher ($P<0.05$) in chicks vaccinated with Vaccine-I as compare to Vaccine-II and Vaccine-III.The IHA antibody titre of chicks vaccinated with Vaccine-I ranged from 1:8 to 1:8192, 1:16 to 1:512 for Vaccine II and 1:2 to 1:64 for Vaccine III. Vaccine I gave 100 per cent protection and oocysts appeared in the faeces (100-200 per gram) on day 10 post challenge which gradually increased (600-900 per gram) on day 16 and 200-400 on day 20 post challenge. Vaccine II gave 60 per cent protection and oocyst appeared in the faeces (3,50,000-4,50,000 per gram) on day 8 post challenge which gradually increased (700,000-900,000 per gram) on day 16 and 100,000-200,000 on day 20 post challenge. Vaccine III gave

30 per cent protection and oocyst appeared in the faeces (8,50,000-9,00,000 per gram) on day 7 post challenge which gradually increased (11,400,000-12,00,000 per gram) on day 16 and 840,000-900,000 on day 20 post challenge. In control group, characteristic bloody diarrhoea was observed in all the chicks and oocysts appeared in the faeces (10,00,000-12,50,000 per gram) on day 5 post challenge of faeces which gradually increased (15,00,000-17,50,000 per gram) on day 16 post challenge. Results of the humoral and challenge response indicated that the Vaccine I induced a strong protection as immune chicks contained high level of antibodies that resisted heavy dose of challenge and gave 100% protection.

Cell mediated immune response of chicken against sonicated coccidial oocyst
Khan, M.A., 2000. *M.Sc. Thesis,* Department of Veterinary Parasitology, University of Agriculture, Faisalabad

Vaccine(s) against avian coccidiosis from the local strains of coccidia was prepared. Supernatant sonicated (Vaccine-I), sediment sonicated (Vaccine-II) and non sonicated (Vaccine-III) vaccines were prepared from the sporulated oocyst of coccidia. These vaccines were evaluated on the basis of cellular and challenge responses. Splenic cell migration inhibition tests with modifications was used to detect the cell mediated immunity. The migration of the splenic cells from chickens immunized with Vaccine I and Vaccine II were inhibited remarkably with antigen and there was a significant difference ($P<0.05$) in migration distance of the splenic cells with and without antigen. The mean migration index was 47.5 and 64.1%, respectively. The migration of the splenic cells from immunized chickens with Vaccine III and control group injected with phosphate buffered saline were not inhibited with antigen; although there was a significant difference ($P<0.05$) in migration distance of the splenic cells with and without antigen. The mean migration index was 74.00 and 83.9%, respectively. Vaccine-I gave maximum protection (100%) followed by Vaccine-II (60%) and Vaccine-III (30%) to the challenge. Results of the cell mediated immunity and challenge response indicate that the Vaccine I induced a strong cell mediated immune response as immune chicks resisted the heavy dose of challenge and gave 100 per cent protection.

Bajwa, A.M., M.Sc. thesis, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

Urea, sodium chloride, calcium carbonate, bakain and sorghum solutions delayed hatching and development of eggs of Haemonchus contortus at lower concentrations and proved lethal at higher (>5-10 %) concentrations. The chemicals mentioned above may be used on farm premises or on pastures in 5-10 % concentrations for the control of Haemonchosis. Further studies are suggested for standardization of doses and mode of application of these agents. Bio-control (EM technology; effective micro-organisms) is not effective against Haemonchus contortus.

Evaluation of Anthelmintic Activity of Some Plant Materials in Sheep
Nadeem, Q.K., 2000. *M.Sc. thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The study was conducted to see the parasitism at University Livestock Farm and to find out the anthelmintic activity of indigenous plants including *Zingiber oficinale* (Ginger), *Allium Sativa* (Lehsan),*Ficus religiosa* (Pipal)and *cucurbata mexicana* (Kaddu)and there comparison with each other and with Oxfendazol. A total of 50 samples were examined of these 45 were found for mixed parasitic infection.It was indicated that anthelmintic activity of *Zingiber oficinale* at two different dose level e:g one gram and two gram /Kg body weight was 79% and 98% effective at single dose level. *Allium Sativa* at a dose level of one gram/Kg body weight was 60% and at a dose rate of two gram/Kg body weight was 85%. Where as *Ficus religiosa* at a dose rate of one gram and two gram/Kg body weight was not satisfactory. Similarly *cucurbata mexicana* at a single dose level of one gram/Kg body weight and two gram/Kg body weight did not cause significant EPG reduction. Oxfendazol at the recommended dose one ml/5Kg body weight was 95% effective. Briefly it is concluded that *Zingeber Oficinale* and *Allium Sativa* at

a dose rate of two gram/Kg body weight is equally effective to that of Oxfendazol and being very cheaper and economical can be replaced with Oxfendazol in controlling parasitic infestation in sheep and goat.

Studies on the prevalence, economic losses and chemotherapy of tick infestation on commercial layers
Khan, L.A., 2001, M.Sc. thesis, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

Studies have been conducted to investigate the prevalence, economic losses and `chemotherapy of tick infestation on commercial layers in Faisalabad district. Twelve thousand birds from three Tehsils of Faisalabad 4.000 each reexamined to investigate the prevalence of ticks by making permanent mounts. Economic losses of the tick infestation based on the blood sucked by ticks were determined at country level in terms of rupees. comparative acaricidal efficacy of three chemicals I.e. cypermethrin , ivermectin and trichlorphon along with 20 and 40 per cent leaves extract of a traditional medicinal plant azadirachta indica neem was evaluated against argas persicus in 500 commercial layers. For the determination of the longevity of he effect of different acaricides, the number of ticks were counted on all the birds before treatment and on day 1,7,14,21, and 28 post treatment to determine he per cent control. The overall prevalence of tick infestation was recorded was recorded as 14.7 /1771/12000/ percent in district Faisalabad. The higher rate of tick infestation was recorded in tehsil samundri 23.5%, followed by Tehsil Jaranwala (12.5%) and tehsil Faisalabad 8.2 only one species of argasid tick , argas persicus , was identified from the infested layers of all the three Tehsils of district Faisalabad . A single tick of argas persicus can suck about 18.75 mgs of blood daily from poultry. On the basis of this amount of blood and present total population f commercial layers in the country, a loss of Rs.21,26559 annually has been estimated. The best control achieved was 86.85 per cent by cypermethrin treated birds against argas persicus infestation followed by ivermectin 82.96% 46% azadirachta indica (51.89%) and trichlorphon (27.54%).

Trichostrongylid Nematodes of Sheep: Epidemiological Aspects and Evaluation of Anthelmintic Activity of Indigenous Plants
Lateef, M., 2002. *Ph.D. thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The present research was conducted to evaluate the anthelmintic activity of some indigenous plants/plant materials being currently used in the ethno-veterinary medicinal system of Pakistan. For this purpose, a total of 41 plants were tested *in vitro* and out of them 10 plants were subjected to *in vivo* studies. All the plant materials were procured from local market (Faisalabad, Pakistan), identified and authenticated by a botanist in the Department of Botany, University of Agriculture, Faisalabad–Pakistan. The materials were dried in shade, ground finally in powder in electric grinder, and stored in cellophane bags at 4°C until use. The aqueous and methanol extracts of the plants were used for *in vitro* studies on *Haemonchus contortus*. The motility/survival of the worms was selected as the criteria for the anthelmintic activity. Six out of 41 plants showed *in vitro* anthelmintic activity in their aqueous extracts. These plants were *Anethum graveolens, Croton tiglium, Cucurbita pepo, Geranium wallichianum, Lens culinaris* and *Phoenix dactylifera.* Likewise, methanol extracts of 13 out of 41 plants exhibited *in vitro* anthelmintic activity. These plants were *Acacia catechu, Allium cepa, Artemisia brevifolia, Balsamodendron mukaul, Brassica nigra, Carum bulbocastaanum, Codria myxa, Leucaena leucocephala, Pimpinella anisum, Terminalia belerica, Terminalia chebula, Vernonia anthelmintica* and *Ziziphus jujube.* Nineteen out of 41 plants exhibited *in vitro* anthelmintic activity both in aqueous and methanol extracts. These plants included *Acacia arabica, Adhatoda vesica, Allium sativa, Areca catechu, Azadirachta indica, Butea monosperma, Calotropis gigantea, Carum copticum, Curcuma longa, Eremostachys vicaryi, Ferula feotida, Mangifera indica, Melia azedarach, Morus indica, Nicotiana tabacum, Sorghum bicolor, Swertia chirata, Tamarindus indica* and *Zingiber officinale.* Three plants viz., *Ficus bengalensis, Ficus religiosa* and *Tridulus terrestris* did not exhibit anthelmintic effects in any form. Levamisole (positive control) was 100% effective.

For *in vivo* studies on sheep naturally infected with mixed gastrointestinal nematode species including *Haemonchus contortus, Trichostrongylus colubriformis, T. axei, Oesophagostomum columbianum, Strongyloides papillosus* and *Trichuris ovis,* 10 plants were selected. These included *Adhatoda vesica, Artemisia brevifolia, Butea monosperma, Calotropis gigantea, Carum copticum, Azadirachta indica, Nicotiana tabacum, Swertia chirata, Vernonia anthelmintica* and *Zingiber officinale.* All these plants were found to possess varying anthelmintic activity. This activity also varied in the form of plants used, i.e., crude powder, crude aqueous extract, methanol extract. The top 29 plants/forms at different doses (Fig. 11) in order of increasing activity were *Artemisia brevifolia* CME3 (12.7%), *Azadirachta indica* CAE2 (16.6%), *Calotropis gigantea* CME2 (20.9%), *Butea monosperma* CME3 (23.2%), *Zingiber officinale* CME2 (23.6%), *Zingiber officinale* CP3 (25.6%), *Adhatoda vesica* CME3 (25.6%), *Azadirachta indica* CP3 (29.3%), *Adhatoda vesica* CP2 (33.1%), *Swertia chirata* CAE3 (34.0%), *Butea monosperma* CAE3 (34.5%), *Adhatoda vesica* CAE3 (37.4%), *Azadirachta indica* CME3 (40.2%), *Nicotiana tabacum* CAE3 (49.4%), *Carum copticum* CAE3 (53.3%), *Vernonia anthelmintica* CP3 (56.9%), *Nicotiana tabacum* CP3 (58.3%), *Swertia chirata* CP3 (59.0%), *Vernonia anthelmintica* CME2 (60.2%), *Swertia chirata* CME3 (61.0%), *Artemisia brevifolia* CP3 (62.1%), *Zingiber officinale* CAE3 (66.6%), *Artemisia brevifolia* CAE3 (67.2%), *Calotropis gigantea* CP3 (77.8%), *Carum copticum* CP3 (78.1%), *Butea monosperma* CP3 (80.7%) and *Calotropis gigantea* CAE3 (88.4%). There were no observed untoward effects of any plant or the form of drug used.

Influence of Age, Space per Bird and Litter Change Frequency on Lice Infestation on Layers of District Faisalabad

Nadeem, M., 2002. *M.Sc. Thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The study was planned to determine the propagation of lice infestation, taxonomy, control practices and some other parameters like age of the birds, seasonal fluctuation, space availability, frequency of litter change and egg production. For this purpose 50 commercial layer farms examined properly during September 2001 – August 2002 in and around the Faisalabad City. The collected specimens were preserved, stained and identified after preparing permanent mounts under the stereoscopic microscope in the epidemiology laboratory. The species of lice identified from the farms were: *Menacanthus stramineus, lipeurus caponis*, *Goniodes dissimilis* and *Goniocotes gallinae*. The overall flock incidence of lice infestation was 20 % per annum. The most prevalent species was *Lipeurus caponis* (10 %), followed by *Menacanthus stramineus* (6.0 %). The mixed infection of *G. dissimilis* and *L. caponis* (2.0 %) and *G. gallinae* and *M. Stramineus* (2.0 %) were recorded. The infestation recorded was highest during May 2002 to August 2002 and having a minimum temperature of 27.8 °C with a maximum temperature of 40.7 °C and humidity range of 50.2 – 63.0 %. Suggested that hot season contributes a major role in the propagation of lice infestation. Lice infestation was dominant in older birds 36 – 74 weeks than the groups lower than 36 weeks. Less space availability and poor frequency of litter change plays important role in the lice infestation. The infested flocks dropped in egg production. In the control practices of lice infestation permethrin, trichlorphon and cypermethrin gave satisfactory results. The results of present study will help in planning better control measures in order to minimize lice infestation.

Studies on Epidemiology, Economic Significance and Chemotherapy of Hypodermosis in Cattle and Buffaloes

Anwar, M., 2003. *Ph.D. thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The present studies were conducted on the epidemiology, economic significance and chemotherapy of hypodermosis in cattle and buffaloes at Dera Ghazi Khan and Rajanpur districts (Pakistan). Studies included assessment of prevalence of hypodermosis in the field and in slaughter houses. The second part of the study comprised of estimation of economic losses incurred by the leather industry as a result of

downgrading of hides with holes due to presence of warbles. The last part of the study comprised of chemotherapy of hypodermosis. The prevalence of hypodermosis in cattle examined in slaughter houses at Dera Ghazi Khan and Rajanpur districts was recorded as 51.00 and 48.22 per cent respectively and in buffaloes the prevalence was recorded as 8.13 and 7.64 per cent respectively. Prevalence of hypodermosis in cattle examined in the field in Dera Ghazi Khan and Rajanpur districts was recorded as 28.91 and 26.15 per cent, respectively. In buffaloes the prevalence remained 5.11 and 4.40 percent respectively. Investigations on the estimation of economic losses based on the infested hides were carried out at Dera Ghazi Khan and Rajanpur districts. Twenty hide merchants in different areas were interrogated to find out the prices of warbled and warble free hides. This price index was used to estimate the economic losses in terms of rupees. The economic losses due to warbles in cattle hides in both Dera Ghazi Khan and Rajanpur districts was estimated as Rs.20.6 m and due to buffaloe affected hides the losses were estimated as Rs.2.2 m. The total losses due to affected hides of cattle and buffaloes were estimated as Rs.22.8 m. Chemotherapeutic trial of two insecticidal drugs viz Ivermectin and Cypermethrin was carried out to evaluate their efficacy against hypodermosis in cattle and buffaloes. Ivermectin was found to be 100 per cent and Cypermethrin 98.27 per cent effective for the control of hypodermosis.

Prevalence and Chemotherapy of Lice Infestation in Cattle and Buffaloes of District Faisalabad
Hussain, M.A., 2003. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The present study was conducted to find out the prevalence and chemotherapeutic control of lice infestation on cattle and buffaloes in and around Faisalabad. An overall prevalence of lice was recorded as 24.00 per cent on cattle and 18.83 per cent on buffaloes. It is apparent from these results that relatively higher prevalence of lice infestation was recorded on cattle than buffaloes. Prevalence of lice on cattle was recorded in different areas of Faisalabad. It was recorded as 21.42 per cent in Faisalabad, 24.44 per cent in Jaranwala, 20.00 per cent in Chak Jhumra and 28.00 per cent in Jhang. The highest rate of lice infestation was recorded in Jhang (28%) and the lowest in Chak Jhumra (20%). Similarly prevalence of lice on buffaloes was also recorded in different areas of Faisalabad. It was recorded as 18.57 per cent in Faisalabad, 17.14 per cent in Jaranwala, 16.92 per cent in Chak Jhumra and 21.57 per cent in Jhang. The highest rate of lice infestation was recorded as in Jhang (21.57%) and the lowest in Chak Jhumra (16.92%). The prevalence of lice on the basis of animal species was recorded as highest (24%) in cattle and lowest (18.83%) in buffaloes. The breed wise prevalence of lice was recorded highest (27.33%) in Friesian and lowest (22.18%) in Sahiwal cattle. Whereas in Nili-Ravi buffaloes the prevalence of lice was recorded highest (18.83%) and lowest (17.33%) in Kundi buffaloes.
The age wise prevalence of lice was recorded highest (25%) in adult cattle and lowest (22.5%) in aged cattle. Similarly age wise prevalence of lice was recorded as highest (24.5%) in adult buffaloes and lowest (14.5%) in aged buffaloes. The prevalence of lice based on house type was recorded highest (31.33%) in close, mud plastered housing type in cattle and lowest (16.66%) in open type, cement plastered in cattle. Similarly prevalence of lice was recorded highest (24%) in buffaloes of close type, mud plastered and lowest (13.33%) of opened type and 14 per cent of cement plastered. Month wise prevalence of cattle lice was recorded highest (94%) during the month of March, 2003 and lowest (20%) during the month of August, 2002. Similarly in case of buffaloes, the highest prevalence (84%) was recorded during the month of April, 2003 and lowest (12%) during the month of September, 2002. Different species of lice were identified on the basis of their morphological characters. Three types of sucking lice were identified viz, *Haematopinus eurysternus, Haematopinus tuberculatus and Linognathus vituli.* Two drugs were used for the control of lice infestation. Ivermectin was best acaricide as compared to cypermethrin in order of their effectiveness. Ivermectin was found to be 100 per cent effective against lice and infestation on the 28th days of post treatment.

Condensed Tannins in Some Feed Ingredients/Forages of Pakistan and Their Anthelmintic Activity in Layers
Anwar, H., 2003. *M.Sc. Thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad,

Pakistan

This study was carried out to i) Characterize the condensed tannin content in the some feed ingredients and forages of Pakistan ii) Evaluate the effect of tannins on the performance of layers and their anthelmintic activity against experimentally induced *Ascaridia galli* infection in layers. The plant/forage samples were collected from Kherimurat rangeland (District Attock), and sorghum samples procured from market. These samples were analysed for condensed tannin content in the Department of Veterinary Parasitology, University of Agriculture, Faisalabad. For evaluation of anthelmintic activity of condensed tannins, 150, day-old layer chicks were used. The tannin content in different forages/plants in descending order was found in Kandair (*Cassisu spomerum*, 14.5 g/kg DM), Junglee Beri (*Zizyphus nummularia*, 14.3 g/kg DM), Snatha (*Dodonea viscosa*, 13.5 g/kg DM), Desi beri (*Zizyphus jujuba*, 12.4 g/kg DM), Amaltass (*Cassia fistula*, 12.4 g/kg DM), Commercial tannin (Kenya source, 11.9 g/kg DM), Dheela (*Cyperus rotundus*, 11.1 g/kg DM), Jaman (*Eugena jambolana*, 10.9 g/kg DM), Kachnar (*Bauhinia veriegata*, 10.7 g/kg DM), Junglee swank (*Echinocloa colonum*, 8.5 g/kg DM), Iple Iple (*Leucaena leucocephala*, 6.4 g/kg DM), Dhaman (*Cenchrus setigerus*, 2.5 g/kg DM), Kahuw (*Olea cuspidata*, 2.1 g/kg DM), Shehtoot (*Morus indica*, 1.2 g/kg DM), Amla (*Phyllanthus emblica,* 1.0 g/kg DM), Dodh Tibel (0.9 g/kg DM), Kahawe (*Stuntedolea didata*, 0.6 g/kg DM), Waree (Grow on trees, 0.6 g/kg DM), Bhkair (0.4 g/kg DM), Shreen (*Albezia lebbek*, 0.3 g/kg DM) and Waree (Grow on beri, 0.08 g/kg DM). The tannin content in the commercial cattle feed sample obtained from the Department of Animal Nutrition, University of Agriculture, Faisalabad was 9.8 g/kg DM; whereas, in three different samples of sorghum it ranged from 10.1 to 12.4 g/kg DM. Results of eggs per gram of faeces of layers fed on rations containing different levels of tannin revealed no effect of tannin supplementation at any level on the eggs per gram of faeces. Dietary inclusion of tannins in the rations resulted in reduced feed intake and lowered egg production along with poor efficiency of feed utilization. The layers fed rations supplemented with tannins at 2 and 3% levels gained significantly lesser weight compared with those fed rations without tannins and those supplemented with tannins at 1% level. There was a graded decreasing response in weight gain with an increase in the tannin supplementation. Likewise, there was a significant reduction in feed consumption in layers fed on rations containing tannins at 2 and 3% levels. Per week egg production, egg weight, feed conversion ratio (both feed consumed per dozen of eggs and egg mass) also significantly decreased at all the levels of tannins. Leg abnormalities and mortality were recorded in layers fed on rations containing tannins at 2 and 3% levels.

Anthelmintic Resistance and Parasite Control Practices against Gastrointestinal Nematodes of Sheep
Afaq, M., 2003. *Ph.D. thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The present study was conducted with the objective to assess the current parasite control practices and screening of anthelmintic resistance in gastrointestinal nematodes in sheep against most commonly used anthelmintics in Pakistan. The data on on-farm current parasite control practices indicated maximum (57 out of total 113 dewormings) use of anthelmintics belonging to the benzimidazoles group followed by imidazothiazole (levamisole; 38 out of total 113 dewormings). The nematodes prevalent in the area of study were within the spectrum of activity of these two groups of anthelmintics. Levamisole was used underdose most of the times (23 out of total 38 dewormings) followed by benzimidazoles (12 out of 57 dewormings). The frequency of using anthelmintics ranged from 3.3 to 4.0 dewormings per year with a mean interval of 70 to 113.8 days (range 6 to 306 days) on different farms included in the study. There was no practice of rotation of different anthelmintics, except in case a different anthelmintic was provided on the farm through central purchase by the Livestock and Dairy Development Department. The use of anthelmintics was neither strategic not tactical as evident from distribution of dewormings in different months; however, it had a higher trend in the months from May to August, and then in December on an overall basis. There was a uniform pattern of grazing the animals on all the farms, releasing the herd for open field grazing in the morning in crop harvested fields or the land not used for sowing other crops, canal banks, roadsides and/or rangelands. Record was not available on any of the farms included in the study on parasitic outbreak, morbidity/mortality due to parasitic infections and efficacy of various anthelmintics.

Most of the respondents (86/200) in farming community had a "medium" level of awareness, i.e., familiar with the worms, problem months and having knowledge about traditional or modern anthelmintics. The majority (32/50) of the veterinary officers, however, had a high level of awareness, i.e. well familiar with the types of worms, major parasitic diseases and modern anthelmintics. There was a tendency of better awareness in better educated respondents. Most of the respondents (116/200) were found to use modern anthelmintics. Traditional anthelmintics were, although, used by all the categories of the respondents separately or in integration with the modern anthelmintics, yet its trend was higher in the sheep herders compared with the other categories and this also was associated with the level of education and awareness. Kameela (*Mallotus phillipinensis*) was the most commonly used as traditional anthelmintic followed by Ajwain (*Trachyspermum ammi*) and Kalonji (*Nigella sativa*). Levamisole, benzimidazoles and ivermectin were used by 35.5 (71/200), 27 (54/200) and 6% (12/200) of the respondents for the treatment of gastrointestinal helminths. Most of the respondents (97/200) were used to treat whole the herds of sheep. It was, however, closely followed by those (89/200) treating clinically sick animals only. Very few respondents (14/200) based the use of anthelmintics on diagnosis through faecal examination, and dewormed their animals on seasonal basis (107/200) and on the basis of signs and symptoms like loose faeces/loss of weight (46/200). Pasture rotation and animal species rotation was known to only 9 and 2%; 4 and 2%, veterinary officers and veterinary assistants, respectively; none of the sheep herders and farmers. Almost equal number of respondents knew the role/use of balanced rations in the integrated efforts for the management of worm loads.

Results of FECRT and copro-cultures revealed development of resistance in *H. contortus, Trichostrongylus colubriformis* and *Ostertagia* species, and a tendency for the development of resistance in *Cooperia curticei* against benzimidazoles on all the farms. FECRT and copro-culture indicated that *Haemonchus contortus* is the only nematode resistant to levamisole on all the farms. There was no evidence of development of resistance in nematodes against ivermectin based on FECRT. Egg hatch assay confirmed the results of FECRT, which indicated development of resistance in gastrointestinal nematodes against benzimidazoles on all the farms except LES Rakh Ghulaman (Farm # 2), where EHA did not confirm the results of FECRT. It was concluded that (1) the current parasite control practices on the farms are incorrect, baseless, and neither strategic nor tactical; (2) the knowledge of farming community about parasitic diseases and their handling in an appropriate manner is hardly sufficient to comply with the standard worm management practices (as reported in literature) from diagnosis of the diseases to its treatment and application of various integrated control procedures; (3) the tests used in the current study for detection of anthelmintic resistance are not sufficient enough to give the true picture of the problem of resistance in study area, which seems to involve other compounds and species of nematodes as well and (4) conclusions number 1 and 2 seem to contribute towards development of anthelmintic resistance.

Evaluation of Tannins for Anthelmintic Activity in Sheep
Mufti, K.A., 2003, *M.Sc. thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

Studies which have examined the effects of CT extracts and CT-containing forages on resistance and resilience to GI nematodes indicate that forages that confer a greater degree of resilience do not necessarily enhance resistance. Conclusions about the ability of CT-containing forages to improve resistance via enhanced DP supply are difficult to make because of the short duration of many of the trials. Increased resistance to GI nematodes has been demonstrated for sulla and QT but we conclude that these effects appear to be mediated through 2 distinct mechanisms. Quebracho tannin may enhance resistance through increases in DP supply which are prioritized for tissue repair and immune response. Sulla has been demonstrated to greatly reduce establishment of *O. circumcincta* and *T. colubriformis* which is unlikely to be due to changes to DP supply and may or may not be associated with CT. Condensed tannins appear to have direct anthelmintic properties and reduce larval migration and development. Further work to confirm and identify the anthelmintic properties of CT in general, and from sulla specifically, would be of much interest.

Anthelmintic Resistance in Some Gastrointestinal Nematodes of Sheep
Jabbar, A., 2003. *M.Sc. thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

Helminths are recognized as a major constraint to livestock production throughout the tropics and elsewhere and adversely affect the productivity of small ruminants. The chemical control of nematodes has become increasingly difficult as a consequence of the appearance of nematode populations with resistance to commonly used anthelmintics. The present study was planned with the aim to determine the AR through Egg Hatch Assay (*in vitro* assay) in a highly prevalent gastrointestinal nematode (*H. contortus*) of sheep against oxfendazole.

One hundred abomasums of sheep, suspected with infection of Haemonchosis, slaughtered at Faisalabad abattoir were collected. Age, sex, and breed of the each animal were recorded on a prescribed questionnaire from the owners before slaughtering.

Fifteen isolates of *H. contortus* collected from Lohi and five of those from Kajli breeds of sheep were found to have developed resistance against oxfendazole having LC_{50} values ranging from 0.13547 to 0.26699 µg/mL and 0.12935 to 0.43091 µg/mL, respectively. Ten isolates of *H. contortus* collected from Lohi male and five of those from Lohi female showed resistance against oxfendazole having LC_{50} values ranging from 0.13547 to 0.26699 and 0.16202 to 0.23184 µg/mL, respectively. Three isolates of *H. contortus* collected from Kajli male and two of those from Kajli female showed resistance against oxfendazole having LC_{50} values ranging from 0.12935 to 0.27147 and 0.14049 to 0.43091 µg/mL, respectively.

Six isolates of *H. contortus* collected from Lohi sheep aging from 9-12 months old, six of those from 13-15 months old and three of those from 16-18 months old were found to have developed resistance against oxfendazole having LC_{50} values ranging from 0.16202 to 0.22808, 0.13547 to 0.26699 and 0.18729 to 0.23184 µg/mL, respectively. Two isolates of *H. contortus* collected from Kajli sheep aging from 9-12 months old, one of those from 13-15 months old and two of those from 16-18 months old were found to have developed resistance against oxfendazole having LC_{50} values ranging from 0.14049 to 0.21478, 0.27147 and 0.12935 and 0.43091 µg/mL respectively.

Epidemiology and Vector Role of Ticks in Diseases Transmission in Layers
Shah, A.H., 2003. *Ph.D. thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

Studies have been conducted on the epidemiology and vector role of ticks in layer chicken in Faisalabad district of Punjab (Pakistan). For epidemiological studies, prevalence of ticks on layer chicken was determined by selecting eighteen layer farms at random; 5,5,3,3 and 2 layer farms from tehsil Faislabad, Jaranwala, Sammundri, Tandlianwala and Chak jhumra, respectively. Different species of ticks were collected and identified from layers.Tick infestation in layers was correlated with different factors like temperature, humidity, variety of layers, age, species of ticks and the use of acaricides. The vector role of fowl ticks in the transmission of diseases was explored. For this purpose, ticks were examined for natural infection with spirochaetes, bacteria and rickettsia. The vector status of different species of ticks naturally infected with spirochaetosis was confirmed through experimental transmission in healthy birds.

The prevalence of tick infestation was found as 11, 24 and 12.7 per cent on Indigenous, Babcock and White Leg Horn varieties of layers, respectively. Two species of ticks namely *Argas persicus* and *Argas vespertilionis* were found to infest layer chicken in the area of study. The prevalence of *Argas persicus* and *Argas vespertilionis* was 10 and 3.5 per cent, respectively. Tick infestation was found to be more prevalent in July, August and September (63, 63 and 62 per cent, respectively) while lower in February,

March and April (20, 19 and 25 per cent, respectively). The highest rate of tick infestation was recorded in tehsil Sammundri (24 per cent), followed by tehsil Chak jhumra (20.5 per cent), tehsil Tandlianwala (19.5 per cent), tehsil Jaranwala (13 per cent) and tehsil Faisalabad (7.5 per cent). Age-wise prevalence of tick infestation was 14 and 7.2 per cent in young and old layer chicken, respectively. The prevalence of ticks was 17.85 and 44.5 per cent on the farms using acaricides and those not using acaricides, respectively.

The vector role of *Argas persicus* and *Argas vespertilionis* in the transmission of spirochaetosis in layer chicken was confirmed through isolation of *Borrelia anserina* from naturally infected ticks. The rate of *Borrelia anserina* infection in *Argas persicus* and *Argas vespertilionis* was 72.7 and 55 per cent, respectively. *Borrelia anserina* infection in fowl ticks on different varieties of layer chicks was also recorded and found to be 54, 66 and 84 per cent in the Indigenous, Babcock and White Leg Horn layers, respectively. The transmission of spirochaetosis by fowl ticks was assessed by experimental transmission in the layer chicken.

Three species of bacteria namely *Staphylococcus aureus, Salmonella pullorum* and *Escherichia coli* were isolated from the triturated *Argas persicus* and *Argas vespertilionis*. The relative abundance of *Staphylococcus aureus, Salmonella pullorum* and *Escherichia coli* in *Argas persicus* was 80, 36.7 and 53.3 per cent, respectively and of *Staphylococcus aureus* and *Escherichia coli* in *Argas vespertilionis* was 60 and 46.6 per cent, respectively. No rickettsial organisms were detected from any of the species of ticks identified from the area. Results of the present study have provided the base line data for making new projects in the field of acarology, which would ultimately help in the control of ticks in local layer chicken.

Studies on the Immunomodulatory Effect of Ivermectin in Rabbits
Sajid, M.S., 2004. *M.Sc. Thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The effect of ivermectin on cellular and humoral immune response of rabbits was studied at therapeutic and more than therapeutic levels (double and triple than recommended therapeutic dose). For this purpose, twenty 6–wks-old male rabbits were randomly divided into four groups.

Ivermectin @ 0.2, 0.4 and 0.6 mg/kg body weight was administered subcutaneously in group A, B and C respectively. Group D was administered with a sham treatment of normal saline. Following ivermectin administration, rabbits were injected with the primary and booster doses of *Pasturella multocida* antigen and the humoral and cellular immune response were analysed by using indirect haemagglutination assay (IHA) and dinitrochlorobenzene test respectively. The highest geometric mean titer (GMT) was found in group C followed by group B, A and D. Skin sensitivity at 24 and 48 hours was found highest in group C followed by A, B and D. Ivermectin was found to have no direct affect on the live body weight of animals. Other parameter included the total leukocytic count (TLC), differential leukocytic count (DLC), absolute lymphocyte count (ALC), total proteins (TP), serum albumins, serum globulins and albumin globulin ratio. Ivermectin had caused significant increase in TLC, TP and serum globulin but no significant effect on DLC, ALC, Serum albumin and Albumin globulin ratio. The results indicated that both the cellular and humoral immune response of rabbits was increased with increase in dose rate of ivermectin as compared to control.

Evaluation of Taramira (*Eruca Sativa*) Against Ticks in Naturally Infested Cattle
Mehmood, A., 2004. *M.Sc. thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

This study describes the comparative efficacy of taramira oil (*Eruca sativa*) and ivermectin in cross bred cattle (Sahiwal x Fresian) naturally infested with hard tick (*Boophilus microplus*). Taramira oil was purchased from local market of Faisalabad and authenticated by a Chemist from Department of Chemistry, University of Agriculture, Faisalabad. Eight naturally tick infested cross breed cattle of same

age group were selected at Livestock Farm, Department of Animal Breeding and Genetics, University of Agriculture, Faisalabad. Ticks were counted on the complete body. Taramira oil (100%) was sprayed on the whole body of the cattle and petrol was added in the oil just before spraying to thin the oil to sprayable concentration. Taramira oil was sprayed to give good soaking without much runoff while ivermectin was injected subcutaneously @ 200µg kg^{-1} body weight. Taramira oil was found 100 % effective on 10 day post treatment (PT) and efficacy persisted up to 18 days PT while percentage efficacy of ivermectin was 97.06% and this higher efficacy remained persistent only for five days PT. There was no difference ($P>0.05$) in the efficacy of these products. The present study proved taramira oil as a good candidate for research as an acaricide. However, more studies should be carried out to determine the most effective concentration of taramira oil, dose rate, and protection period and cost effectiveness for the control of ticks.

Descriptive Epidemiological Studies on Traumatic Myiasis in Ruminants in Faisalabad
Usman, M., 2004. *M.Sc. thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

An epidemiological study was undertaken to know the basic data on the prevalence and agents causing traumatic myiasis in livestock especially ruminants. For this purpose, the veterinarians in district Faisalabad were asked to complete a questionnaire on traumatic myiasis. Of 62 veterinarians contacted, all of them replied (100%). Myiasis was commonly observed by 85.48% of respondents while it was observed rarely by 14.15% of the respondents. Out of 62 respondents 53 (98.11%) reported myiasis to be a problem among the livestock they treated. Infestation levels were high in case of buffalo, cattle and sheep. The myiasis season lasted from March to November with the most cases reported in July and August. Significantly more respondents reported that fly larvae were present deep in wounds rather than superficially, consistent with infestation due to obligate parasite of genus Musca (Diptera: Muscidae) and Sarcophaga (Diptera: Sarcophagidae). Frequent inspection and treatment were reported by all of the veterinarians, contributing to the economic impact of traumatic myiasis. Economic losses were observed when infested animal counts low market price, poor hide quality and low production (94.11%of the respondents). Host factor of disease i.e. age and breed of animal has no effect on the occurrence of disease (96.22% and 100% of respondents respectively). But the environmental factor i.e. environmental temperature has positive effect on the disease occurrence as reported by 96.22% of veterinarians .The most common form of treatment was the manual removal of larvae followed by topical application of insecticides. More than half of the veterinarians (56.6%) reported that there is increasing trend of disease, as the farmers adopt no flying control methods. Further studies are recommended for complete larval taxonomy and control strategies of traumatic myiasis.

Effect of coccidiosis on humoral response of broiler chicks vaccinated against hydropericardium syndrome
Ishaq, H.M., 2004. *M. Sc. Thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

A total 150 days old broiler chicks were use to study the effect of coccidiosis on the humoral response of chickens vaccinated against Hydropericardium syndrome. Chicks were also be vaccinated against Newcastle disease, Infectious bursal disease and hydropericardium syndrome at 6, 12, and 20 days of age. Chicks were divided into two groups (A&B). On day 22, group A was given orally 60,000-70,000 sporulated oocysts of mixed species of genus eimeria to induce coccidiosis. Group B served as control. On day 7^{th} day post infection, 20 chicks from each group were slaughtered t collect the serum. A total of 25 blood samples were also collected from a commercial broiler flock infected with coccidiosis. Indirect haemagglutination test was performed on the serum to detect the humoral response of chicks against hydropericardium syndrome. In results, there were three groups in the table experimental groups in the table experimental group, control group and field sampling comparison between them clearly showed that experimental and field sampling had low antibody titre as compared to control group due to

immunosuppressive effect of coccidiosis.

Evaluation of Neem (Azadirachta indica) Against Ticks in Naturally Infested Cattle Calves
Sandhu, Z., 2004. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The present study was designed to evaluate the effect of methanol-aqueous (70:30) extracts of different parts of neem (*Azadirachta indica* A. Juss) and neem oil on hard ticks. All the stock solutions and NO were formulated as 10 and 20% emulsions, using commercially available canola oil (Seasons Canola®). N-hexane was added as thinner, just before spraying. Twenty seven cattle calves, naturally infested with ticks were selected for the experiment. On set of activity was observed on day 2 PT with all the treatments. Maximum efficacy achieved was 90.94%, 91.41%, 93.78%, 92.31%, 94.29%, 74.70%, 88.28%, 92.54% and 88.93% with 20% NO, 10% NO, 20% NSKE, 10% NSKE, 20% NLE, 10% NLE, 20% NBE, 10% NBe and with ivermectin, respectively. Ticks samples, collected from experimental calves were identified as *Boophilus microplus*. Comparison of 10 and 20% NO with ivermectin reveled that neem oil was more effective at both the concentrations as compared with the commercial product. After treatment with 10% and 20% NSKE results were comparable with ivermectin. A decrease in the protection period of ivermectin against *B. microplus* was observed, due to the development of resistance. There was no difference in the pre-treatment and post-treatment blood picture. Based on to-date research, farmers are advised to use Neem as an anti-tick agent and neem could be a potential candidate for research as an anti-tick agent.

Evaluation of Neem Fruit (Azadirachta indica) and Turmeric (Curcuma longa) as Anticoccidial Agents in Broiler Chicks
Abbas, R.Z., 2004. *M.Sc. Thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The study was designed to determine the prophylactic effect of Salinomycin sodium (Sacox) and indigenous preparations i.e. Neem fruit (*Azadirachta indica*) and Turmeric (*Curcuma longa*). For this purpose 150, day old broiler chicks were reared under controlled conditions. They were divided into nine groups. Group 1 was fed on the ration containing Salinomycin sodium (Sacox). Groups 2, 3 and 4 were fed on the rations containing Neem fruit @ 1%, 2% and 3% respectively. Groups 5, 6 and 7 were fed on the rations containing Turmeric @ 1%, 2% and 3% respectively. Group 8 was kept as infected untreated control group and group 9 was kept as uninfected untreated control group. Infection was given to the chickens on 20th day of age and the treatment was given from the start of the experiment till end of the experiment. A dose of 50,000 sporulated oocysts of mixed Eimeria species (80-90% *Eimeria tenella*) was given orally to the chickens. Chickens in uninfected untreated group were alert, active and healthy. Their faeces were normal and feathers were shiny. The signs and symptoms of the coccidiosis were absolutely absent. Chickens in infected untreated group showed symptoms of coccidiosis including severe bloody diarrhoea, ruffled feathers, reduced feed and water intake, leg paralysis, droopiness of wings along with dullness and depression. Prophylactic effect was compared by the number of oocysts per gram of faeces, comperative weight gains, feed consumption and feed efficiency among different groups. Maximum weight gain was attained by the chicks in uninfected untreated groups which was similar to those fed on rations containing Salinomycin sodium (Sacox), *Curcuma longa* @ 3 % and similar to the chicks of infected untreated group. There was a significant reduction in weight gain attained by the chicks fed on rations containing *Azadirachta indica* (@ 1%, 2 % and 3%) and *Curcuma longa* (@ 1 % and 2 %), which were all statistically similar to each other except the chicks fed on *Azadirachta indica* @ 3 %. Feed consumption in the different groups was in the order as for weight gain in different groups. Feed conversion ratio was maximum (1.420) in group fed on ration containing *Azadirachta indica* 3% which was similar to group fed on ration containing *Azadirachta indica* 2 %. There was significant reduction in feed conversion ratio in the groups fed on rations containing Salinomycin sodium (Sacox) @ 12g/50 Kg feed, *Curcuma longa* (@ 1%, 2 % and 3%) and those of infected untreated and uninfected untreated

group. All these groups were statistically similar to each other. Overall number of oocysts per gram of droppings was lowest in group treated with Salinomycin sodium (Sacox) @ 12g/50 Kg feed while it was highest in infected untreated control group. Oocyst per gram of faeces was lower in all the groups fed on rations containing *Azadirachta indica* (@ 1%, 2 % and 3%) and *Curcuma longa* (@ 1%, 2 % and 3%) as compared to infected untreated group.

Evaluation of Anthelmintic Activity of Ajwain *Trachyspermum ammi* (L.) Sprauge (Umbelliferae) Against Gastrointestinal Nematodes of Sheep
Rehman, A., 2004. *M.Sc. Thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

Trachyspermum ammi (Umbelliferae) locally named as Ajwain in Pakistan, has been widely used in ethno-veterinary medicine system of Pakistan as a stomachic, an anthelmintic and in digestive disorders. However, its use as an anthelmintic lacks enough research based support. This study was carried out to rationalize use of *T. ammi* seeds as an anthelmintic against mixed infection of gastrointestinal nematodes in sheep. Egg Hatch Test indicated that both aqueous and methanol extracts inhibited nematode egg hatching, but the dose of *T. ammi* required for this inhibition was much higher than that of control (benzimidazole) drug. Maximum reduction (89.7%) in EPG was recorded in the animals treated with crude powder of *T. ammi* @ 7 g/kg body weight followed by 54.3 and 43.3% in animals treated with crude powder of *T. ammi* @ 5 g/kg body weight, and crude aqueous extract of *T. ammi* equivalent to 7 g/kg body weight on day 6 post-treatment. The anthelmintic effect, however, was not consistent and EPG was found to increase after day 6 PT.

In conclusion, the use of *T. ammi* seeds as an anthelmintic in the form of water decoction by the farmers is valid in the light of results of the current study. Therefore, quality controlled extracts of *T. ammi* seeds or possibly isolated bioactive compounds could be a promising alternative to conventional anthelmintics for the treatment of gastrointestinal trichostrongylids of small ruminants in the future. Such a treatment could be used in control strategies against gastrointestinal nematodes in organic and conventional production systems.

Further research is needed for studies on the bioactive constituents, as well as on the reproducibility, dosage, application regime, toxicity, and effectiveness of *T. ammi.* Moreover, chemical constituents can vary considerably between individual plants due to genetic or environmental differences, development stages of the plant at harvesting, drying process and storage technique. Thus, a quality control of the plant material, the extraction scheme and the extract itself is strongly recommended for further studies.

Gastrointestinal Helminthiasis in Ruminants in Tehsil Jatoi (Distt. Muzaffar Garh) 1. Prevalence 2. Documentation of Ethnobotanicals used as anthelmintics
Raza, M.A., 2005. *M.Sc. Thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The present study was aimed at: I. Prevalence of gastrointestinal helminthiasis in ruminants of Tehsil Jatoi (District Muzaffar Garh), and II. Documentation of ethnobotanicals used as anthelmintics. Therefore, 100 faecal samples of each cattle, buffalo, sheep and goat were examined by direct, indirect (sedimentation and floatation techniques) and coproculture techniques. Overall prevalence was 53% comprising 51% in cattle, 47% in buffalo, 62% in sheep and 52% in goat. The results on sex-wise prevalence in cattle revealed 65% males (20/31) and 45% females (31/69) having infection with one or the other species of helminthes. In buffaloes, 91% males (20/22) and 35% females (22/78) were infected with the helminthes. As far as small ruminants were concerned, in sheep, 77% male (30/39) and 52% females (32/61); and in goats, 56% male (24/43) and 49% females (28/57) were found infected.

The results of age-wise prevalence in cattle revealed 34% adults (21/61) and 77% calves (30/39) having infection with one or the other species of helminthes. In buffaloes, 35% adults (24/69) and 74% calves (23/31) were infected with the helminthes. As far as small ruminants were concerned, in sheep, 55%

adults (34/62) and 74% lambs (28/38); and in goats, 40% adults (25/63) and 73% kids (27/37) were found infected. The prevalence of helminthes was higher in young animals as compared to old cattle, buffaloes, sheep and goats.

Species recorded were *Fasciola hepatica, Fasciola gigentica, Toxocara vitulorum, Paramphistomum cervi, Monezia expansa, Monezia bendeni, Oesophagostomum radiatum, Haemonchus placei* and *Bunostomum phlebotomum* in cattle, *Fasciola hepatica, Fasciola gigentica, Toxocara vitulorum, Paramphistomum cervi, Monezia expansa, Monezia bendeni, Oesophagostomum radiatum, Haemonchus placei, Bunostomum phlebotomumn, Trichostrongylus spp*. and *Cooperia spp.* in buffaloes, *Fasciola hepatica, Fasciola gigantica,Haemonchus contortus, Paramphistomum cervi, Trichostrongylus axei, Chabertia ovina, Monezia expansa, Oestertagia oestertagi* and *Oestertagia circumcincta* in sheep, *Fasciola hepatica, Haemonchus contortus, Paramphistomum cervi, Oesophagostomum Columbian,Cotylophoron cotylophorum, Monezia expansa, Oestertagia oestertagi* and *Oestertagia circumcincta* in goats. For documentation of ethnobotanical, a questionnaire was developed. By using the questionnaire survey was conducted in Tehsil Jatoi by direct interviewed to the local healers and the livestock owners. After that questionnaires were cross checked through local healers and livestock owners meeting. 29 locally used plants against helminths were collected and identified by the botanist. The plants considered in this study and used in ethnoveterinary system of Pakistan have a potential to be used as anthelmintics.

Studies on Anthelmintic Activity of *Caesalpinia Crista* (L.)
Zaman, A., 2005. *M.Sc. Thesis*, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

The present research was conducted to evaluate the anthelmintic activity of indigenous plant (*Caeslapinia crista*) being currently used in the ethnoveterinary system of Pakistan. The purpose, express plant was tested *in vitro* as well as *in vivo*. Plant material was purchased from local market (Faisalabad), identified and authenticated by a botanist in the Department of Botany, University of Agriculture, Faisalabad. The material was dried in shade, ground finally in powder in electric grinder, and stored in cellophane bags at 4C until use. The crude aqueous methanolic extract of the plant was used for *in vitro* studies on *Haemonchus contortus*. The motility of the worm was selected as the criteria for the anthelmintic activity. Crude aqueous methanolic extract of the plant proved its anthelmintic activity. Levamisole was 100% effective whereas PBS has no significant effect on motility of the worm. Egg hatch test was also performed for the assessment of anthelmintic activity. Crude aqueous methanolic extract showed activity by inhibiting of hatching of eggs. For *in vivo* studies on sheep naturally infected with mixed GINs species including *Haemonchus contortus*, Trichostrongylus species. Plant showed anthelmintic activity. This activity also varied in the form of plant used, i.e., crude powder, crude aqueous methanolic extract. There was no observed untoward effect of plant or the form of the drug used. In conclusion, quality controlled extracts of *C. crista* or possibly isolated bioactive compounds could be a promising alternative to conventional anthelmintics for the treatment of gastrointestinal trichostrongylids of small ruminants in the future. Such a treatment could be used in control strategies against gastrointestinal nematodes in organic and conventional production systems. Further research is needed for studies on the bioactive constituents, as well as on the reproducibility, dosage, application regime, toxicity, and effectiveness of *C. crista* in other host species and against other economically important gastrointestinal nematode species.

Prevalence, Taxonomy and Hematological Disturbances Associated with Mange Mites in Sheep in Dera Ghazi Khan District
Aatish, H.U., 2005. *M.Sc. Thesis,* Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

This study was carried out to find out the prevalence and taxonomy of mange mites and their effect on different blood parameters. A total of 20 flocks comprising of 400 sheep of different age, sex and breed

were examined in the city and villages around Tehsil Taunsa Shareef, Distt. D.G. Khan .Out of above mentioned animals, 30 suspected sheep were thoroughly examined and 24 (6%) were found positive for mange mites infestation. Species of the only one genus namely Sarcoptes were found infesting these animals. The average number of mites recovered from the species of genus sarcoptes was recorded as 40. For the identification of different species of mange mites, microscopic examination was carried out. Mites were first seen under low power and then high power of magnification. The slides were mounted with mites then examined to study their morphological characters. Only one genus identified was sarcoptes. The effect of mange mites on different blood parameters was also recorded. For this purpose sheep were divided into two groups. Group-1 comprised of clinically infested untreated sheep, and group-II included healthy non infested sheep which were kept as a control for comparison. The effect of the mange mites on different blood parameters of two groups of sheep was recorded. The findings of this study indicated that infestation of mange mites is a quite common problem of sheep populations in this area. The sheep suffering from mange mites exhibit poor feed intake severe irritation, scratching, bleeding, and loss of wool, low body weight, reduced production and damaged skin. Such infested sheep are also susceptible to various viral and bacterial diseases which make sheep production uneconomical and put extra burden on sheep growers. Keeping all this in view, suitable and prompt measures should be taken for early diagnosis and treatment of the infested animals. This will result not only for the control of the disease but also help to improve the economical condition of the owners. It will also increase the gross national product of Pakistan.

VETERINARY MICROBIOLOGY

1. MASTITIS (BUFFALOES, CATTLE, SHEEP AND GOAT)

Studies were undertaken to isolate and characterize the organism responsible for mastitis in buffaloes and cattle. In a preliminary study, out of 125 cases of mastitis, *Staph. aureus* was found from 114 cases (91.2%), *Strep. agalactiae* and *P.aeruginosa* from one case (0.8%) and *E.Coli.* from 2 cases (1.6%). Similarly milk samples from mastitis buffaloes when cultured on Staph. 110 medium yielded *Staph. aureus* in 44% cases. Penicillin were found to be the drug of choice for treatment of varying degree of mastitis in buffaloes.

2. MICROBIOLOGY OF RUMEN

Rumen microflora had been subject of a number of studies. The predominent bacterial species were identified. Fourteen bacterial groups and six species were isolated. Effect of low and high plan of nutrition showed significant increase in bacterial count in reponse to increasing levels of protein in the ration. Out of 14 morphologically different organisms, only three could be indentified belonging to genera veillonella, Lactobacillus and Salmonella. Effect of different sources of nitrogen as well as dry roughage on total bacterial count, viable bacterial count and cellulolytic bacterial count have been measured. The NPN resulted into increase in the bacterial count.

Urea, Urea phosphate and ammoniated mollases were fed to fistulated buffalo bulls to see the effect of these NPN sources on the rumen microflora. The bacterial count increased when these NPN sources were added to the basal ration. Sugarcane pith also supported higher counts when compared with wheat straw, although pH of the rumen liquer did not vary significantly.

3. METRITIS

Studies were carried out on vaginal microflora in buffaloes and their relationship was found with infertility and 157 bacterial strains were isolated from 100 buffaloes. Vaginal samples showed the preserve of following species. *Serratia marscens* (43 strains), *Proteus mirabilis* (32 strains) *Proteus vulgaris* (27 strains),

Escherichia Coli (30 strains) and *Gaffkya tetragena* »25 strains). Regarding the antibiotic sensitivity test streptomycin, chloramphenical, kanacillin etc. were tried and were quite effective against all strains of species mentioned except those of *E.Coli* which exhibited more sensitivity. Only *Prot. vulgaris* and *E.Coli* were found pathogenic in G.pigs No. PPLO, Vibrio, corynebacteria and streptococci strains could be isolated.

During studuing the organisms associated with metritis in buffaloes and their in vitro antibiotic sensitivity made on 200 samples (125 exudative swabs & 75 uterine washings) revealed greatest incidence of Bacillus megaterium (33.5%) and lowest one, that of *Proteus vulgaris* (9%), other isolates were *Bacillus cereus, Coryne pyogenes, Staph. aureus* and *E.Coli.* In vitro antibiotic sensitivity test established the strepto-pencillin to be most effective.

4. HAEMORRHAGIC SEPTICAEMIA

Haemorrhagic septicaemia is one of the major diseases of economic importance in Pakistan. Although treatment of this disease is possible, but due to sudden onset and acute nature of the disease, veterinary

aid is impracticable in most of the instances. The effective control is possible only by mass vaccination. Presently alum precipitated formalin killed vaccine is in use which gives an immunity of short duration. Moreover, there are four antigenic varients of the causative agent. Keeping in view the antigenic variation among P.multocida. The organisms were isolated from local cattle and buffalo. The local isolates were isolated from local cattle and buffalo. The local isolates were typed according to Roberts classification by indirect haemagglutination test. The local isolates were found to bo Roberts type 1. Presently Carter and IIedeltson typing of P.multocida is being used. Therefore 40 local strain have been isolated and are underway of sero-typing. To improve the vaccine a number of attempts were made to test the immunogenicity of capsular material of P.multocida trials indicated that capsular material is more immunogenic than the bacterin. Some workers have alleged that formalin inactivated the capsular antigen thus lower the immune response. Another trial to inactivate and to remove the capsular material through physical methods (Bonification) was under taken. The immunogencity of the sonicated P. multocida induced a better immune response when evaluated in rabbits by i direct haemagglutination test than bacterin. The results are encouraging. Further studies are in hand to compare the immunogenicity in large animals and the preparation of sub-unit vaccine against haemorrhagic septicaemia.

5. INFECTIONS OF RESPIRATORY TRACT

Incidence and etiology of pneumonia in sheep was investigated. The lesions were observed in 19%. The isolates included Pasturella soptica (49.53 per cent), P.haemolytica (29.9 per cent), PPLO (23.6%) and corynaebacterium pyogenes (27.01%). Pneumonia was also produced experimentally in 6 out of 20 sheep. There seemed a possibility that more than one organisms were involved in the etiology of pneumonia in sheep. Bacterial infection of the respiratory tract of sheep was found to be due to *P.haemolytica,* Cory. pyogenes, *P.aoruginosa, JS.Coli, Stap. eipdermicus, Gaffkya tetragenea, B. subtilis* and *B.badius.* Streptomycin, Oxytetracyclin, aeromycin and chloramphenicol were found sensitive to all isolates. All the isolates proved to be non pathogenic when inoculated intratrachealy into experimental sheep. In a comparative studies on the aetiology of pneumonia in sheep and goats, it was found that psteurella species were commonly associated with pneumonic lesions in sheep and goats. *Stap. aureus* and *Corynebacterium pyogenese* were the most common respiratory pathogens found singly or in combination with pasteurella species.

6. WOUND INFECTIONS

A number of studies were conducted to isolate and characterize microorganisms causing wound infections of cattle and buffalo. The isolates were *Staph. aureus. Strop, pyogenes, P.pyocyanae, Proteus vulgari^, B.coli, Coryne. diptheriae, Asp. fumigatus,* and *Trichophytan verrucosum.* In vitro sensitivity of eight antibioics namely penbritin, pyopen, Kanacillin, Chloramphenicol, Tetracycline, Oxyteracy din, erythromycin and penicilin was tested against all the strains isolated. In equines chronic wound infection and apparently normi horse skin, have shown the pressure of *Staph.* aureus, *Proteus vulgaris, Staph. epidermidis, D.sutilis, E.Coli. Strop, pyogenes, Coryn. pyogenea* and *Sarcina ventericuli.* However, Ps. pyogenee could be isolated from cutaneous wounds only. In vitro antibiotic sensitivity using penicillin, Streptomycin, achromycin, chloramphenicol, sulphathiazole and sulphathiazine was also performed.

7. POULTRY 7.1. Newcastle disease (vaccination)

In spite of certain managemental practices and measures adopted for control of poultry diseases, newcastle disease still occures in sporadic form and kills even the vaccinated birds. Vaccination is the only effective method to control this disease. Therefore various vaccines of strains including Mesogenic and lentogenic as well as live attenuated and killed through different routs i.e. intranasal, drinking water and subsutaneous in different doses have been tried. The incidence and significance of certain concurrent infections which precipitate Newcastle disease including Colibacillosis, Salmonellosis,

Coccidiosis and worm infestations have also been studied.

The presence of maternal antibody have been studied by many workers through serological tests. However, congenital pssive immunity gradually decreases with increase in age of bird, and the titre comes to zero around the 4th week of age although Ali and Majeed (1965) could not find any resistance to virulent virus in 15 days chicks hatched from immune hens. In the presence of sufficient maternal antibodies in chicks, active immunization should be delayed. However, active vaccination should be carried out in chicks with little or no maternal antibodies.

Several types of vaccines in different doses through various routes have been used against Newcastle disease in the country. The choice depends upon a number of factors including virulence of field virus and the extent to which it spreads. For example when there is a threat of challange with a virulent strain, an attenuated vaccine which retains some of its virulence such as Mukteswar can be used. If the challenge is mild vaccine with a weaker strain of the virus such as LaSota should be preferred.

It has been said that virulent strains of ND are more immunogenic than less virulent strains. Presently the inactivated oil adjuvent vaccine prepared from virulent virus is getting popular for the control of ND in the country. Therefore, few studies were undertaken to assess its immunity and experiments were made to inactivate a local velogenic ND virus by physical methods (Ultra-sounds). The protection results of this experiment are encouraging. However .dose determination and Kinetics of immunity is underway.

7.2. Salmonellosis

The introduction of large scale incubation method and transportation of day old chicks causes rapid spread and high incidence of selemonellosis. The disease has been recorded countrywide affecting young and adult birds. Isolation and characterization of the causative organisms were made from cases of natural outbreak of disease and droppings of apparently healthy birds.

A haemaggluti nation test was found to be effective in screening the carrier state of birds infected with salmonella which helped to reduce further vertical spread of the disease.

7.3. Spirochaetosis

Spirochotosis vaccine was prepared in 10 days old embryonated eggs using chorioallantoic route and 0.2 ml of infective citrated fowl blood. It was found that embryo fluid and the embryo organs (liver, spleen,heart and lungs) when formalized,induced a good immune response after intramuscular administration in birds. One ml inoculum produced solid immunity against spirochuetosis. The proper age of vaccination was found to be 12 weeks or over. Transfer of maternal immunity was demostrated in chicks hatched from vaccinated hens after 3 and 6 months vaccination. The vaccine thus prepared was found to retain its antigenicity when tested after 3 months of storage at room temperature.

Some chemotherapeutic agents were tested for treating fowl spirochetosis and terramycin 10 or 20 mg I/M dose was found to be more effective s compared to Streptomycin and Penicillin.

7.4. Aflatoxicosis

Various feed ingredients such as rice polish, corn grain, corn gluten feed, cotton seed cake, sesam oil cakes, guar meal, wheat straw were screened for aflatoxins. The highest incidence i.e. 60% was found in broken rice while in corn grain 25%, corn gluten feed 25% and cotton seed cake 25%. It was also concluded that damaged sample revealed much high incidence than unbroken. The incidence of aflatoxin ranged from 29-100% when moisture conent exceeded 8%. Cultural examination of feed stuff gave 39 isolate of different species of fungi with the highest number of Aspergillus species. Various species of

fungi have been found to produce patent toxins responsible for contaminating rice ratio Prola, the cause of Deg Nala disese in Buffalo.

7.5. Omphalitis

A number of other ailmen-s of poultry were studied. Of which emphalitis had been a common problem of hatcheries in chicks. Bacterial isolation studies from umblicus and yolk revealed the association of Sa/. *gallinarum, Ps. aorogenosa* and *Sal. ftyphimurium* alongwith other containments.

7.6. Chronic respiratory disease

Studies on the chronic respiratory disease isolation and aerology of Mycoplasma infection in poultry have been conducted. 71 serum samples were tested, out of which 47 showed positive agglutination against M. gallisepticum.

8.PUBLIC HEALTH

8.1. Uro-genital infection in man

A problem of postparturient infection in women was investigated. In large number of cases were found, infected with mixed infection with *Strop, pyogenes Staph. aureus, Aerobactor aerogenes, Strep, Pneumonaa, Staph. epidermidis, Strep. faecalis, Candida albican Strop, imitis Clostridium welchii.* In vitro antibiotic. Only 41 cases out of 50 showed sensitivity whereas 9 cases did not show any response to these drugs. Effective drugs were streptomycin Erythromycin, cloxacillin with ampicillin, Pyopnn ampicillin Kanacillin in order of effectiveness.

Organisms associted with leukorrhoea in women were also investiated which were *Staph. epidermidis B.subtilis Strop. pyogenes, Strep. faecalis, E.CoU,* and *staph. saprophyticus.* Invitro antibiotic sensitivity in these cases reveled that 95 percent cases were sensitive to Penbritin Erythrocin Streptomycin Pyopen and combiotics. Penicillin, Vibramycin and Kanamycin were not effective.

Bacterio logical studies on urine to detect the urinary tract infection was undertaken. The organisms indentified were *E.Coli.* (40.09X), *Klobsiolla aerogcncs* (13.31%), *Pscudomona aeroginosa* (14.28%), *Proteus mirabilis* (7.83%), *Proteus vulgaris* (1.38%), *Staph. aureus* (6.91%), *Staph. epidermidis* (8.74%), *Strept. fecalis* (6.45%), and *Strep. Pyogones* (0.92%). Gram negative bacteria constituted 1.67(77%) and gram positive bacteria 50 (23%) cases. When the isolates wore tested for in vitro drug sensitivity against gram negative organisms Gentamicin, Kanamycin, co-trimoxazole, nitrofuranton streptomycin, emplicillin were observed quilo effective while chloramphenical, tetracycline and penicillin could not show appreciable activity. Against gram positive organism, cloxacillin was observed the best drug although carbencillin, gentamycin, kanamycin, Co-trimoxazole, streptomycin and ampicillin were also effective. Chloramphenical, nitrofurantol, tetracyclin andpenicillin showed moderate activity. Three strains of PS. aeroginosa were resistant to all the drugs tested.

8.2. Ear nose throat

Studies were focussed to isolate staphylococci, streptococcus and Pseudomonas from ENT infection. In vitro antibioic sensitivity test was also performed.

The incidence of Staph. aureus was 53.5%, Staph. epidermidis 16.5 per cent and Staph. saprophyticus 1.4 per cent.

The most effective drug including gentamycin, septran, vibrmycin, ampic.lox, and chloramphenicol

whereas amoxicillin, penicillin and tetracyclin were the least effective. Among the streptococci isolated from the ENT infection, the incidence of Strep. pyogcnes was 54.7%. Strop, pneumonia 20.5 per cent, Strep. salivarius 7.6 per cent and Strep. equisimils 7.2 per cent. Randomly selected 12 strains of Strep. pyogenes proved to be fatal for: rabbits within 30-48 hours post inoculation. All the isolates of strep. pyogenes and strop, pneumoniae were subjected to in vitro antibiotic sensitivity tests. Penicillin, septran, gentamycin, erythromycin, vibramycin, ampiclox, cloxacillin and combiotic were found to be more effctive.

The incidence of *Pseudomonas aeroginosa* in ENT infections was 20.2 per cent Psudomonas fluorescence 7 per cent and *Pseudomonas putida* 2.5 per cent. All the isolates were subjected to in vitro antibiotic sensitivity. Carbenicillin and Kanamycin wore found to bo the most effective whereas the chloramphenicol was the least effect.

8.3. Milk

Studies made on the bacterial counts of normal milk preserved with different concentrations of hydrogen peroxide in different types of containers, revealed that under the tropical environment, raw buffalo milk can be preserved with 0.06 per cent hydrogen peroxide upto about 21 hours and with 0.08 per cent upto 36 hours after milking without adverse effect on its physici characteristics. It was also concluded that milk can be preserved in clean (washed with soap and water) alluminium and unglazed earthen containers upto about 21 hours after milking. The overall efficacy of hydrogen peroxide is higher in the glass medium and aluminium and low in unglazed earthen containers.

The standard plate counts recorded in 150 composite fresh milk samples ranged from 50 x 103 to 23 x 107 with an overall average 12.3 x 106. The highest conform count was 2.5 x 105 minimum 1 x 103 and overall average 1.9 x 105 organism per ml. of milk. The isolated species were E.Coli. (90 srains), Aerobactor aerogenes (72 strains), Staph. aureus (137 strains). Bacillus cereus (1929 strains) and bacillis megaterium (13 strains)

8.4. Meat

Bacteriological investigations carried out to assess the risk of public health through the vehicle of raw meat revealed in total 1705 isolates of which 55.98 per cent were gram negative and 44.02 per cent gram positive. The percentage of strictly anaerobic organisms was 4.46 per cent v/hilc the rest were aerobic organism. Relative incidence of different species of bacteria was *E.Coli.* 31.10%, *Staph. aurous* 26.26%, *Staph. epidermidis* 13.90%, *Cl. perfringens* 4.66%, *Anaorobactor aorogens* 4.66%, *B.Subtilis* 4.08%, *Strep. faccalis* 6.70%, *Coryn. pyogens* 3.36%, *Sal. Typhiniurium* 2.91% and *SaL entoritidis* 1.74%. A total of 12 Salmonella strains were isolated of which eight were *Sal. typhimurium,* two *Sal. enteritidis,* and one *Sal. paratyphi.* The serotype of one strain could not be confirmed. The- commonest serotype isolated was Sa*l*. *typhimurium.* As overall 6 per cent infection of Salmonella infection in raw moat was observed.

8.5. Water bacteriology

Bacteriology studies on ponds water revealed in all 250 strains. Organisms isolated were : *Bacterium* c7oacae(28 strains), *B.aerogens* (46 strains), *E.Coli* (8 strains), *Alkaligenes faecalis* (60 strains, *Ps. aoroginosu* (8 strains), *Micrococcus luteus* (26 strains), *Staph. aurous* (54 strains), *Strop, faocalis* and *Bacillus subtilis* (9 strains). Bacteriological examination of water supplies proved that hand pumps supply was the best source provided that there were no fishor or leaks externally in the hand pumps. The wells proved to be unsatisfactory. From Municipal Committee supply only 6.6% were either suspicious or unsatisfactory. The mill colony showed 12.8X water supply excellent, 3.6% satisfactory and rest as suspicious or unsatisfactory.

8.6. Sewage microbiology

Assaying for coliphages qualitatively and quantitatively on *E.Coli* strain B, it was found that the sample from congested population areas were the richest in P.F.U. content next in order were the industrial areas and the least were the residential areas. It was also noted that overall mean PFU content was higher in summer months than in the winter months and the phage content was increased after rain fall.

METRITIS

Among the diseases of cattle and buffalo, infectious diseases may result in abortion such as endometritis/metritis. The study was planned to find out the bacterial etiology of metritis with special reference to brucella in buffalos and cows. A total of 300 samples of uterine discharge were included in this study. 20 samples revealed the presence of mixed infection, 255 samples contained only one species of bacteria and 25 samples did not show any growth on commonly used laboratory media. The incidence of different species of bacteria was *Staph. aureus* (26.88%), *Strep. pyogenes* (14.09%), *Strept. bovis* (3.28%), *Corynebacterium pyogenes* (13.15%), *Corynebacterium bovis* (2.99%), *E. coli* (6.88%), *Proteus vulgaris* (8.19%), *Pseudomonas aeruginosa* (7.21%), *Bacillus cereus* (10.81%) and *Bacillus megaterium* (6.56%).

RINDERPEST

Rinderpest or cattle plague is an oriental scourge of domestic cattle and buffaloes. Rinderpest has considerable impact on world food supply and has got tremendous destructive potential in high-risk areas. Single Radial haemolysin (SRM) test was performed for the first time in Pakistan to quantitate antibacterial against rinderpest in cattle& buffalo sera (499) acquired from different sources. Sonicated tissue culture fluids and infected cell culture debris were used as antigens for SR1+/1++A and AGPT respectively. Out of total 499 cattle and buffalo sera, the percentages of positive samples by using SRIT, IHA and AGPT were 62.32%, 55.51% and 38.48% respectively. It was further noted that generally, rinderpest antibody titres of buffalo sera excelled those of cattle sera by 15.35.

Foot and Mouth Disease

Among the infectious diseases, Foot and Mouth disease (FMD) is one of the major causes of reduced productivity in bovine in Pakistan. According to a reliable estimate almost 1/3 out of the total bovine population is exposed to FMD every year. An indirect haemagglutination test (IHA) was performed to detect and measure antibodies against FMD rilus in cattle & buffaloes. The sera were obtained from Bahadarnagar Farm, Okara and Department of Animal Reproduction, University of agriculture, Faisalabad. The results of IHA showed that 54.2% serum samples were positive for FMDV type 0 while 46.8% were positive for FMDV type Asia I.

Brucellosis

Brucellosis is a crucial contagious disease causing abortion and sterility in all livestock. Being a zoonotic problem, disease can be transmitted from animals to man by ingestion of milk or milk products. Diagnosis is possible by both bacteriological and serological tests. The serological as well as epidemiological survey of brucellosis was carried out on 568 serum samples (cattle & buffalo) obtained from LPRI Bahadarnagar. Rose Bengal test (RBPT) serum agglutination test and in direct haemagglutination test were performed for serological studies and the prevalence of brucellosis was found 10.92%, 10.56% and 7.22% respectively. RBPT was found better screening test.

Mastitis-Epidemiological aspects

The productive efficiency of the dairy animals is adversely affected by mastitis which is a multy factor

disease causing high economic losses. The project was designed to con duct an epidemiological survey of mastitis in cows, microbiological studies to test the antibiotic sensitivity of bacterial isolates and biocharacterization of the isolated staphylococcus. A total of 3980 milk samples were collected from different livestock farms. Whiteside test and pH indicator paper technique was applied for preliminary screening. A total of 220 cows were positive for mastitis thus the incidence was maximum in nondescriptive indigenous breeds (7.69%). Disease was more prevalent in cows during the first month of lactation (24.90%). A total of 190-pooled samples were positive for bacterial counts. The percentage of isolated sample aureus was found to sc 32.90% and staph aureus was highly sensitive to oxytetracyline.

Serodiagnosois of FMD by using ELISA

Enzyme Linked Immunosorbent Assay (ELISA) was performed as advanced serodiagnostic test. The sera were obtained from Live Farm Haroonabad while the FMD virus (Ag) types 0, A and Asia-I were obtained from Veterinary Research Institute Lahore. It was found that 96.9% of the samples showed positive response against FMD type 0, while 93.9% were positive against type A whereas 54.54% samples were positive from FMD Type Asia-I.

Infectious Bursal Disease in Layers

Infectious Bursal Disease (IBD) is an acute highly contagious viral disease of young chicken. Different live and killed vaccines are being used in Pakistan to control the disease. The study was conducted to compare three IBD vaccines in layer chicks. Total of 120-day-old layer chicks were divided into four groups. Three groups were vaccinated at day 7 and 21 while fourth group was maintained as control. The chi9cks were examined for IHA titres against IBD. It was concluded that LUKERT gave better immunization.

Milk Whey Biological Fluid

The studies were conducted to compare the proteins pattern of cow milk whey colostrums Whey by SDS-PAGE. The whey from fresh milk and colostrums whey was purified. The cow milk whey and colostrums had similar protein pattern. So chicken embryo fibroblast growth was obtained by using colostrums whey and milk whey so colostrums and milk whey can be used as cheaper alternative to fetal calf serum.

Pasteurellosis in Control

Camel is an important source of meat and milk in some regions of Punjab. Pasteurellosis is quite prevalent in camels. Seroepidemiological studies were conducted on Pasteurellosis in camels. A total of 100 sera were collected from camels having clinical history of pyrexia from the area of Faisalabad. All the sera were examined for the presence of antibodies through IHA test by applying socinated antigen of Pasteurella multocida. Sero prevalence of Pasteurellosis was recorded 21.0% through IHA tires ranging from 32 to 256. Analytical epidemiological studies were further suggested for the identification of various risk factors.

Pathogenesis of IBD

The study was designed to know the course of disease (Pathogensis) of different IBD virus and their immunosuppressive effect to ND virus vaccines. For this purpose, 100 birds were divided into 7 (A-G) groups. Different vaccines vaccinated six groups and seventh group was maintained as control. Mortality and morbidity were recorded. The serum samples of the birds were collected and subjected to IHA. Gross and histopathalogical lesions were recorded and studied. The study revealed that birds were more prove to concurrent diseases after the attack or live vaccinations of IBD virus.

Bacteriology of Raw Milk

The investigations were carried out to study the bacterial load of raw milk supplied to Faisalabad city during summer months. A total of 100 raw milk samples were examined for standard plate count, methylene blue reduction test and presumptive test for the presence of coliform organisms. Direct microscopic count and electrical conductivity was also carried out. Twenty four percent of the milk samples fulfilled the international standard of grade A but their methylene blue reduction test was fair. An overall hygienic quality of milk supplied to Faisalabad city was very poor.

Bacteriology of Drinking Water

A total of 100 drinking water samples were collected randomly from various areas of Faisalabad and subjected to bacteriological analysis using multiple tube method and plate count to determine the presence of pollution indicators. The major water sources were ground water, WASA water supply and canal water. The ground water proved to be the excellent quality drinking water. WASA water supply got second position. All the canal water samples proved to be highly unsatisfactory and hazardous for drinking and all other domestic purposes.

Penicillin Production

Production of penicillin has been the subject of many studies because of its academic and industrial importance. The study was conducted aimed at exploring the native isolates of *Penicillium chrysogenum* series. Two series *Penicillium chrysogenum (RS-UAF I and RS-UAF-II)*were isolated from local sources. These were found to possess significantly better penicillin production potential. Growth can be manipulated by addition of PEG. Overall results have revealed that these series may be recommended better yield of natural penicillin.

Disinfection of Drinking water

The investigations were carried out for the disinfection of drinking water by solar radiation. A total 100 drinking water samples were collected from various areas of Faisalabad in transparent plastic bottles and half-blackened plastic bottles. These samples were subjected to bacteriological analysis before and after exploring to solar radiation treatments. These samples were also subjected to ultraviolet light treatment. Controlled experimental trials were performed on two microbial groups, *E. coli* and streptococcus faecalis. Solar water disinfection is an efficient economical method to disinfect small quantities of water at household level.

Egg Drug Syndrome

Egg drug syndrome is a disease of chicken caused by adenovirus. The disease prevalence of EDS in Pakistan was reported in many poultry breeding farms. So EDS virus was propagated through duck embryo incubation. Identification was done through HI test using known antiserum. Chicken serum was collected and partially purified through ammonium sulphate precipitation technique. An indirect enzyme linked immunosorbant assay (ELISA) was performed for the detection of antibody. ELISA was found a sensitive and reliable method.

Anthrax Vaccine

Anthrax is a zoonotic disease caused by the spore forming bacteria *Bacillus anthrasis*. The antigun was procured from Veterinary Research Institute Quetta. A total of 80 animals were vaccinated against anthrax with live attenuated anthrax spore vaccine. Serum samples were collected for antibody determination. The IHA test showed sensitive, specific and responsible results.

Respiratory Problems in Poultry

Mycoplasmosis is one of the most important health hazards in poultry industry. The investigations were carried out to detect avian mycoplasma infections through isolation, identification and characterization. In total 50 flocks of commercially reared poultry were observed for collection of samples. Total 52 field specimens for isolation were collected from total of 49 birds showing respiratory distress. Of field specimens, 19/52 were positive by culture. Each one of isolated species was subjected to antigen production for Rapid Serum Agglutination (RSA) test at HI test.

Use of effective microorganisms

The trials were conducted to evaluate the beneficial effect of microorganisms to prevent salmonella infections as well as effects on weight gain, feed efficiency and immune system of broiler chicks. Beneficial microorganisms (*Lactobacillus acidophlus, Streptococcus thermophilus & Aspergillus oryzae*) were isolated from intestinal contents of healthy birds as well as from yogurt. One hundred and sixty day old broiler chicks were divided into 8 groups. These microorganisms were given differently to various groups. These birds were given challenge with salmonella. It was concluded that group G, which was given combination of all microorganisms against the maximum weight with better FCR and minimum morbidity was quoted after challenge.

Sero Prevalence of egg drop Syndrome virus

The sero prevalence of egg drop syndrome virus was recorded in broiler breeder, layer breeder and commercial layer chicken in District of Mansehra. The serum against vaccinal strains of EDS virus was raised in rabbits. Among 50 flocks, 17 were found sero positive and remaining 33 flocks were found sero-negative for EDS. In different localities of Mansehra, the Seroprevalence varied from 16 to 50%.

Tuberculosis

Tuberculosis is a disease of great antiquity. Studies were undertaken to characterize the different isolates of Mycobacterium and their sensitivity against different antibiotics. A total of 100 human sputum samples and 150 cattle samples (Nasal secretions & Milk) were collected from different hospitals and government farms. All the samples were evaluated microbiologically. Total 93/100 sputum & 73/100 were positive for mycobacterium.

Avian Influenza

Avian influenza is a contagious viral disease, world wide in distribution. Mortality ranges 30-100%. Some epidemiological aspects of avian influenza were determined in broiler & broiler breeder flocks. For this purpose, sera samples, cloacal swabs and tissue samples were collected from suspected flocks located in and around Faisalabad, Sumundri, Satiana Road, Jaranwala Road and Sargodha Road. AGPT and I+T tests were performed for Seroprevalence of AT. Only 4 farms were positive for seroprevalence. Percentage at these farms was 40%, 30% and 50%. The most affected age of broiler population was 28-35 days.

Molecular Characterization of Mycoplasma

The investigations were designed to detect avian Mycoplasma infections through effective isolations, identifications and molecular characterization. Total 50 flocks having respiratory distress were observed for collectio0n of samples. Total 200 field specimens were collected. After isolation and identification, purified cultures of Mycoplasma spp. were separately processed for the segregation of various molecular

weight proteins bands using SDS-PAGE tech. The overall results showed 80% homology and 15-20% variable protein bands. The study showed the antigenic relatedness.

Antibiotic residues in Meat, Milk and eggs

Due to wide spread use of antibiotics, much effort and concerns have been directed towards monitoring of antibiotics in animal food products. In a study, a microbiological inhibition test i.e. Swab Test on Animal Food (STAF) was developed indigenously for screening of animal foods for presence of antibiotic residues. In this local test, *Bacillus subtilus(JS 2004)* was used as a test organism isolated and characterized from local soil samples, in the department of vet. Microbiology.. The test was developed by the modification of PHAST and STOP tests. Nutrient agar was used as a medium. After the placement of Neomycin control disc, Swabs samples of beef, mutton, poultry meat, eggs and milk were adjusted on STAF plate. All swab samples showing a minimum of 2mm zone were considered as positive. Overall results showed that there was highest incidence (60%) of STAF positive in poultry meat followed by in eggs, mutton, milk and lowest in beef.

Avian Influenza Virus H_9 N_2

The study was carried out to detect Avian Influenza Virus H_9 N_2 in non-vaccinated commercial layers, which are seroconverted against AIV without clinical signs. A total of 164 samples were collected from commercial layer flocks without showing any sign of influenza. The similar samples were collected from flocks vaccinated against H_9 N_2. Samples were subjected to ATI, HA, RT-PCR after isolation. It was found that the flocks at some time were exposed to Avian influenza virus H_9 N_2. Due to exposure, immunity was induced in the flocks but the infections subsided so it did not persist in the tissues.

Seroprevalence of Mycoplasmosis in small Ruminants

Mycoplasma capri sub spp PG3 strain was found associated as carrier in cattle, buffalo, sheep and camel as detected through CFT and IHA test. Companion animals also play an important role in the perpetuation of Mycoplasma infection in goat's population. Immunoprophylaxis of *Mycoplasma capri* was highest in the oil base vaccinates compared to formalin inactivated vaccinated goats. Adjuvanted vaccines also found successful in experimental trials on sheep and goats and revealed promising future of implementing mass scale production and vaccination programmes in the country.

CLINICAL MEDICINE AND SURGERY

1. GASTRO-INTESTINAL PARSITES IN LIVESTOCK

The survey of gastro-intestinal parasites livestock of Azad Kashmir was conducted approximately 32 km along the Jhelum river. The faecal samples were randomly collected and examined for the. presence of parasitic egg oocysts. It was noticed that 100 per cent of bovines (n=1000) were harbouring infection with more than one species of parasite. The highest infection rate (70%) was found with *Fasciola hepatica* and the lowest being 5 per cent with *cotylophoron cotylophorum.* The highest nematohelminth' were *Ostertagia ostertagi* (64.6%), *Haemonchus contortus* (58.5%) and *Ascaris vitulorum* (48%). The faecal examination revealed the presence of following 26 different species of prasites.

Ascaris vitulorum, Bunostomum phlebotomum, Cooperia pectinata, Dictyocaulus viviparus, Haemonchus contortus, Mecistocirrus digitalus, Oesophagostomum radiatum, Ostertagia ostertagi Syngamus largneus, Strongyloides papillosus, Trichuris globulosa, Trichostrongylus axei, Trichostrongylus colubriformis, Cotylophoron cotylophorum, Dicrocoelium dendriticum, Eurytrema pancreaticum, Fasciola hepatica, Fasciola gigantica, OrnithobUharzia turkestanicum, Paramphistomum cervi, Schistosoma indicum, Schistosoma bovis, schistosoma japanicum, Monieza expansa, coccidia spp *and* Entamoeba bovis.

The results in ovine (n=500) and caprine (n=500)species indicated. Fasciola gigantica *73.1%,* Ostertagia ostertagi *65.3%,* Moniezia expansa *62.2%,* Eimeria *species 53.0%,* Ascaris vitulorum *25.1%,* Moniezia bcnodeni *11%,* Bunostomum trygonocephalum *33.0%,* Dictyocaulus filaroa *53.5%* Haemonchus contortus *66.2%,* Nematodirus *spp.* 26%, Oosophagostomum columbianum *40%,* Strongyloides papillousus 50% Trichostrongylus axei *50.4%,* Trichostrongylus colubriformis *41.2%* Fasciola hepatica 35% and Moniezia benedeni 11X.

2. ECONOMIC LOSSES DUE TO LIVERPLUKE INFECTION

The precise extent of economic losses due to Fascioliasis in livestock in Pakistan is not available. Liverfluke infestation significantly reduced wool growth by 20-40 per cent irrespective of the age. In subclinical cases there was reduction of 2-3 Ib of milk per head of cattle and buffaloes. There were 42.8 and 10.3 per cent mortalities in buffaloes and ovines, respectively from fluke infestation.

3. INCIDENCE OP HAEMONCHOSIS

The studies were conducted on a large number of animals of different species to check the efficacies of various drugs against mature and immature flukes. Carbon Tetrachloride (effective against adult flukes only) Hexachloroethane, Nitroxynil, Niclofolous, Hexachlorphene and hexachloroparaxylene were highly effective against mature flukes. Oxyclozamide, rafoxanide, bromsalans and diamphenethide were 100 per cent effective against mature flukes but 50-99 per cent effective against immature flukes.

The incidence of Haemonchosis in and around Kut was recorded. About 500 sheep were examined for the presence of Haemonchosis infestation by faecal examination. Haemonchosis was confirmed in 179 sheep of which 105 showed heavy infestation. The incidence was about 18 percent.

Field trials with Thiabendazole and Rintal were conducted against Ascariasis in buffalo-calves. By faocal examination of 240 animals, Ascariasis was confirmed in 170 calves of which 72 showed heavy infestation. These animal were divided into 3 groups one control and the 2 groups were treated with

Thiabendazole and Rintal respectively. The efficacy of the drugs was calculated on the basis of reduction in the number of ova discharged in faeces. The results showed that Thiabendazole was 92 and Rintal showed 94.2 per cent efficacy.

Bilivon and Ranide injections against Fascioliasis in buffaloes were evaluated in these studies. The results showed that Bilivon ws 90 per cent effective while Ranide showed 87 per cent efficacy against Fascioliasis Bilivon injection was safe both in pregnant and lactating animals.

Twenty-four calves of the Dutch Friesian breed were housed after their first grazing season and divided into 4 grous of 6 animals each. One group was treated with 10 mg/kg body weight levamisole in a 'poor on' formulation, the second group was injected with 0.2 mg/kg body weight ivermectin, the third was drenched with 4.5 mg/kg oxfendazole, whilst the remaining group was retained as an untreated control. Efficacy was determined by means of a comparison of the nematode egg output on the day of tretment and one week later. Oxfendazole and ivermectin reduced the *egg* output of both Ostertagia spp. and Cooperia spp. for 100 per cent. Nematodirus spp. egg output was 100 per cent reduced in oxfendazole treated calves, but not in ivermectin treated calves. Out of 6 levamisole treated calves four showed a 100 per cent reduction in egg output of Ostertagia spp., Cooperia spp. and Nematodirus spp. whilst in two calves the tretmont showed no effect. The reason for the inefficacy in these two calves remained unknown.

4. HAEMATOLOGY OF BUFFALO IN DISEASE

The ESR observed in traumatic pericarditis was about 2 mm at the end of first hour. Haemoglobin concentration in normal healthy adult Pakistani Buffaloes was 11.85 to 12.75 gm/100 ml of blood. In traumatic pericarditis it was observed to be 6-13 gins and 9.54 gms on an average. Normal buffalo blood contains 6.8 millions RBCs/cu mm. The results of this study showed reduced number of RBCs i.e. 5.75 million/cu mm. Normal total leucocytic count of Paistani buffalo is 8600/cu mm. Whereas in traumatic pericarditis the WBC count ranged between 3400 to 13400 with an average of 9400. The differential leucocytic count showed 41 per cent lymphocytes as compared to normal value of 43 per cent. An increase in neutrophils count was observed in animals suffering from this disease. This number ws 50 per cent as compared to normal i.e. 38 per cent. The number of oesinophils was recorded .to be 0.3 per cent with an average of one per cent and basophilic count noticed was 0.5 to 1.0 per cent.

5. PIROPLASMOSIS

The average ESR observed in piroplasmosis was 28 mm/hour which is higher than normal 5.7 mm/hours. Haemoglobin (Hb) 6.77 gm/100 ml was lower than the normal due to haemolysis in 6.8 millions of RBC/cu mm. In piroplasmosis the average RBC count was recorded 2.11 million against normal value of 6.8 million/cu mm. Normal TLC was 8615/cu.mm, on piroplasmosis the count increased significantly to 12429/cu.mm. Normal buffalo blood contains 38.58% neutrophils, 3.66% eosinophils 0.64% basophils, 52.44% lymphocytes and 4.47% monocytes. In this study the neutrophils were 50.00%.

6. METRITIS

Buffaloes suffering from metritis were treated with 40,00,000 I.U. of procaine penicillin alongwith 2.0 grams of streptomycin sulphate for four consecutive days. The blood samples were examined on tho first and the last day of treatment. Haemoglobin concentration and number of RGB's showed no difference when examined before and after treatment. Pretretment average ESR values were significantly higher than post treatment values at first (P /0.05) as well as at 24 hours (P/ 0.01). A highly significant difference existed between the total leucocytic count at pre-and post-treatment days (P/ 0.01). Neutrophils, lymphocytes, and monocytes significantly differed in their values recorded on pre and post treatment days (P/0.01). The study revealed that the examination of blood for ESR, WBC and DLC values are important

to asses the efficiecny of the treatment and for the diagnosis of metitis.

7. HAEMORRHAGIC SEPTICAEMIA (HS)

During the attack of HS, the erythrocyte sedimentation rate of buffalo blood varied according to the severity of the disease. The average value at the end of one hour was 1.44 mm with a range from 0 to 3 mm. During diseased condition, erythrocyto sedimentation rate was observed to vary considerably from normal values and may not be constant. The mean haemoglobin value was 9.07 gm/100 ml with a range from 8.0 to 10.5 gm/100 ml. The red blood cell count was ranged from 4.24 to 10.40 millions per cubic mm with a moan value of 6.06 millions. The leucocyte count was observed to be fairly increased (15,700/cubic mm). The number of lymphocytes, neutrophils and eosinophils showed marked increase.

8. CAPRINE MASTITIS

Microbial isolates from 50 milk samples of mastitic goats included *Staphylococcus aureus* 18, *Streptococcus agalacticae* 15 *EBcherichifi coli* 10, *Streptococcus dysgalactiae* 5 and *Streptococcus faecalie* 4 strains. Strepto-penicillin and Chloramphenicol were tho most effective drugs and Tetracycline, Streptomycin and penicillin were found to be the least effective for the treatment.

9. DEG NALA LIKE DISEASE IN BUFFALO CALF

The symptoms and lesions observed in the buffalo-calf resembled with those of Deg Nala disease. This buffalo-calf was administered oil of Brassica twice daily before each suckling. It is possible that this oil may have been extracted from such seeds of Brassica which may have become mouldy and the toxic matter may be present in oil. In villages, extraction of oils, particularly the oil of Brassica, is commonly done in wooden crushers but the storing conditions of the seeds are poor and conductive for mycotoxin formation. In what form, the toxic matter is present, it appears to share common effects with the etiological agent of Deg Nala Disease in causing vasoconstriction, leading to necrosis and sloughing of extremities.

10. STUDIES ON THE ANATOMY, HISTOLOGY AND BIOMETRY OF THE PITUITARY GLAND (ADENOHYPOPHYSIS) OF BUFFALOES

The pituitary gland of Nili-Ravi buffalo was found lodged in the sella turcica and was enclosed in a tough and fibrous connective tissue capsule, the diaphragma sella. The gland was elongated in heiers but thicker and oval in adult and aged buffaloes. The mean length, width and depth of adenohypophysis was 1.20 + 0.05, 0.92 + 0.07 and 0.55 + 0.10 cm in heifers below 2 years, 1.48 + 0.11, 1.13 + 0.12 and 0.78 + 00.02 cm in buffaloes of 2-5 years, 1.55 +0.05, 1.21 + 0.06 and 0.81 + 0.04cm in buffaloes of 6-8 years and 1.60 + 0.05, 1.23 + 0.04 and 0.88 + 0.03 cm in buffaloes above 8 years of age respectively. The average weight of entire gland in animis below 2,3-5, 6-8 and above 8 years of age were 1.17 + 0.12, 1.60 + 0.24, 2.20 + 0.21 and 2.45 + 0.14 gm respectively. The size and the weight of pituitary from pregnant animals were significantly higher from non-pregnant buffaloes. Microscopically, connective tissue capsule around the pituitary gland was composed of reticular and collagenous fibres. Parenchymal cells of adenohypophysis comprised of acidophils, orangiophills, carminophils, basophils and chromophobes. A moderate degree of acidophilia was observed in pregnant animals.

11. CUTANEOUS SQUAMOUS CELL CARCINOMA IN A BUFFALO

Squamous cell carcinoma, the malignant one of squamous epithelial cells, is a common neoplasm affecting all domestic animals but most common in dog, horse and cat. It has been found in all areas of the skin of domestic animals. Squamous cell carcinoma of skin and eyelids is not uncommon in bovine. In all species of animals there is a tenoon^.y for squamous cell carcinoma to develop in areas of

unpigmented skin. Squamous cell carcinoma is especially common in melanin-deficient skin. The melanin pigment acts as a screening agent for sun's rays, and thereby reduces the amount of injury to the skin. A grey coloured female buffalo, seven and a half years old, was brought to the university veterinary clinic for the reatment of swelling on the skin at dorsal of the left scapula. The grey colouration in buffaloes in due to the genetic relative deficiency in the melanin content of the skin. It is suggested that melanin deficiency might have played some role in the intiation of the carinogenic process in the skin of the buffalo. It revealed an association between the incidence of ocular squamous cell carcinoma and degree of pigmentation of the periorbital skin in Hereford cattle. The brownish-red pigment seon in some cattle of this breed has a definite inhibitory effect on the development of lesions.

However, there is no history that the buffalo under discussion had ever been exposed to x-rays or that any carcinogenic chemical had applied to its skin.

12. SCROTAL HERNIA IN RAMS

Six cases of unilateral scrotal hernia in rams treated successfully by surgory has been described. In three cases loft side of the scrotum was involved, while in three right side was affected. The hernial contents consisted of intestine and omentum. The mode of inheritance has not been determined. Suggestions have been made to control this affliction through sound breeding practices.

13. FALSE SCROTAL CUM VENTRAL HERNIA IN DONKEY

The precise aetiology of congenital and acquired scrotal hernia in male; domestic animals is enshrouded with controversy, but in the present case the peritoneal rents at both the locations of hernia probably occurred simultaneously, consequent to trauma. The spontaneous appearance of swelling in the ventral hernia was due to abdominal pressure, while the swelling in the left scrotum resulted gradually after inflammation subsided.

It is not always possible to differentiate clinically between false and true scrotal hernias. Differentiation is either possible through a careful rectal examination or at the time of surgical exploration. It is recommended that such cases must receive prompt attention and surgical correction as the prolapsed viscera may strangulate in the narrow and strange confines of hernial sac. In addition, prolapsed mass is vulnerable to trauma.

14. PENETRATING THORACIC WOUNDS IN HORSES

Punctured wounds of the thorax are always serious and must be treated as emergencies. Surgical debridement and reconstruction of the body wall must be carried out, even for those cases that have sustained severe contamination. The two cases being reported occurred in horses over a span of 6 years, both had perforation of the pleura, one of which survived while other succumbed to trauma.

In case I, the recovery was mainly due to the fact that the meticulous surgical care was provided promptly and the wound was luckily plugged by a segment of the lung which averted the collapse of the lungs. In case 2 there was apartial dehiscence of the skin wound after suturing. This may have resulted in generalized emphysema. This in concert with pulmonary infection and respiratory embarassment resulted in the death of the horse. In this emergency, authors did not have any facility to create negative pressure. In our field hospitals adequate facilities to manage any serious problem are non-existent. A short term management in the absence of such facilities consist of placing a moist cloth on the wound during an expiratory pause and then held in place. Chest should not be tightly bandaged as this would restrict thoracic movement and ventilation. Indeally such a case is best handled by nducing general anaesthesia, providing positive pressure ventilation, wound debridement and suturing in layers under an effective systemic antibiotic cover.

15. CHLORAL HYDRATE ANAESTHESIA

Chloral hydrate 6 per cent solution at dose level of 100 ing/kg was tried alone and in combination with magnesium sulphate. Fourteen clinically healthy buffaloes, divided into two age groups (adults and buffalo calves) were selected for the intravenous administration of the drugs. The effect of anaesthetic administration was observed on various body reflexes, tonicity of the muscles, blood pressure, pulse and respiratory rates. It was concluded that chloral hydrate can be used as a safe and reliable anaesthetic. No superiority of the addition of magnesium sulphate was recorded over chloral hydrate alone.

16. HYDRONEPHROSIS IN CAT

Two groups of cats of different age, sex and mixed breeding heritage were used in this study. In group I, consisting of 14 cats, the right ureter was ligated to produce sudden and complete occlusion. Euthanasia of 2 cats each was performed at 2, 4, 8, 16 and 24 weeks after ligation of ureter.

In each cat, complete ligation of ureter resulted in Hydronephrosis and hydroureter. The degree and nature of hydronephrotic atrophy followed a systematic pattern, and depended on the duration of obstruction. The left kidney showed macroscopic signs of compensatory hypertrophy.

In group II, consisting of 4 cats, bilateral occlusion of the ureters resultted in bilateral hydronephrosis. The degree of hydronephrosis was less marked as uraemia cut short the duration of the experiment. All the cats died within five days. It was concluded that complete and sudden occlusion of the ureter resulted in hydronephrosis.

17. FRACTURE

Radiographs of the fractured limbs of 12 dogs divided in a 4 groups were prepared at 42 days after operation. It was concluded that mobility at the fracture site, inadequate immobilization of the fractured part, inter-position of the soft tissue between the fractured fragments and infection were the potential cuses of non-union fractures of long bones in the dog.

18. PROLAPSE OP UTERUS IN THE BITCH

Perineal region was clipped and clean. Animal was premedicated with 25 mg chlorpromazine hydrochloride supplemented with local infiltration of 2% xylacaine solution in the body of the uterus. A transfixing ligature was applied in the uterine body. The prolapsed organ was amputated just caudal to the ligature. The stump was closed with a row of 00 chromic catgut stitches. After liberally dusting the slump with streptopenicillin, it ws replaced into the pelvis. Patient was given parenteral injection of streptopenicillin daily for 4 days. Two weeks post operation patient was reported to be fit and esting revenously.

19. DERMOID CYSTS IN PUPS

Occular dermoids is an embryological defect, composed of aberrant mass of skin like tissue an arise from foetal ectodermal transplants. It consists of fibrous tissue, hair follicles, subaceous glands, sweat glands and fat, and usually have hair projecting from its surface. This anomally is noticed by a vigilant owner soon after the lid separation takes place in pups. There lesions are irritative and there should, therefore, be little delay in excising them. During dissection penetration of the concern should be avoided, but it should be deep enough to remove all hair follicles. Treatment include surgical removal of dermoid under general anaesthesia. Cold liver oild was instilled to lubricate and protect the cornea. Dermoid was dissected away with a contaract knife and scissors. After care consisted of installation of cortisporin eye

ointment for several days.

20. TRIPLETS IN COWS

Dsairying cows are naturally uniparous animals. Multiple births are comparatively rare, though there is considerable variation between breeds, families and daughter's of seres within a breed. There is paucity of published records, perhaps none on the incidence of triplet births in our indigenous cow. Two cows were reported to deliver triplets. In both the cases the dam and triplets were normal in health. Several fetors point to the economic undesirability of multiple births in cattle. The general consensus is that cows producing multiple births are subject to post partum difficulties which endanger the life of the dams and impair subsequent reproduction. It is a reflection of genital disease rather than of health.

21. INFECTIOUS & METABOLIC DISEASES

21.1 STUDIES ON;

1. **EVALUATION OF SURF FIELD MASTITIS TEST FOR THE DETECTION OF SUBCLINICAL MASTITIS IN BUFFALOES AND CATTLE**
2. **ANTIBIOTIC SUSCEPTIBILITY OF THE PATHOGENS**
   BY FAZAL-UR-REHMAN - 1995

Four hundred quarter milk samples from apparently mastitis free 50 buffaloes and 50 cows were examined to evaluate the sensitivity, specificity, accuracy, predictive values and per cent agreement (Kappa value) of a new test viz. Surf field mastitis test (SFMT) vis-à-vis California mastitis test (CMT), modified Whiteside test (WST) and direct microscopic somatic cell counts (SCC). Using SCC a 5 x 10 cells ml of milk as gold standard of mastitis, sensitivity, specificity, accuracy, positive and negative predictive values (in percentage) of SFMT, respectively were 81.0, 88.7, 85.5, 74.6 and 92.0 in buffalo, and 88.9, 95.8, 93.0, 93.5 and 92.7 in cows. Corresponding values of these parameters for CMT were 86.2, 85.9, 86.0, 71.4 and 93.8 in buffaloes, and 90.1, 91.6, 91.0, 87.9 and 93.2 in cows. For WST, the values of these evaluation parameters in the sane order were 62.1, 94.4, 85.0, 81.8 and 85.8 in buffaloes and 66.7, 97.5, 85.0, 94.7 and 81.1 in cows.

With microbial status of quarters as gold standard of mastitis, the percent values of sensitivity, specificity, accuracy, positive and negative predictive values of SFMT, respectively were 68.8, 84.9, 80.0, 66.7 and 86.1 in buffaloes and 70.0, 87.9, 79.5, 81.8 and 78.0 in cows. For CMT, corresponding values in the same order were 68.8, 79.9, 76.5, 60.0 and 85.4 in buffaloes and 73.3, 84.5, 79.5, 79.5 and 79.5 in cows. The values of above parameters in the same order for WST were 55.7, 92.8, 81.5, 77.3 and 82.7 in buffaloes and 58.9, 96.4, 79.5, 93.0 and 74.1 in cows. A somatic cell count of $\geq$ 5 x I0^5 cells ml^{-1} with relevant value of 75.4, 91.4, 86.5, 79.3 and 89.4 per cent in buffaloes and 78.9, 90.9, and 85.5, 87.6 and 84.0, was the most efficient indicator of subclinlcal mastitis in both species.

Using a more stringent gold standard (combination of microblal status and SCC $\geq$ 5 x 10^5 cells ml^{-1}), sensitivity, specificity, accuracy, positive and negative predictive values (in percentage), respectively were 88.9, 85.2, 86.0, 63.5 and 96.3 for SFMT, 88.9, 80. 6, 82.5, 57.l and 96.1 for CMT, 73.3, 40.0, 88.5, 75.9 and 92.3 for WST and 100.0, 91.61, 93.5, 77.6 and 100.0 for SCC in buffaloes. Corresponding values in cows were 88.2, 87.1, 87.5, 77.9 and 93.5 for SFMT, were 89.7, 83.3, 85.5, 73.5 and 94.0, for CMT, 75.8, 95.4, 88.5 89.5 and 88,1 for WST and 100.0, 90.1. 93.5, 83.9 and 100.0 per cent for SCC, respectively.

The per cent agreement (Kappa value) between SFMT and CMT, SFMT and WST, SFMT and SCC, CMT and WST, CMT and SCC, and WST and SCC in buffaloes ware 92.13, 76.03, 70.40, 62.75, 70.25 and 60.77, respectively. In cows Kappa value between these tests in the same orders were 92.7, 78.81, 86.36, 71.95, 79.33 and 67.33, respectively.

Mean somatic cell counts ± SE in 10^5, found to be associated with -ve, ±, +, ++ and +++ scores of SFMT, respectively were 2.07 ± 0.22, 4.35 ± 1.47, 13.33 ± 4.10. 24.65 ± 8.05 and 144.64 ± 33.70 in buffalo milk and 2,22 ± 0.177, 8.09 ± 2.08, 9.73 ± 1.23, 60.9 ± 30.38, 350.81 ± 81 ± 268.50 in cow milk. Corresponding scores of CMT indicated similar cell counts both in buffaloes and cows. On the basis of sensitivity, specificity, accuracy and predictive values, somatic cell counts of 5×10^5 cells ml^{-1} of milk was found to be a suitable threshold value for delineating infected from noninfected quarters in both bovine species.

Somatic cell counts clearly responded to changes in microbial status of quarters. In case of buffaloes for no infection, infection, infection with minor pathogens and major pathogens mean of log 10 somatic cell counts respectively (LSCC) were 4.777 ± 0.127, 5.891 ± 0.133, 5.386 ± 0.237 and 6.219 ± 0.099. In case of cows, mean of LSCC for above microbial status in the same order were 4.893 ± 0.131, 5.986 ± 0.06, 5.674 ± 0.098 and 6.167 ± 0.065.

All the direct and indirect mastitis tests were quite efficient and gave the closer figures of animal and quarter wise prevalence. Animal wise prevalence was up to 78.0 per cent in cows and 64 per cent in buffaloes. Quarter wise prevalence in cows and buffaloes, respectively were up to 45 and 30.5 percent. The herdmate animals had higher prevalence of subclinical mastitis (upto 84.81 for cows and 75.01 for buffaloes) than individual animals (upto 64.70% in cows and 44.44% in buffaloes).

Staphylococcus aureus was the most frequently encountered pathogen (39.1 % in buffaloes and 47.3% in cows). Other organisms isolated were Staphylococcus h*ycus* (4.7% in buffaloes and 17 .0% in cows), *Staphylococcus* ep-idermidus (3.11 in buffaloes and 6.4% in cows), *Staphylococcus capitis* (1.6% in buffaloes), unidentified staphylococci (1.6% in buffaloes and 3.2% in cows, *Micrococcus varians* (3.2% in cows). Streptococcus a*gatlactiae* (10.9% in buffaloes and 7.4% in cows), *Streptococcus agalactiae* (3.1% in buffaloes and 1.1% in cows). Streptococcus *lactic* (1.1% in cows). Streptococcus progenies (1.6% in buffaloes, Corynebacterium *bovis* (7.8% in buffaloes and 1.1% in cows), C. *pyogenese* (3.1% in buffaloes and 2.1% in cows), other diphtheroids (4.7% in buffaloes), *E. coli* (6.2% in buffaloes and 1.1% in cows), non-coliform Gram -ve bacteria (4.3% in cows). Bacillus spp. (7.8 in buffaloes and 4.3% in cows), yeast (3.1% in buffaloes and Prototheca (1.6% in buffaloes). Mixed infections of 2 organisms was encountered in 1.5 and 2 per cent quarters of buffaloes and cows, respectively.

Of the 16 antibiotics tested, gentamycin, norflaxacin, chloramphenicol, cephalothin, sulfa-trimethoprim, clavulanated amoxycilline, lincomycin and oxytetracyclIne showed an in *vitro* efficacy over 90 per cent. Novobiocin, streptomycin, fusidic acid and erythromycin had efficacies between 80 to 90 per cent. The *In vitro* efficacy values for penicillin, amplcillln, cloxacillin and ampiclox were less than 80 per cent. *In vitro ß* lactamase activity was observed in *Staph. aureus* (80% both in buffalo and cow isolates) *Staphylococcus hyicus* (20% in cow and 100% in buffalo isolates) and *Staph. epidermidis* (20% in cow isolates).

In view of a close approximation of Surf field mastitis test (SFMT) and California mastitis test (CMT) in terms of sensitivity, specificity, accuracy, predictive values and Kappa values, it is tempting to recommend that SFMT be used as a reliable, cheaper, alternative to CMT for mastitis detection in developing countries where the use of CMT reagent may be economically prohibitive.

21.2 HAEMORRHAGIC SEPTICAEMIA;

(I) COMPARATIVE EFFICACY OF 2 TREATMENT PROTOCOLS AND
(II) SOME HAEMOTOLOGICAL AND BIOCHEMICAL PROFILES
BY M. ASHRAF RAZA – 1996

A total of 50 animals (39 Buffaloes and 11 cattle) suffering from haemorrhagic septicaemia (H.S) were

selected from the field. These animals were divided into 3 groups (A, B, C) and assigned randomly to either of three treatment protocol. Group A (20 animals) was treated with treatment protocol A i.e. Norfloxillin plus Diflosid and Novacoc forte. Group B was treated with treatment protocol B, which was essentially same as protocol A except Novacoc forte was omitted. Group C (10 animals, control) was treated with one of conventional therapies of H.S. i.e. Dipyron plus Gentamicin. The disease severity index under each treatment protocol was scored and recorded at 0, 12, 24, 48 and 72 hours from the start of treatment. All the treatments were started after application of cold water on head for 15 minutes. The treatment was repeated at 12, 24 and 48 hours after start of treatment as the situation warranted.

Two blood samples, one with EDTA for haematology (TLC, PCV, platelet count and fibrinogen) and other without EDTA for serum biochemical profiles (Na, K, Ca and Zn) were collected. A group of 10 healthy animals (group D) was also analyzed for haematological and biochemical profiles. These values were compared with those of H.S affected animals to assess the alterations as a result of the disease.

The survival percent was 85, 80 and 30 among animals treated respectively with protocol A, B and C. In terms of reduction of severity of disease, there was significance difference between protocol C and A and between protocol C & B at 12 and 48 hours after treatment but there was non-significant difference at hour 24. There was significant decrease in values of TLC, PCV, fibrinogen a non-significant decrease in platelet count, a significant decrease in serum sodium values and a significant increase in Ca while non-significant increase in K and Zn values between H.S affected animals and healthy animals.

Both treatment protocols A and B exploiting the use of quinolone plus a non-steroidal anti-inflammatory drug (Diflosid) with or without toxin neutralizer circulatory- stimulant (as Novacoc forte) were more effective than conventional line of treatment. In view of the preliminary nature of this work, further work is needed.

21.3 ASPECT OF COMMON DISEASE PROFILES, ETHNOVETERINARY AND MANAGEMENTAL PRACTICES, AND COMPARATIVE EVALUATION OF POUR-ON AND INJECTABLE IVERMECTIN IN PARASITISED DRAUGHT CAMELS

BY MUHAMMAD IQBAL - 1999

Draught camels working in cities represent a special class of dromedary, which has not as yet grabbed the desired attention of camel researchers. In part-1 of this study, data of 200 dromedary draught camels working in Faisalabad city were analyzed for common clinical disease problems, traditional treatment methods (Ethnoveterinary practices) and managemental practices.

A total of 427 entries of 33 different clinical disorders were recorded. Sarcoptic mange with 70 entries (35% of 200 camels) was the most common disease affecting draught dromedary working in Faisalabad city. This was followed by anhidrosis (23%), Surra (19%), dipetalonemiasis (17%). gastrointestinal parasitism (15%), abscesses (13%), nose-peg wounds (12%), automobile accidental wounds (11.5%), ticks (7%), diarrhoea (6.5%), harness injuries (5.5%), prescapular lymph node swelling (adenitis) (5%), pyrexia of unknown origin (5%), kumri (4%), pedestal pad wounds (4%), contagious skin necrosis (5.5%), pox (3.5%), leg/foot injuries (5.5%), orchitis (5.5%), Foot-and-mouth like disease (5%), dental irregularities (5%), chemical/fire burn (2.5%), rheumatism (2.5%), haematuria (1%), colic (1%), capped elbow (1%), dermatitis (non-specific) (1%), eye problems (1%), pediculosis (1%), chronic moderate tympany (0.5%), indigestion (0.5%), bronchitis (0.5%) and subcutaneous granuloma (0.5%).

The types as well as the frequencies of the clinical disorders as observed in the present study are fairly different from those reported from Bahawalpur area by Pakistan Agricultural Research Council Workers (Anonymous, 1992-95). These differences may be attributed to the differences in habitats and management as well as differences in the purposes of the two study populations.

Traditional treatment methods for 8 common diseases were listed. A mixture of Taramira oil, DDT powder and yogurt was the most common folk remedy used on camels affected with mange, Other traditional remedies consisted of a mixture of common salt, black salt, omum seed, cardamom, dhodda paneer, kali ziri and ginger for indigestion, a mixture of Jaggery, aniseed and kali ziri for rhinitis, a mixture of red chilli, black pepper. Kali ziri. kourh and cardamom for toxaemia, a mixture of omum seed and common salt for anhidrosis, a mixture of Tab. phenyl and tobacco for nasal myiasis, a mixture of simple oil. Ammonium chloride and vinegar for colic and a mixture of tobacco boiled in water for ticks and lice.

Mean age of the camel working in Faisalabad city was 9,52 ± 0.25 years. Camels of the Bikaniri breed (48%) were found the most common. Majority (58.5%) of camels were assessed to be in moderate body condition. Majority (65%) of the camels had shown rut during the past one year and mean duration of rut was 2.24 ± 0,04 months. Mean weight hauled/load was 5850 ± 90.50 Kg. Mean number of loads/day was 2.14 ± 0.06. Mean distance traveled/day was 10.91 ± 0.55 km. Mean working days/week was 6,01 ± 0.05 days. An average of 45.80 ± 0.55 kg of lucerne plus 5.46 ± 0,08 kg of broken gram mixed with 1.85 ± 0.09 kg of wheat straw/day was ration fed/day. *Veronia anthelmintica* (Kali ziri) was the most common ingredient of the "potions" administered to the camels. Vitamin/mineral supplementation and vaccination were not practiced. Mean water intake by the draught dromedary during summer was 48.40 ± 0.96 lit/day followed by 8-10 lit/day in autumn, 8-15 lit/days (forced) in winter and 8-10 lit/day during the spring season. Majority (89%) of the camels were kept in the open during winter, whereas, during the summer 100% camels were kept in the open. Eighty five percent of the camel owners used rug during the winter season.

Part-II of the study attempted to evaluate the comparative efficacy of pour-on and injectable ivermectin in mange and other parasitic conditions simultaneously affecting camels. Either preparation was tested on 10 mange-affected camels. In case of injection 2 camels were completely cured, 6 were partially cured and 5 remained uncured 15 days post-treatment. Application of pour-on product, affected a complete cure in 30% and partial cure to 20% camels at day 15 post-treatment, fifty percent camels could not be cured by pour on ivermectin product. All of the positive fecal and blood samples were declared negative to case of injectable product, whereas in case of pour-on product, both (2) of the positive fecal samples remained positive. 15 days post-treatment.

21.4 COMPARITIVE EVALUATION OF A COMMERCIALLY AVAILABLE HOMEOPATHIC PREPARATION AND AN ALLOPATHIC PREPARATION FOR THE TREATMENT OF BABULINE MASTITIS

BY IHSAN-UR-REHMAN - 2000

The Study was undertaken to evaluate comparative efficacy of a commercially available homoeopathic preparation and an allopathic preparation for the control of bubaline mastitis. Twenty quarters of buffaloes were selected on basis of Surf Field Mastitis Test. Two groups were made having 10 quarters (6 buffaloes) in group A and 10 quarters (4 buffaloes) in group B, Animals of both groups were kept in same managemental conditions. Out of 20 quarters, 16 quarters were SFMT negative after treatment. Two quarters in each group were SFMT positive even after treatment. So cure ate on basis of SFMT was 80 percent in both groups.

Bacteria in milk samples were cultured on Staph. 110 and Blood agar. Out of 20 samples, 18 milk samples yielded growth of various organisms and 2 samples were sterile. No. of colonies after culture were counted before and after treatment There were no significant differences In number of colonies between both *groups, (before and after the treatments*). There were significant differences between before and after treatments of each group. Gram's staining was (done lo identify Gram positive or Gram negative bacteria. Bacteria were identified on the basis of cultural characteristics. *Staphylococcus* had the highest prevalence followed by *Streptococci, E. coli, Micrococci* and *Bacilli* spp.

To study the effect of both treatments on somatic cell count (SCC). It was conducted before and after the treatments. Staining of' 1 cm^2 marked area with Newman's Lampert Stain was done and seen under oil immersion objective microscope. Somatic cells per ml of milk were counted. There was non-significant and slight increase in SCC of before and after treatments of both groups.

To study the effect of both treatments on milk composition. It was also determined before and after treatments There was non-significant difference between the milk composition of both groups. However, there were significant differences between before and after treatments in both groups. Milk fat, protein, acidity, total solids. SNF and specific gravity were low before treatment due lo subclinical mastitis. Above values of milk composition parameters become almost normal alter the treatment in both groups.

Statistical analysis revealed that efficacy of homoeopathic preparation Mastcare and allopathic preparations (Spectrazole I/mm tube plus injection tribrissin) was almost equal. However, the cost of treatment of allopathic drug used in this project was too high as compared to that of homeopathic preparation. Therefore, it is recommended that cheaper and effective preparations like Mastcare can be used to cure sub clinical mastitis in buffaloes.

21.5 PREVALENCE OF TRYPANOSOMIASIS AND DETERMINATION OF BLOOD PARAMETERS IN EQUINES AND CAMELS OF FAISALABAD

BY MUHAMMAD SAEED - 2001

Trypanosomiasis in camels and equines caused by *Trypanosoma evansi* occurs in both acute and chronic forms. Huge production losses occur, in chronic forms i.e. lower milk and meat yield in camels. The present study has been designed to find out the prevalence of disease, estimation of haemoglobin, packed cell volume, total erythrocyte count, total leukocyte count, differential leukocyte count. This study will help in control program of trypanosomiasis.

For the prevalence, blood samples were collected from different localities of Faisalabad including outdoor clinic, Department of Clinical Medicine & Surgery, University of Agriculture of Faisalabad and confirmed by wet blood film, making smears stained with Giemsa's stain and hematocrit centrifugation technique. Out of 200 samples (150 equines and 50 camels) 2 camels were proved to be positive but none of the equine was positive.

Haematology of positive camels showed significant difference regarding its comparison with the normal average values. The average values of haemoglobin, packed cell volume, total erythrocyte count and total leukocyte count g/100 ml, 24 %, 4.2 $xl0^6$ / micro liter, 12.4x 10^3 / micro liter respectively. Neutrophils, lymphocytes, eosinophils monocytes and basophils and were found 29 %, 66 %, 2 %, 2%, 1 % respectively. The laboratory finding of total erythrocyte count, total leukocyte count, differential leukocyte count, haemoglobin estimation and packed cell volume showed an increase in lymphocyte and total leukocyte. While there was a decrease in total erythrocyte count, neutrophils, hemoglobin and packed cell volume.

21.6 ANTIGENIC RESPONSE OF A LIVE ATTENUATED STAPHYLOCOCCUS AUREUS MASTITIS VACCINE IN RABBITS

BY ABDUL ASIM FAROOQ - 2002

The study was undertaken to prepare and evaluate the antigenic response of the experimental live attenuated *Staphylococcus aureus* vaccine in rabbits. A total of 30 buffaloes were examined for mastitis. The surf field mastitis test (SFMT) was used for the detection of sub-clinical mastitis. Total eight buffaloes were found positive giving prevalence of 26.6%. The prevalence of sub-clinical and clinical mastitis was measured as 16.6% and 10% respectively.

Milk samples were cultured on staph-110 and blood agar. *Staphylococcus aureus* isolate were confirmed on the basis of morphological and biochemical characteristics of these one isolate of *Staphylococcus aureus* was used for the preparation of vaccine that was Gram + ive cocci, non motile, catalase & coagulase positive. It gave complete haemolysis on 5% sheep blood agar at the out set and last after 37 successive passages.

A total of 30 rabbits were divided into 3 groups, A, B & C each having 10 animals. Group A was given single injection of vaccine, group B was vaccinated twice at two weeks interval while group C was kept as control. Serum samples were collected from 3 rabbits selected randomly from each group at weekly interval.

From day 0 to 6 weeks post vaccination, antigenic response was evaluated through anticoagulase, antihaemolysin and bacterial agglutination tests which showed that antigenic response was highly positive at day 21 in group A & B while same was in group B at 42 day of post vaccination.

The results of anticoagulase test showed that these were positive for anticoagulase test and the results of antihaemolysin test showed that these were positive for antihaemolysin test.

21.7 STUDIES ON THE CLINICAL MASTITIS IN BUFFALOES WITH SPECIAL REFERENCE TO STAPHYLOCOCCUS AUREUS

BY MUHAMMAD MALIK AUWAIS AKRAM – 2002

This study was conducted to investigate the most common pathogens, which cause this important disease of livestock. A total of 50 buffaloes were included in this study. Bacteriological examination of the milk samples obtained from these buffaloes was conducted for the isolation and identification of the pathogens involved in the incidence of the disease. For this purpose, a total of fifty buffaloes milk samples were utilized. Quarters infection was higher in the hind quarter than the fore quarters.

All the breeds of the buffaloes maintained in the area were reported to be occasionally affected during the lactation. Age and lactation wise distribution of mastitis varied in different age groups being highest in 6-8 years of the age group and 4-6 lactation (24.0%) and (40%) respectively. Out of these 50 cases, 50 isolates of different species were isolated as i.e. 20 *Staphylococcus aureus, 4 Staphylococcus epidermidis, 6 Streptococcus agalactiae,* 4 *Streptococcus dysgalactiae, 1 Streptococcus pyogenes,* 6 *Bacillus cereus* and 8 *E.coli.*

Antibiotic sensitivity of the isolates showed that they were sensitive in descending order to Gentamycin (100%), ciprofloxacin (97.1%), chloramphenicol (91.3%), cephalothin (95.7%), sulphatrim (94.4%), amoxycillin (88.4%), Lincomycin (94.2%), oxytetracycllne (88.4%), novobiocin (86%), erythromycin (93%), ampicillin (49.2%) and penicillin G (45%). The high incidence of *Staphylococcus aureus* is calculated that is the most common pathogen present in the local conditions causing mastitis.

21.8 PRELIMINARY CLINICO-EPIDEMIOLOGICAL AND THERAPEUTIC OBSERVATIONS ON THE BARSEEM-ASSOCIATED SLOBBERING SYNDROME IN LIVESTOCK

BY SHELLA KANWAL - 2002

In Pakistan, outbreaks of slobbering syndrome (excessive salivation syndrome) are encountered regularly by the farmers and veterinarians in spring months (March-thru-May), when animals are fed on berseem *(Trifolium alxendrinum)* also called Egyptian clover. The syndrome is typically associated with second-last cutting of this fodder. The etiology of this widely rampant syndrome has always baffled the minds of Pakistani veterinarians and farmers who generally relate it to the ingestion of berseem infested with caterpillars (insects larvae colloquially called *'Sundhee'* or snails. A similar syndrome characterized clinically by profuse salivation, copious lacrimation, excessive urination, and frequent defecation

reportedly occurs in certain parts of US, when animals are fed on Red Clover infested with a saprophytic fungus viz. *Rhizoctonia legumincola.* The acronym SLUD is used to describe the signs of this syndrome. As far as could be ascertained, no local research seems to have been undertaken thus far on the berseem-associated slobbering syndrome (BASS) in livestock.

In a bid to resolve etiologic nature of BASS, outbreaks of the syndrome were recorded in 17 villages of Pakistani Punjab. Analysis of results revealed that the syndrome was restricted in its occurrence to a 3-month spring period (March-thru-May), Species-based attack rates of the syndrome were highest in cattle (86.2%), followed by buffalo (84%), equine (80%), and sheep (64%). The lowest attack rate (52%) was recorded in goats. All berseem fodder samples (n=60) carried blackish-brown specks on leaves whereas presence of larvae (caterpillars) and snails were recorded in 71.7 and 41.8% samples, respectively. The clinical signs and their percent frequencies recorded were as follows: salivation (100), lacrimation (71.6), urination (16.6), increased defecation (30), anorexia (100), decreased milk production (95), increased water intake (43.3), dehydration (46.6), bloat (5), abdominal pain (8.3), increased respiration and pulse rate (48), respiratory distress (1.6), fever (15) and complications (15). Combination signs in different permutations were: salivation and lacrimation (71.6%), salivation and urination (16.6%), salivation and defecation (30%). All SLUD signs were observed in only 15% of the cases. An attempt was also made to determine the etiologic nature of BASS. To this end, samples of putative berseem fodder were examined grossly and microscopically for the presence of specks. Culturing the putative fodder on potato-dextrose agar, Waklsman agar and Cezapek-Dox agar plates yielded growths of *Rhizictonia solani, Fusarium oxysporum* and *Alternaria altema.* The pure cultures of these fungi were grown for 30 days on water extract of berseem fodder enriched with soybean, calcium carbonate, dextrose and corn steep liquor. Guinea pigs (200-500g) dosed with the mycelial mats of R. *solani* blended in culture medium nitrate through orogastric tube exhibited signs of SLUD in different combinations and finally died within 6—12 hours post-administration. However, when this mixture was administered either with chlorpheniramine maleate, atropine sulphate or a mycotoxin-adsorbent preparation containing HSCAS (hydrated sodium, calcium, aluminium silicates) together with a mixture of illite and chlorite clays (MYCO-AD™, Special Nutrients, Inc. USA) no such signs appeared. It is noteworthy that feeding of culture medium filtrate of *F. oxysporum or A. altema* consistently culminated in death of guinea pigs without exhibiting any constituent signs of SLUD syndrome.

In conclusion, the popular notion relating the bcrseem-associated slobbering to the ingestion of caterpillars or snails infesting the fodder appears to be untenable. Contrarily, the salivation factor(s) associated with berseem feeding appears to be the product(s) of R. *solani.* The clinical signs of slobbering syndrome in guinea pigs appear to be blockable by the administration of either antihistaminic or anticholinergic drugs as well as by a mycotoxin-binder. Comparable investigations in the target livestock species are yet to be undertaken. The results reported here still await external validation. It is hoped that this preliminary study will spur further interest in establishing definitively the cause and therapy of this syndrome, which in theory should be rife in all berseem growing regions particularly in the contiguous Indian Punjab.

21.9 FIELD SURVEY OF ANTIBIOTIC TREATMENT OF *ESCHERICHIA COLI* INFECTION IN POULTRY AND EVALUATION OF EFFICACY OF ENROFLOXACIN PLUS COLISTIN IN EXPERIMENTAL COLIBACILLOSIS

BY TANVEER AHMAD – 2002

In part I of the present project thirty Escherichia coli infected broiler farms located District, Faisalabad were visited from May 2002 to August 2002 to obtain data pertaining to antibiotic usage pattern, storage of antibiotics, withdrawal, and farmers perceptions on antibiotic resistance. Data collected from these farms showed that antibiotics are mostly used in combination in order to treat/control *Escherichia coli* infection in broilers. Different antibiotics combinations were being used in order to combat *Escherichia coli* infection. But enrofloxacin was being used along with colistin on most of the poultry farms.

On the basis of this study, the efficacy of enrofloxacin plus colistin was determined in vivo conditions in part II of the present project. For this purpose 140 broiler birds were purchased and reared under uniform managemental conditions. At the age of 25 days, birds were divided into four groups (Viz. A, B, C and D having 35 birds each). Escherichia coli infection was induced experimentally by oral inoculation of $1xl0^6$ CPU/bird. The birds of group A were treated with enrofloxacin (20% @ lml/41it) plus colistin sulphate (1 gm per 10 liter drinking water), group B birds were treated with enrofloxacin (20% 1 ml per 4 liter) birds of group C were treated with colistin sulphate (1 gm per 10 liter) while group D served as untreated control. Cumulative feed consumption, mean body weight, mortality and FCR were recorded. Minimum mortality was observed in group A (i.e. 5.76 %) while mortality in group B and C was 22.86 and 17.14 % respectively. Highest mortality was recorded in group D i.e. 40 %. F.C.R. in group A, B, C and D was 2.45 , 2.51 , 2.65 and 2.89 respectively.

The results of the present study demonstrated that enrofloxacin-colistin combination is more effective in reducing *E. coli* associated mortality and in accruing better FCR than either of these antibiotics alone.

21.11 TRYPANOSOMA EVANSI INFECTION IN EQUINE AND DROMEDARY: I. EVALUATION OF LATEX AGGLUTINATION TEST AND, II. EFFICACY OF SURANOL-T AS A THERAPEUTIC AGENT

BY MURTAZ-UL-HASSAN – 2002

Trypanosomiasis "Surra" in camels and equines was caused by *Trypanosoma evansi.* It adversely affects the health and productivity of camels and equines. The information on the *Trypanosoma evansi* infection, efficiency of latex agglutination test and other diagnostic tests (direct and indirect) and the chemotherapy of the disease was limited. The present study was therefore designed to investigate *Trypanosoma evansi* infection, evaluation of latex agglutination test and other diagnostic tests (direct and indirect) and to check the efficacy of Suranol-T as a therapeutic agent. The positive or negative results of all tests were compared with the haematocrit centrifugation technique (HCT), which was used as gold standard. The efficiency of latex agglutination tests (LAT) was compared with the haematocrit centrifugation technique (HCT). To check the efficacy of Suranol-T, the results of parasitemia was noted at day 7, 14, 21 and compared with Cymelarsan.

A total of 320 animals (150 camels and 170 equines) of either sex, different ages, different functional classes from different localities in Punjab (Faisalabad, Toba Tek Singh, Bahawalpur, Gojra and Okara) were investigated over a period of one year (May, 2001 to April, 2002). Of 150 camels, four (2.66%) camels were detected positive by wet blood film (WBF), thin stained smears (TSS) and thick stained smears (THSS). Five (3.33%) camels tested positive by haematocrit centrifugation technique (HCT). In the indirect test category, 13 (8.66%), 16 (10.66), 12 (8.0%), and 6 (4%) camels tested positive by formol gel lest (FGT), mercuric chloride test (MCT), thymol turbidity test (TTT) and latex agglutination test (LAT), respectively- Direct tests detected the number of positive cases 4-5 (2.66%-3.33%) whereas the value observed by indirect tests ranged between 6-16 (4%-10.66%) in camels, while none of equines detected positive by these tests.

Comparative efficiency of the stated tests was evaluated on the basis of their sensitivity, specificity, accuracy, predictive values (positive and. negative) in relation to gold standard, haematocrit centrifugation technique (HCT). In diagnostic tests, all the direct tests i.e. wet blood film (WBF), thin stained smears (TSS) and thick stained smears (THSS) showed 80% sensitivity, 100% specificity, 99.31% accuracy, 100% positive predictive values and 99.31% negative predictive values. Whereas in case of indirect tests the sensitivity was >60%, specificity >91.03%, accuracy was >90%, positive predictive values >18.75% and negative predictive value was >98.50%.

In case of latex agglutination test (LAT) the sensitivity was 80%, specificity was 98.62%, accuracy was

98.00%, positive predictive value was 66.66% and the negative predictive value was 99.30% and these values were found very close to the gold standard. The percent agreement (Kappa value) was >85% in the direct test, while in the indirect test it was >20.40%. In this study the physiological parameters revealed a slight rise in temperature (101.80 ± 0.38 °F, Pulse (40.40±78 per minute) and respiration rates (12.40 ± 0.74 per minute) in *Trypanosoma evansi* infected camels. Petechial haemorrhages, difficulties in work, decrease in feeding, decrease water intake and atrophy of hump was also recorded in infected animals.

Out of 150 camels, five were detected positive for *Trypanosoma evansi* infection by the gold standard, haematocrit centrifugation technique (HCT) and they were treated with Suranol-T (n=4) and Cymelarsan (n =1). After treatment, the blood and serum samples examination were carried out at day 7, 14 and 21. It was observed that Suranol-T (Homoepathic injectable preparation.) was 25% effective at day 14 and 50% at day 21 while the camel treated with Cymelarsan were observed for parasitemia at day 7, 14, 21 and it was 100% effective at day 7.

21.12 DRINKING WATER QUALITY IN RELATION TO ESCHERICHIA COLI ASSOCIATED POULTRY PROBLEMS

BY MUHAMMAD ZAFAR – 2002

The project was designed to investigate the drinking water quality being supplied to various poultry farms in peri-urban and rural areas of Faisalabad. In addition, the association of drinking water quality with *Escherichia coli* associated poultry problems was also determined.

Fresh drinking water samples from 50 randomly selected commercial poultry farms were collected. Samples were analyzed for total dissolved salts, electrical conductivity, calcium, magnesium, sodium, carbonate, bicarbonate, residual sodium carbonate and pH. Information about *Escherichia coli* associated poultry problems, mortality, morbidity and other managemental practices were collected on proforma.

The values of water quality parameters were matched with the maximum threshold levels for domestic fowl and found that water being supplied to various poultry farms in Faisalabad district is rich in salts. These excess salts are responsible for various abnormalities and pathological conditions in birds-Also cause vaccination failure and may alter antibody production.

In the next phase of this project, the association between drinking water quality parameters and *Escherichia coli* was studied. For this purpose, values of these parameters were stratified into various ranges. The total number of farms falling in each range were counted. Morbidity rates and total number of birds for each farm were added respectively. Then the percent incidence of *Escherichia coli* associated poultry problems was determined for each range. In this way, percent incidence of *Escherichia coli* associated poultry problems was derived for all the parameters.

Finally, data obtained was drawn into separate graphs for each parameter. It was observed that there is no association between drinking water quality and *Escherichia coli.* Moreover, no specific trend of disease in relation to water quality parameters was noted.

21.13 ANTIGENIC RESPONSE TO COMPOSITE FORMALIN INACTIVATED *STAPHLOCOCCUS* AUREUS, *STREPTOCOCCUS* AGALCIAE and *E. COLI* IN RABBITS

BY MUHAMMAD AVAIS - 2003

The study was undertaken to prepare and evaluate the antigenic response to formalin-inactivated S. *aureus, Str. agalactiae* and *E. coli* composite antigen in rabbits. A total of 20 buffaloes positive for clinical mastitis were selected for the isolation of *S. aureus, Str. agalactiae* and *E. coli.*

Milk samples were cultured on blood agar for primary isolation of bacteria. The suspected colonies of *S. aureus, Str. agalactiae* and *E. coil* were confirmed by culturing on staph. 110, Edward's media and MacConkey's agar respectively and their morphological and biochemical characteristics were observed. *S. aureus* was found G +ve, cocci arranged in clusters, non-motile, catalase and coagulase positive. *Str. agalacliae* was also G +ve, cocci arranged in chains, non-motile, calalase and citrate negative. *E. coli* was G -ve, rods, citrate negative and triple sugar iron test positive. Of these isolates of *S*. *aureus, Str. agalactiae* and *E. coli* a formalin-inactivated composite was prepared and its primary, secondary and dose-dependant antigenic responses were determined in rabbits.

A total of 21 adult healthy rabbits were kept and divided randomly into 7 groups (A, B, C, D, E, F, G) containing 3 rabbits each. The rabbits of groups A and B were inoculated with 0.2 mL of the inoculum containing 10^9 cells/ml of each of *S. aureus, Str. agalactiae* and *E. coli,* whereas the rabbits of group C were kept uninoculated control. The rabbits of group B were given a booster dose at day-15 of the primary injection. Serum samples were collected at weekly intervals till day-60 to compare the primary and secondary antigenic response. The rabbits of groups D, E and F were injected with inocula containing 10^7, 10^8 and 10^9 cells/ml of each of 5. *aureus, Str. agalactiae* and *E. coli,* respectively, to compare the dose dependent antigenic response. Group G served as control. Blood samples were collected from rabbits of each group at weekly intervals for four consecutive weeks and serum was obtained and stored at -4°C.

In group A and B, (from day 0 to 60) primary and secondary antigenic response and in group D, E and F, (from day 0 to 28) dose-dependent antigenic response was evaluated through Indirect Haemaggluti nation (IHA) test. The results showed that at day 30, antibodies were significantly higher with GMT 97.0, 39.4 and 24.3 against *S. aureus, Str. agalactiae* and *E. coli* in group B respectively compared with group A with GMT 9.8, 9.8 and 12.1 against *S. aureus, Str. agalactiae* and *E. coli* respectively. At day 28, the GMT of group D was 19.7, 16.0 and 32.0 against *S. aureus, Str. agalactiae* and *E. coli* respectively. In group E the GMT at day 28 were 48.5, 39.4, and 48.5 against *S. aureus, Str. agalactiae* and *E. coli* respectively. In group F the GMT at day 28 were 64.0, 64.0 and 78.8 against *S. aureus, Str. agalactiae* and *E. coli* respectively. The results of group A and B for assessing primary and secondary antigenic response showed that selected field isolates were antigenic in nature and they may elicit antigenic response in laboratory animals.

The results of group D, E and F for assessing dose-dependent antigenic response showed that antigenicity of *S. aureus, Str. agalactiae* and *E. coli* is dose-dependent. So there is direct relationship between antigen concentration and its antigenic response.

21.14 ANTIGENIC RESPONSE TO FORMALIN INACTIVATED *Escherichia Coli* IN RABBITS BY KAMRAN IBRAHIM - 2003

The study was conducted to monitor the antigenic response of formalin inactivated *Escherichia coli* antigenic preparation in rabbits. The ultimate objective of the study is to evaluate the experimental vaccine in buffaloes, which are the actual hosts of the disease. However preliminary trails are prerequisites before its final commencement in buffaloes. That is why present study was conducted in rabbits.

An *Escherichia coli* isolate recovered from an acute case of mastitis in buffalo was utilized to prepare antigenic preparation of this organism. Indirect haemagglutination (IHA) method was used for evaluating primary and secondary immune response of *Escherichia coli* and dose-dependent antigenic response to *Escherichia coli* antigenic preparation.

A total of 21 adult healthy rabbits, divided randomly into 7 groups containing 3 rabbits each, were utilized in this study. The rabbits of groups A, B, and C were utilized for assessing the primary and secondary

immune response of *Escherichia coli* antigen where as those of groups D, E, F, and G were used for evaluating the dose-dependent antigenic response to *Escherichia coli* antigen.

Both A and B groups resulted positive increase in GMT but in group B, there was further increase in titer at day 45 and 60 as animals of this group was given a booster dose of *Escherichia cot's* antigen at day 15. This indicated a positive relation between primary and secondary immune response while giving a booster dose of antigen at day 15.

Groups D, E, and F resulted a progressive increase in titers with reaching maximum at day 21 with GMT of 24.3, 39.4, and 78.8, respectively. While sera of group G showed no increase in titers. This indicated a positive dose dependent antigenic response of *Escherichia coli* antigenic preparation.

21.15 IMMUNOLOGICAL CROSS-REACTIVITY AMONG DIFFERENT ISOLATES OF *STREPTOCOCCUS AGALACIA* FROM MASTITIC BUFFALOES AND COWS

BY RAI KHUDA DAD - 2003

Streptococcus *agalactiae* is one of the major causes of mastitis in dairy animals, which results in heavy economical losses to the livestock industry. Milk samples from a total of 100 dairy animals were examined. Among positive mastitic cases, 32 Streptococcus agalactiae variants were isolated. Out of these only eight variants varying in their morphology, cultural and biochemical characteristics were used for the preparation of 8 different inactivated whole culture vaccines. All the variants were found cocci, Gram positive, with small, moist and dewdrop like colonies ranging 1-2 mm on blood agar medium. All the strains were negative for catalase and Esculin but positive for CAMP reaction. For selected variants, respective hyperimmune sera were also prepared in rabbits.

The cross-reactivity among these *Streptococcus agalactiae* variants was determined with the help of two tests viz. bacterial agglutination test and modified counter immunoelectrophoresis (MCIE).

Bacterial agglutination occurred in the presence of other variants immune serum with some exceptions. Using the bacterial agglutination test, 93.75 percent cross-reactivity among the variants on the basis of agglutination among the variants and the immune sera against each of the variant. About 6.25% reactions showed no agglutination.

In modified counter immunoelectrophoresis (MCIE), results indicated 100% cross-reactivity among the Streptococcus agalactiae isolates showing precipitation band among isolates and immune sera.

Keeping in view the results of this study, it may be said with that the isolates of Streptococcus agalactiae cross-react with each other. So the vaccine being developed against Streptococcal mastitis at the Department of Clinical Medicine, University of Agriculture Faisalabad was conceivably be effective to control the Streptococcus *agalactiae* mastitis in buffaloes and cows in Faisalabad, Jhang, Toba Tek Singh and Sargodha districts of the Punjab province.

21.16 PRODUCTION, PURIFICATION AND EVALUATION OF STAPHYLOCOCCUS AUREUS BETA-TOXIN IN RABBITS

BY HAFIZ MUHAMMAD IHSAN ULLAH - 2004

Thirteen strains of *Staphylococcus aureus,* ten from buffalo mastitis and three from cow mastitis were isolated on *Staphylococcus* medium No.I10.

The isolated strains were maintained on nutrient agar slants. All the strains of *Staphylococcus aureus* were coagulase positive but strains from different sources showed variation in their coagulase activity with rabbit and sheep plasma

Fibrinolytic activity of *Staphylococcus aureus* strains was also tested with rabbit and sheep plasma. All strains were non-fibrinolytic with sheep plasma. The rabbit plasma gave better results.

Strains of *Staphylococcus aureus* were cultured on trypticase soya agar slants & then shifted to semi solid Brain heart infusion agar. After that isolation of crude beta hemolysin was done by centrifugation method.

The concentration of beta hemolysin in broth cultures reached to its peak after 24 hours, and then declined rapidly in the semisolid agar, the concentration of beta hemolysin reached an identical peak after 24 hours, and remained unchanged for 64 hours.

The addition of agar to the culture medium potentiated the production of beta haemolysin; 0.3 percent agar was satisfactory and higher amounts were not required.

Crude beta haemolysin on sheep blood agar plates produced only zones of darkening, which changed into zones of complete lysis on subsequent refrigeration.

The preparation of crude beta haemolysin not only caused hot cold lysis of sheep cells but also haemolysed rabbit cells. However, further studies with a purified form of the factor causing of rabbit cells revealed that it was not alpha haemolysin.

Purification of beta haemolysin was done with double ammonium sulphate precipitation. Purified beta toxin was used to calculate the haemolytic activity against sheep & rabbit erythrocytes.

Maximal haemolytic activity of beta haemolysin occurred around pH 7.0. The haemolysin also required magnesium or manganese ions for maximal activity. Ferrous ions were less effective than magnesium ions, and calcium ions inhibited the activity of beta haemolysin.

Purified beta-toxin was injected intradermally into the rabbits to demonstrate the dermonecrotic activity and intravenously injected to demonstrate the lethal activity of beta-toxin. After that toxin was inactivated to convert into toxoid with 4 percent formaline.

Now beta-toxoid was used to calculate the hemolytic antibody titre, inoculated into rabbits, which shows that beta-hemolytic antibody titre is inversely proportional to dilution of beta toxoid.

The graphical presentation also shows that, there is successful production of antibodies in both groups inoculated with and without adjuvanted beta hemotoxoid and beta hemolytic antibody titre is directly proportional to the concentration of beta hemotoxoid.

Dextran sulphate produced best results as compare to simple beta hemolytic toxoid. So at the end it was concluded that beta toxoid seems to be a better candidate for further study in dairy animals. Bcta-haemotoxoid may be used as subunit vaccine for control of *Staphylococcus aureus* mastitis.

21.17 PRODUCTION, PURIFICATION AND IMMUNOLOGICAL EVALUATION OF *STAPHYLOCOCCUS AUREUS* ALPHA-TOXIN IN RABBITS

BY MUHAMMAD IKRAAM - 2004

The study was conducted for production, partial purification of *Staphylococcus aureus* alpha toxin along with its antigenic response in rabbits. A total of 44 rabbits divided into three groups i.e. A, B and C. Group-A was further divided into 5 subgroups of 4 rabbits each (A1 thru A5). In group A, five subgroups were administered with different amounts of partially purified *Staphylococcus aureus* alpha toxoid alone

i.e. 1:10, 1:20, 1:40, 1:80 and 1:160 HU respectively Similarly group-B was further divided into 5 subgroups (Bl thru B5). Group B, was administered with different doses of Dextran Sulphate adjuvanted alpha toxoid of *Staphylococcus aureus.* The Group C served as control group. The analysis of purified alpha toxin was done by hemolytic activity, dermonecrotic activity and lethal action in rabbits. The different levels of alpha toxin was determined by hemolytic units. To prepare alpha toxoid, the alpha toxin was inactivated by 4 % formaline. Then again checked its hemolytic activity by using 1% sheep RBCs. There was no hemolytic activity. Blood sampling was done at weekly intervals to collect serum from all subgroups for a period of three weeks in order to measure the antigenic response using Toxin Neutralization test (Alpha Hemolytic Antibody titre). There was Production of alpha-hemolytic antibodies in both cases i.e. Simple toxoid and adjuvanted toxoid. Alpha hemolytic antibodies titer was directly proportional to the concentration of toxoid dilution. As 1:10 HU showed highest Alpha-hemolytic antibodies titer as compared to the remaining i.e. 1:20, 1:40,1:80,and 1:160 HU. Dextran Sulphate adjuvanted Toxoid showed overall better results than simple toxoid at all concentration of toxoid in rabbits.

21.18 IMMUNOLOGICAL CROSS-REACTIVITY AMONG DIFFERENT ISOLATES OF *STAPH AUREUS* ORIGINATING FROM MASTITIC CASES OF BUFFALO AND COWS

BY MUHAMMAD NAEEM 2004

Staphylococcus aureus is one of the major etiological agents of mastitis in dairy animals in Pakistan. Mastitis associated with this microorganism results in heavy economical losses to the livestock industry. Owing to a lack of applications of standard mastitis control practices, efforts are a foot at the Department of Clinical Medicine and Surgery, University of Agriculture, Faisalabad, to develop an immunological control of *S. aureus* intra mammary infections. In order to anticipate a wide applicability of *S. aureus* mastitis vaccine being developed, it is imperative to examine the cross-reactivity between the vaccinal *S. aureus* and isolates of this organism originating from other major dairy farming areas of Punjab. To this end, milk samples from a total of 200 dairy animals kept by dairy farmers in district Toba Tek Singh, Jhang, Sargodha and Faisalabad were examined. Forty-eight *S*. *aureus* isolates were recovered. Of these, 10 variants varying in their morphology, cultural and biochemical characterization (two isolates from each of four district of Punjab viz. Toba Tek Singh, Jhang, Sargodha and Faisalabad) were used for the preparation of 10 different inactivated whole culture vaccines. All variants were found cocci, *G +ve,* with yellow, white, orange pigmented colonies ranging 0.5-/nm on staph. 110 medium. All isolates were positive for catalase, coagulase and casein hydrolysis tests. Hyperimmune sera were raised against the selected 10 variants of *S. aureus.* Bacterial agglutination test was performed to determine the cross-reactivity between Held and vaccinal isolates and among the field isolates. All the isolates cross-reacted with each other. The range of cross-reactivity index (CRI) was 0% (on a scale of 0-100%, with 0% being complete identity and 100% being nil identity). While performing drug sensitivity these isolates showed a higher degree of sensitivity to gentamycin, ciprofloxacin and progressively decreasing to amoxycillin and penicillin G.

A high degree of immunological cross-reactivity among *Staphylococcus aureus* isolates originating from 4 districts of Punjab (Toba Tek Singh, Jhang, Sargodha, and Faisalabad), points to potential effectiveness of *Staphylococcus aureus* vaccine being developed at the Department of Clinical Medicine and Surgery, University of Agriculture, Faisalabad, in these districts.

22. METABOLIC DISEASES

22.1 EVALUATION OF SINGLE SUPER PHOSPHATE AS SOURCE OF PHOSPHORUS SUPPLEMENT IN COW CALVES FED ON BARSEEM

BY MUHAMMAD UMAIR IQBAL - 2004

The study was planned to evaluate the single superphosphate fertilizer as a source of phosphorus in

Sahiwal cows calves (n=16) for a period of two months at Livestock Experimental Station, Department of Livestock Management, University of Agriculture, Faisalabad. Feeding treatments comprised of a mixture of berseem *&* wheat straw (group A, control); super juice of single superphosphate (group B); single super phosphate powder (group C) and super juice of single super phosphate powder 20% extra (group D) supplemented to cow calves according to Nutrient Requirement Council. The experimental animals were examined for serum calcium and phosphorus, packed cell volume and haemoglobin concentration, weight gain, salivary phosphorus and calcium and faecal phosphorus and calcium-Mean values and percent increase of serum phosphorus and calcium in group A (3.32 & 9.80 mg/dl; 6.15 & 2.56 %), group B (7.10 & 10.75 mg/dl; 199 &2I %), group C (9.32 & 11.55 mg/dl; 346 & 20 %) and group D (8.01 & 14,63 mg/dl; 300 & 12,8 %) indicated that group C in which the feed of'calves were supplemented with superphosphate responded well as compared to other treatments. The percent increase in serum phosphorus level varied at different sampling days and phosphorus supplementation had no significant effect on serum calcium level. There was no significant increase in body weights between control and treated groups having mean values/percent increase of 101.90kg/15 % (group A); 102.20 kg/14 % (group B); 101,02 kg/5.5 % (group C) and 110.10 kg/25 % (group D). However, group D that was supplemented with super juice (20%) above the NRC recommendations acquired a non-significant little more weight gain. The salivary phosphorus level was elevated in group A (27.45 mg/dl; 8.5 %), B (27.70 mg/dl; 19 *%), C* (28.85 mg/dl; 37 %) and D (31.20 mg/dl; 25 %) with a non-significant difference in salivary calcium level in different groups, The mean values of packed cell volume and hemoglobin concentration were 22.80 & 10.35; 23.05 & 10.85; 22.45 & 10.40 and 23.40 *&* 11.15 mg/dl in group A, B, C, and D showing a non-significant change in packed cell volume and hemoglobin concentration throughout the investigation period.

The mean values and percent increase in phosphorous excretion in faeces were 0.266, 15.5 % (group A); 0.278, 36.0 % (group B); 2.88, 32.00 % (group C) and 0.313, 51.00 % reflected an increase in phosphorus excretion through faeces in all treated groups except the control one. There was noted a marked increased in phosphorus excretion in group D which received the supplemented fodder with superphosphate juice (20%) above the NRC recommendations. The mean values and percent excretion of calcium through faeces were 83.90 mg/dl; 8.5 % (group A); 141.30 mg/dl; 98.0 % (group B); 141.60 mg/dl; 114 % (group C) and 142.10 mg/dl; 102 % (group D) showed that there was more excretion of calcium than absorption. There was a highly significant excretion of calcium through faeces.

The phosphorus supplementation has positive impact on product performance of calves. Further studies on the evaluation of single super phosphate in lactating cow/buffalo should be conducted. Comparative studies should also be conduct on same line to determine the best and economical phosphorus supplement.

22.2 SERUM COPPER IN LACTATING COWS AND BUFFALOES (I) LEVELS IN NORMAL AND HAEMOGLOBINURIC ANIMALS AND, (II) EFFECT OF ORAL ADMINISTRATION OF ORAL COPPER SULPHATE

BY ZAHID IQBAL - 2005

The present preliminary study was undertaken to investigate copper deficiency in apparent normal animals of district D. G. Khan, to determine the role of copper (if any) in occurrence of postparturient haemoglobinuria and to evaluate oral feeding of copper sulphate in terms of effect of serum copper levels, total erythrocyte count, haemoglobin concentration and milk somatic cell count.

Serum samples of 50 animals (cows=25, buffaloes=25) were collected randomly from twenty-five villages of district D. G. Khan. Samples were analyzed for copper with the help of a commercially available diagnostic kit (REF: Cu 2340 Random Laboratories Ltd, Ardmore, Diamond Road, Crumlin, Co.Antrim, United Kingdom BT29 4QY) the results were compared with the normal scrum copper level (5.34 µmol/L) documented for cow. The mean copper levels of buffaloes and cows were found 4.71 µmol/L and 4.07

µmol/L respectively, which showed a widespread deficiency of this trace mineral. The cows were found more deficient than buffaloes.

Then serum samples of five haemoglobinuric buffaloes (cases) and five matched control (normal) buffaloes were analyzed for copper. The both groups were also found significantly copper deficient and their comparative analysis showed a greater deficiency in case of diseased (haemoglobinuric) buffaloes. The mean copper levels were found 3.I7 µmol/L and 4.24 µmol/L in diseased and non-diseased animals respectively. The results indicated that hypocupraemia may be a risk factor in occurrence of postparturient haemoglobinuria.

In a copper feeding trial 20 buffaloes were divided into two equal groups (A) and (B). Group (A) was supplemented with copper sulphate @ 250mg/animal/day for 45 days while group (B) was kept as unsupplemented control. Serum samples, haematological indices (total erythrocyte count and haemoglobin concentration) and somatic cell count (SCC) of both groups were determined at day 0, 15, 30 and 45. The results showed a non-significant increase of all the parameters during first fifteen days, a significant increase in serum copper levels during the next fifteen days and onward. A highly significant increase was observed in serum copper levels and a significant increase in total erythrocyte count during last fifteen days, while a no significant decrease in somatic cell count was observed during the whole study period.

23. PARASITIC DISEASES

23.1 EFFICACY OF OXFENDAZOLE (OXAFAX) AGAINST HELMINTHIASIS IN RHODES ISLAND RED LAYERS

BY ARFAN YOUSAF – 2000

Studies were conducted to evaluate the efficacy of 5 different levels of oxfendazol against mixed infection in Rhode Island Red Layers. The dose levels of 5, 7.5, 10, 15 and 20 mg/kg body weight was evaluated on the basis of reduction in EPG count and worm burden.

Results revealed that minimum dose level which was 100% effective in reducing EPG was 10 mg/kg, The lower dose levels of 5 and 7.5 mg/kg was effective but this efficacy was not 100%. The dose levels of 15 and 20 mg/kg body weight were 100% effective in elimination of roundwonns and tapeworms. The drug showed erratic behavior as far the elimination of worms is concerned.

The treatment with oxfendazol at all dose levels results in increase in total serum protein values of treated groups. The 2 higher doses of oxfendazol (i.e., 15 and 30 mg/kg body weigh!) resulted in significant increase in SOFT level treated groups as compared to control. The lowest feed conversion efficacy was recorded for the group E treated at dose level of 20 mg/kg body weight, however the FCR for this group improved somewhat in 3rd week post medication. The weight of oviduct and length, and width of its different segments were also noted at different time point for all groups including untreated control. The drug had non significant effect on weight of oviduct. As far as the length and widths of oviducts' parts concerned, there was no clarity in the action of drug on these parts.

Oxfendazol at dose level of 10 mg/kg body weight was found most feasible and non toxic level to be used in poultry to treat mixed helminth infection in poultry.

23.2 STUDIES ON CLINICAL TRIALS OF IVERMECTIN AND CYPERMETHRIN FOR THE TREATMENT OF MANGE IN DOGS

BY MUHAMMAD IRFAN ULLAH - 2000

A total of 120 dogs in and around Faisalabad showing the signs of pruritis alopecia were examined for the

presence of *Sarcoptes scaibei* var canis. Sarcoptic mange was confirmed by skin scrapings examination in 45 dogs. Of these 30 were selected for chemotherapeutic trials. These dogs were divided into three main groups i.e. A, B and C. Dogs in groups A and B were further subdivided into two subgroups i.e. A_1. A_2 and B_1, B_2, each having 5 dogs. Animals in sub group A_1 and A2 were treated with ivermectin at the rate of 0.2 mg/kg and 0.1 mg/kg body weight, respectively. Dogs in subgroups B_1 and B_2 were treated with cypermehtrin at the rate of 1m /1 liter of water and 1 ml/1.5 liter of water, respectively. Whereas dog in group C were served as untreated control. Most of animals cleared up after the 1^{s}' treatment whereas other were given a second dose on 15 day after the 1st treatment.

The efficacy of the drug was calculated on the basis of disappearance of mites, subsidence of skin surface as confirmed by skin scraping on 6th, 14th and 28th day. Ivermectin (0.2 mg/kg body weight) and cypermethrin (1 ml/1 liter) caused 80 and 60 per cent efficacy after single treatment and 100 and 80 per cent effective, respectively after the second treatment.

Ivermectin (0.1 mg/kg), cypermethrin (1 ml/l .5 liter) caused 60 per cent and 20 per cent efficacy, respectively after the 1st treatment, whereas, 80 per cent and 60 per cent, efficacy was achieved after second treatment. No side effects were observed in animals with both the drugs. The untreated control animals remained positive for mange throughout the course of the study.

23.3 PREVALENCE OF HAEMOPARASITES OF DOGS IN THE FAISALABAD CITY AND THEIR EFFECTS ON VARIOUS BLOOD PARAMETERS

BY AZIZ AHMAD - 2001

The study was conducted to determine the prevalence of haemoparasites, comparative sensitivity of different techniques in a reliable detection of haemoparasites and evaluation of effects of haemoparasites on various blood parameters of infected canines.

For this purpose blood samples (n=320) of pet and stray dogs were collected from the outdoor clinics, Department of clinical Medicine and Surgery, University of Agriculture, Faisalabad, as well as from Faisalabad City. An overall prevalence of haemoparasites was recorded as 8.43% (27/320) in dogs on the basis of wet blood film method, Giemsa's stained smear technique, modified Knot's technique and haematocrit centrifugation technique. Three genera named *Dirofilaria, Dipetaionema* and *Babesia* were recorded and their percentages were 40.6%, 0.62%, and 3.75% respectively. The month wise finding indicating highest prevalence of haemoparasites in the month of August (10.83 %) followed by that in July (7.27 %) and June (6.66 %), respectively. The age wise prevalence reveals highest prevalence (12 %) of haemoparasites in the adults, followed by the pups (5.29 %). The prevalence of haemoparasites was recorded in pet dogs and stray dogs 7,08% and 12.5 % respectively. The prevalence of haemoparasites varied among different breeds of pet dogs. It was highest in Bulldog (10.52 %), followed by that in Alsation (10 %), German shepherd (9.52 %), non-descriptive (8.10 %), Russian (6.66 %) and Greyhound (5.71 %).

The results of the comparative sensitivity of different techniques employed for the detection of microfilariasis indicated that modified knott's techniques to be the most sensitive technique (93.33 %; 14/15), followed by wet blood film technique (66.66%; 10/14), Giemsa's stained smear technique (46,66%; 7/15) and haematocrit centrifugation technique (26.66%; 4/15).

The blood samples of 10 adult dogs and pups each, which were positive for haemoparasites, and 10 adult dogs and pups that were healthy were further examined for estimation of Hb, PCV, TEC, TLC and DLC.

The blood parameters of haemoparasites infected and healthy adult dogs were compared and similarly blood parameters of haemoparasites infected and healthy pups were compared. For this comparison

unpaired 't' test was applied. By calculations it was found that Hb, PCV and TEC of haemoparasites infected adult dogs and pups were significantly decreased as compared to healthy dogs and pups while TLC and DLC like neutrophils count and eosinophils count were found significantly increased in case of haemoparasites infected adult dogs and pups as compared to healthy adult dogs and pups.

23.4 PREVALENCE AND CHEMOTHERAPY OF HELMINTHIASIS IN DOMESTIC PIGEONS (COLUMBA LIVIA) IN AND AROUND FAISALABAD

BY SAJJAD HUSSAIN TAYYAB - 2002

This study was designed to investigate the prevalence of helminthiasis in domestic pigeons in and around Faisalabad and its chemotherapy with oxfendazol with two doses to find out the efficacy of drug.

To find out the prevalence fifty pigeon shops and houses of pigeon owners were visited in and around Faisalabad during May to June 2002. A total of 500 samples from May to June 2002 were collected. An overall prevalence recorded in domestic pigeons was 70%. It was highest (76%) in June and lowest (64%) in May 2002. The prevalence of infection was higher in birds raised under unhygienic and poor managemental conditions.

Out of 550 infected pigeons, 60 were chosen randomly for medication and divided into three groups each consisting of 20 pigeons. (A, B, C). These three groups were each further subdivided into four sub-groups (A_1, A_2, A_3 and A_4, Similarly B_1, B_2, B_3, and B_4 and C_1, C_2, C_3 and C_4 each comprising of 5 birds.

Faecal samples of experimental pigeons were examined for counting of Egg per gram of faeces on day its (pre-medication) with McMaster Technique (Soulsby 1982).

Oxfendazol with dose rate 10 mg/kg body weight was given orally to subgroups A_1, A_4, B_3 and C_2. Similarly oxfendazol with dose rate 20 mg/kg body weight was given to subgroups A_2, B_1, B_4 and C_3. The sub groups A_3, B_3, C_1, C_4 were kept untreated control.

Faecal egg counts were again carried out on day 7 and 12 *of* medication and the results were compared with control subgroups. Regarding the efficacy of oxfendazol, 20 mg/kg body weight dose was highly effective with reduction of 68.5 and 97.9 per cent eggs per gram of faces on 7^{th} and 12^{th} day of medication. Oxfendazol with dose 10 mg/kg body weight was found to reduce 59.2 and 88.6 percent egg per gram of faces.

It is concluded that most of the pigeons kept by the people are infected with one or another helminth and oxfendazol at a dose rate 20 mg/kg was found effective in treating pigeon helminthiasis.

23.5 STUDIES ON PREVALENCE AND CHEMOTHERAPY OF GASTROINTESTINAL AND BLOOD PARASITES IN MULES AND DONKEYS IN AND AROUND FAISALABAD

BY ABDUL SATTAR - 2003

For these studies 50 mules and 50 donkeys were selected from different localities of Faisalabad. Their faecal and blood samples were collected and examined for the presence or absence of parasites in them. Out of the positive cases, 15 mules and 15 donkeys were selected and divided into four groups (A, B, C & D). Animals of Groups A & B (each comprising of 10 animals) were treated with Abamectin as avermectin (Abamec L.A., Selmore Agencies Pvt. Ltd. Pakistan). @ lml/50 Kg body weight S/C. Animals of groups C & D (each comprising of 5 animals) were taken as control. Pre-treatment (day 0) and post-treatment (day 3^{rd}, 7^{th} and 14^{th}) examination of faecal and blood samples was carried out.

Out of 50 mules examined 23 were found positive. So the percentage of positive cases was 46. Out of 50 donkeys examined 35 were found positive. So the percentage of positive cases was 70. The species of

parasites, identified were *Strongylus* species (spp.) (large and small), *Oxyuris equi, ascaris spp., Trichonema species, and Microfilaria spp.*

Out of 23(46%) positive mules, *strongylus spp.* were found in 12 mules with a percentage of 24%, *Microfilarae spp.* were the second most prevalent spp. and were found in 6 mules having a percentage of 12%, Oxyuris *equi was* found in 4 mules having a percentage of 8%. *Trichonema spp.* was found in one mule, the percentage of infection being 2%. Out of 35(70%) positive donkeys, *strongylus* spp. were found in 13 donkeys with a percentage of 26%, *Microfilarae spp.* were the second most prevalent spp. and were found in 8 donkeys having *a* percentage of 16%, *Oxyuris equi* was found in 7 donkeys having a percentage of 14%. *Trichonema spp.* was found in 7 donkeys, the percentage of infection being 14%.

Percentage efficacy of avermectin in infected mules in the form of reduction in number of egg count was 60.70%, as the average EPG count was 830 on the 3rd of treatment. On the 7th day post-treatment, the average EPG count was 40 (100-200), as 7 animals became negative for ova in the faeces and the percentage efficacy was 98.34%. The EPG of all the animals was zero on 14th day post-treatment and percentage efficacy was 100%. The Microfilarae disappears from the blood after three days of treatment.

Percentage efficacy of avermectin in infected donkeys in the form of reduction in number of egg count was 60.70%, as the average EPG count was 830 on the *3rd* day of treatment. On the 7th day post-treatment, the average EPG count was 40 (100-200), as 7 animals became negative for ova in the faeces and the percentage efficacy was 98.34%. The EPG of all the animals was zero on 14th day post-treatment and percentage efficacy was 100%. The Microfilarae disappears from the blood after three days of treatment.

From this study, it was concluded that Abamec may be used for the treatment of gastrointestinal nematodes & Microfilarae in equines when it is given @ of 1ml/50kg body weight S/C.

23.6 STUDIES ON PREVALENCE AND CHEMOTHERAPY OF GASTROINTESTINAL AND BLOOD PARASITES IN HORSES IN AND AROUND FAISALABAD

BY NADEEM AKHTAR - 2003

Due to their memorial role in the Islamic history, the horses are considered as symbol of superiority among the horse breeders. In Pakistan, it is still part and parcel of our cultural traditions and plays a major role in transportation of military in hilly areas where other means of transportation fail. According to economic survey of Pakistan, 1998-1999 their population is 0.3 million. In addition horses and mules are used in tonga pony thus serving as a way of livelihood for thousands of poor families in Pakistan. Keeping in view the importance of horses in our community, it is very essential to take care of them, to investigate their disease problems and find the best solutions. The most important and common problem of horses is parasitism. Due to unawareness about parasitic infection and lack of specific treatment the great losses occur at local as well as national level. As little work has been done on the prevalence of G.I.T, and blood parasites in horses in Faisalabad so far.

Therefore this project was designed to study the prevalence of G.I.T., and blood parasites and to determine the efficacy of Abamec L.A. (Abamectin as avermectin BI a). For this purpose 100 horses were selected from different localities of Faisalabad, their faecal and blood samples were collected and examined for the parasitism. Out of the positive cases, 20 horses, 10 for each GIT and blood parasite were selected for clinical trials and were treated with Abamec *L.A.(a),* lml/50 Kg body weight S/C. Pre-treatment (day 0) and Post-treatment (day 3, 7, 14) examination of faecal and blood samples was carried out.

The overall prevalence of GIT & blood parasite was 75% & 10% out of 100 samples. Species wise prevalence was; 50 %. 12 %, 8 % and 5 % for *Strongylus spp., Oxyuris equi spp Parascaris equorum and*

mixed infection respectively. As for as the prevalence of blood parasite is concerned, it was found that the prevalence of blood parasite was 10%, 0% and 0% for *Setaria, Trypanosoma* and *Babesia spp.* respectively. The efficacy of Abamec was found 97-100% against these parasites.

From this study, it was concluded that Abamec may be used for the treatment of GIT parasites & *Setariasis* in horses when it is given at the dose rate of Iml/kg body weight by S/C injection.

23.7 STUDIES ON PREVALENCE AND CHEMOTHERAPY OF GASTROINTESTINAL AND BLOOD PARASITIES IN CAMEL IN AND AROUND FAISALABAD

BY KHAWAJA MUHAMMAD ABUBAKKAR – 2004

The camel is an important animal in the desert, semi desert and mountainous areas of Pakistan. Camel is being used for a variety of purposes such as meat, milk and draught power. According to Economic survey of Pakistan, 2003 their population is about one million heads, with an annual, increase of 1.62%; Pakistan is the 4th largest camel raising country in the world.

Keeping in view the importance of camels in our community, it is very essential to take care of them, to investigate their disease problems and find the effective control package. The most important and common problem of camels is parasitism. Due to unawareness about parasitic infection and lack of specific treatment the great losses occur at local as well as national level. As little work has been done on the prevalence of G.I.T. and blood parasites in camels in Faisalabad so far.

Therefore this project was designed to study the prevalence of G.I.T. and blood parasites and to determine the efficacy of Dectomax (Doramectin) and Cymelarsan (bis (aminoethylthio-4 melaininophenylarsine dihydrochloride) against these parasites.

For this purpose 50 camel were selected from different localities of Faisalabad, their faecal and blood samples were collected and examined for the parasitism. Out of the 50 camels, 30 were positive for GIT Parasites and 5 for Trypanosomiasis. From 30 Camels positive for GIT parasites, 20 were selected for trials and divided in two groups (10 in each). One group was treated with Dectomax (Doramectin) @Iml/50 Kg body weight S/C. and other group was kept as control. The camel positive for Trypanosomiasis was treated with Cymelarsan. The efficacy of the Dectomax determined by taking faecal samples on day 3, 7 & 14 after treatment. The examination of the faecal samples was done, pre-medication i.e. Zero day, then 3, 7 and 14 day post-medication, for evaluating the efficacy of Dectomax.

The overall prevalence of GIT & blood parasite was 60% & 10% out of 50 samples. Of the total number of samples, 30 (60 %) were found to be positive for helminthes ova, comprising 23 (46%) nematodes and 2 (4%) cestodes ova. Not a single case was recorded for trematode egg. Species wise prevalence was; 20%, 14%, 8%, 4%, 4%and 10% for Haemonchus, Trichostrongylus, Strongyloides, Ostertagia, *Moneizia expansa* and mixed infection respectively. So far as the prevalence of blood parasite is concerned, it was found that the prevalence of blood parasite was 10% and 0% for Trypanosoma and Dipetalonema spp. respectively. The efficacy of Dectomax was found 75-90% against GIT parasites and that of Cymelarsan was found 100% against Trypanosomiasis.

From this study, it was concluded that Dectomax (Doramectin) may be used for the treatment of GIT parasites & Cymelarsan was the drug of choice against Trypanosomiasis in camels when it is given at the dose rate of 1 ml/kg body weight by S/C injection.

23.8 COMPARATIVE EFFICACY OF DORAMECTIN, ALBENDAZOLE AND LIVAMISOLE AGAINST NEMATODES OF SHEEP

BY SHUJAAT HUSSAIN - 2005

The present study was conducted to evaluate the anthelmintic efficacy and effect of treatment on weight gain of sheep. Forty sheep of Lohi breed positive for gastrointestinal nematodes were selected from Tehsil Tandlianwala, District Faisalabad (Punjab) and were divided into 4 groups (10 animals in each group). Group A, B and C were medicated with Doramectin (1 ml/50 kg body weight S/C), Albendazole (1 mg/20 kg body weight orally) and Levamisole (5 ml/15 kg body weight orally) respectively and group D remained as untreated control.

Egg per gram (EPG) of the faeces were recorded on "0" day before medication and on 7^{th}, 14^{th} and 21^{st} days after medication. The efficacy of these drugs was calculated on the basis of reduction of eggs per gram (EPG) of faeces after treatment. These drugs showed a progressive decrease in faecal egg count.

The percent efficacy of Doramectin (Dectomax) was 99.28%, 100% and 100% on 7^{th}, 14''' and 21^{s}' day, respectively. Efficacy of Albendazole (Valbazen) was 95.22%, 97.17% and 97.88% on 7^{th}. 14^{th} and 21^{st} day, respectively.

Efficacy of Levamisole (Nilverm) was 98.44%, 99.48% and 99.83% on 7^{th}, 14^{th}, and 21^{st} day, respectively. There was no significant difference ($P<0.01$) in effectiveness of the drugs, however, there was highly significant difference ($P<0.01$) between treated and control groups.

The body weight of animals were recorded on "0" day before medication and on 7^{th}, 14^{th} and 21^{st} days after medication. The average weight gain in group A, B and C was 2.50 kg, 1.82 kg and 2.14 kg respectively whereas member of control group reduced their weight by 1.80 kg.

The result of present study demonstrated that Doramectin have comparatively better efficacy than Levamisole and Albendazole.

24. VETERINARY SURGERY

24.1 COMPARATIVE EVALUATION OF INTROSSEUS AND INTRAVENOUS ROUTS OF BLOOD RESUSCITATION FOR HAEMORRHAGIC SHOCK IN DOGS
BY AKHLAQ AHMAD – 1998

Rapid venous access is often a clinical quandary in patients with severe hypovolemic shock. In above emergency conditions the fluid should be given directly to the circulation in order to save the life. An experimental study was thus conducted to find an alternative line to the intravenous line. So the intreosseous and Intravenous line was selected for study.

Comparison of technique was made after the episode of haemorrhagic shock by bleeding the animal from Juglar vein into a blood bag upto 50 mm/Mg. blood pressure. After 50 minutes the autologous blood was transfused intravenous and intraosseous to the animals of the groups A and B respectively. Comparison was made on the basis of haematological (RBC, WBC, Mb, & SR, PCV and clotting time) and biochemical values (Total protein analysis) by analyzing the samples at 0,1,6,12,24,48 and 96 hrs post blood resuscitation.

Results depicted a non-significance between the intravenous and intraosseous lines. While comparison with the control, there was a highly significance between them was present which suggested that there is a small negligible difference between IO and IV line.

Therefore, according to our study intraosseous line for the autogenous blood resuscitation in hypovlemic shock was found to be comparatively safe and compatible to intravenous line.

24.2 FFECTS OF AGE AND ACUTE LAMINITIS ON HAEMOGRAM AND SERUM IOCHEMISTRY IN

MULES
BY ALTAF HUSSAIN – 1998

The significance of mules in providing the cheapest source of transportation, riding, carrying loads, pulling carriages and supply of ammunition during peace and war, especially in the modern era of mechanization is well known to everyone. Albeit work on various parameters indicative of the health and disease status of mules is completely lacking. The present study was, therefore, under taken on 40 apparently healthy and 10 diseased mules afflicted with a model diseases i.e. acute laminitis. The healthy mules were divided into four groups i.e. I-IV comprising 10 animals each, according to their ages i.e. 1-6 months, 7-12 months, 13-18 months and 9-24 months, respectively. Whereas 10 mules suffering from acute laminitis were kept as group V having the same age as that of group IV i.e. 19-24 months. Blood samples were taken from all the healthy mules (group I-IV) to determine the effect of age on various hematological and serum biochemical parameters. Blood samples were also collected from the diseased mules (group V) to compare the same with those of the healthy mules of group IV.

The age of the animal imparted a significant effect ($P<0.05$) on all hematological parameters. A decreasing trend with the advancement of age was observed in erythrocyte count whereas for leukocyte count and hemoglobin values the trend was otherwise. As regards haematocrit, the values increased upto the age of 13 to 18 months (group III) followed by a significant decrease. When laminitis affected mules were compared with the healthy mules of same age, a highly significant ($P < 0.01$) difference was observed in only hemoglobin values whereas other hematological parameters remained un-affected and differed non-significantly.

Similar to the hematological parameters serum ($P<0.05$) biochemical parameters were also affected significantly by the change in age with a decreasing trend up to the age of 18 months followed by a non-significant increase in the parameters viz. bilirubin (total, direct and indirect) ALP, ALT and serum

24.3 CLINICO-THERAPEUTIC STUDIES ON TRANSMISSIBLE VENEREAL TUMORS IN DOGS
BY AMAR SOHAIL - 1998

Dogs have served man since times Immemorial, and to-date is the most common pet animal throughout the world. In recent times, dog is considered the best animal in guarding, tracking, hunting, various police and military services, guide for the blinds, and subject of experimental studies. Like other living beings, dog also faces a variety of disease problems, some of them are even of zoonotic significance. Among the most common afflictions of dogs, transmissible venereal tumor (TVT) is a naturally occurring, coitally transmitted neoplastic disorder that affects the external genitalia of both sexes (vulva and vagina in females; penis and prepuce in males), which has been reported to occur in most parts of the world but appears to be more prevalent in temperate climates. Keeping in view the wide spread nature of this disease and limitations regarding its surgical rectification in the field situations, the present studies were initiated to evaluate the effectiveness of surgery and chemotherapy with vincristine sulphate alone and in combination for the treatment of TVT.

Eighteen dogs, afflicted with TVT, of either sexes, randomly divided into 3 groups viz. Group-1, Group-11 and Group-Ill comprising 6 dogs each, were used in this project. The dogs in group-I were treated surgically. A complete regression of the tumor mass was observed in 4 (66,67%) dogs, while 2 (33.34%) had incomplete regression at the end of first 5 weeks. A 16.67% recurrence rate were also observed at the end of 6 months study period. The dogs in group-II were treated with vincristine sulphate @ 0,025 mg/kg b.wt. by a slow intravenous injection and an 80.33% complete regression and 16.67% incomplete regression were recorded. Vomiting and inappetance as side-effects were also noticed. The dogs in group-III were treated with vincristine sulphate after surgically debulking of tumor growth. A 100% regression even after 2-3 injections with no recurrence was achieved, when observed after 6th months.

In the present findings, there was a significantly increased (P<0.01) erythrocyte sedimentation rate in afflicted dogs, which became normal after 2-5 weeks of treatment. TLC was also slightly increased in all the afflicted dogs before treatment. Vincristine sulphate had a significant decreasing effect on TLC in both group-II and group-III, which was transient. A non-significant decrease in TEC and haemoglobin before treatment, as seen in our studies might be due to chronic loss of blood from the ulcerating surfaces of tumor mass. On histopathologic examination, uniform sheets of tumor cells were evident with prominent pleomorphic nuclei and mitotic activities.

So it can be deduced from the present findings that surgery + chemotherapy combination is the best mode of therapy as it led to early recovery and minimized the chances of potential risks associated with prolonged use of anticancer drugs like vincristine. Whereas in the field situation, where surgical facilities are almost extinct, chemotherapy with vincristine sulphate seems to be a dependable way of treatment of this condition. More trials should be conducted to evaluate the safety and effectiveness of vincristine sulphate as well as other anticancer drugs in the treatment of venereal tumors.

24.4 FFICACY OF SOME COMMERCIAL ANTISEPTICS/GRANULATION ROMOTERS AND ORALLY FED ZINC IN SURGICALLY INFLICTED WOUNDS IN DOGS

BY M. AAMIR MASOOM - 1999

Full thickness skin wounds were created on both thighs of 12 dogs divided equally into A and B groups further subdivided into two each viz., Al and A2, Bl and B2, respectively, comprising three subjects each. For this purpose, two types of wounds were inflicted i.e., 1" x 1" square wounds and 6 cm long incised wounds on four different locations on both thighs of experimental dogs. Left front wounds (A_{11}, A_{12}, A_{21}, A_{22} and B_{11}, B_{12}, B_{21}, B_{22}) were treated with Oxoferin (Brookes Laboratories Pvt. Ltd.,), left hind wounds (A_{13}, A_{14}, A_{23}, A_{24}, B_{13}, B_{14}, B_{23} and B_{24}) with Pyodine (Brookes Laboratories Pvt. Ltd.,) right-front wounds (A_{17}, A_{18}, A_{27}, A_{28}, B_{17}, B_{18}, B_{27}, B_{28}) with Clostecin (PDH Laboratories) and right-hind wounds (A_{17}, A_{18}, A_{27}, A_{28}, B_{17}, B_{18}, B_{27}, B_{28}) with a self-prepared antiseptic i.e., Tris-EDTA, Treatments of the wounds was started on the day of operation in subgroup Al and BI and were regarded as clean surgical wounds. Whereas to those of subgroups A2 and B2, dressing was started 24 hours after their infliction to evaluate the efficacy of under trial antiseptics/granulation promoters in infected canine wounds. All the wounds were properly covered with sterile bandages (Rayband) as well as wound licking was prevented by the application of muzzles on their mouth. The subjects in group B were supplemented with Zinc sulphate orally while those of group A were kept without Zinc sulphate administration.

The efficacy of these antiseptics/granulation promoters was evaluated in terms of their effect on wound contraction, restoration of normal tissue strength, wound contaminants and wound granulation (assessed by histopathology). Moreover, the isolates were also evaluated for their susceptibility to different routine antibiotics.

No significant difference was found among four treatments in terms of contraction and infection while Zinc enhanced the wound contraction significantly. A significant difference in tensile strength was observed between Pyodine and other treatments. On the other hand Zinc administration did not affect the gain in the tensile strength of the healing wounds. In microbiological assay, a negative correlation was found between wound contamination, wound contraction and restoration of tensile strength. A significant difference was observed among various treatments in epithelialization and granulation formation.

The in vitro susceptibility of the isolates to 11 different antibiotics were as under: norfloxacin (100%), gentamicin (87.5%), flumequine (79%), neomycin (71%), chloramphenicol (62.50%), streptopencillin (54%), doxycycline (44%), pinicillin (35%), furaltadone (31%), erythromycin (21%) and furazolidone (17%).

It can be concluded from the present study that the cheapest antiseptic available in the market i.e.,

Pyodine is superior to the other commercially available and/or self prepared antiseptics in terms of microbial inhibition, restoration of tensile strength and epithelialization of the wounds. In the absence of other commercial antiseptics/granulation promoters, which affected a relatively better contraction of wound, Pyodine seems to be a suitable wound antiseptic meeting most of the criteria in wound healing. Zinc has been found as a useful adjunct to the antiseptics and Norfloxacin has been found as a drug of choice in the modem wound infection.

24.5 COMPARATIVE HEALING EFFICACIES OF POVIDONE IODINE, ALUM, DAKIN'S SOLUTION AND NEEM OIL IN SURGICALLY-INFLICTED FULL-THICKNESS SKIN WOUNDS IN DOGS

BY MUHAMMAD MAQSOOD QADIR – 2001

Full thickness-skin wounds were created both on trunks and thighs of 16 dogs divided equally into A and B groups comprising eight subjects each. For this purpose, two types of wounds were inflected i.e., 1"X 1" two square wounds on trunk and two 6 cm long incised wounds on each thigh of the experimental dogs. Left front wounds (All, A12 and Bit, B12) were treated with Neem oil left hind wounds (A13, Al4, B13, and Bl4) with Alum right front wounds (A15, A16, B15, and B16) with Pyodine (Brookes Laboratories Ltd.) and right hind wounds (A17, Al8, B17, and B18) with a self-prepared antiseptic i.e., Dakin's solution (0.5% solution of bleach). Treatment of wounds were started in group A on the day of operation and regarded as clean surgical wounds, whereas to those of group B, treatment was started 24 hours after their infliction to evaluate the efficacy of in question antiseptic in clean and infected canine wounds. All the wounds were properly covered with sterile bandages (Rayband) as well as neck collars to prevent from licking.

The efficacy of these antiseptics was evaluated in terms of their effect on wound contraction, restoration of normal tissue strength, wound contaminants and wound granulation (assessed by histopathology).

No significant difference was found among four treatments in terms of contraction and infection. A significant difference in breaking strength was observed between Pyodine and other treatments, In microbiological assay, a negative correlation was found between contamination, wound contraction and restoration of breaking strength. A significant difference was observed among various treatments in epithelialization and granulation formation.

It can be concluded from the present study that the household antiseptic available i.e., Neem oil is superior to the other commercially available and/or self-prepared antiseptics in terms of wound contraction, restoration of breaking strength and epithelialization of the wounds whereas Pyodine was found superior due to its antimicrobial effects. In the absence of other commercial antiseptic;;/granulation promoters, which affected a relatively better contraction of wound, Neem oil that seems to be a suitable wound antiseptic meeting most of the criteria in wound healing.

24.6 ANAESTHETIC EFFICAY OF NALBUPHINE HCL ALONE AND IN-COMBINATION WITH PROPOFOL AND KETAMINE HCL IN DOGS

BY SAYED AUN MUHAMMAD - 2002

The scope of anaesthesia is constantly increasing as a pre-requisite to any painless surgical intervention. It is the dire need of the hour to explore spectrum of alternative anaesthetics for veterinarian in order to cope with surgical maneuvers. For this purpose, present study was conducted on 18 adult clinically healthy dogs, which were divided randomly into three groups A, B and C with 6 animals in each. In group A nalbuphine HC1 @ Img/kg B.wt.; in group B, nalbuphine HC1 @ 0.5mg/kg B.wt, along with propofol @ 4mg/kg B.wt. and in group C, nalbuphine HC1 @ Img/kg B.wt. Along with ketamine HC1 @10mg/kg B.wt. were administered. The depth of anaesthesia was gauged by observing various body reflexes. The effects of above treatments on rectal temperature, respiration and pulse rates were also recorded.

The mean duration of anaesthesia (in minutes) in animals of group A, B and C was 0.0±0.0, 10.17± 1.49

and 16.17± 2.89 respectively. Thus the longest duration of anaesthesia was recorded in dogs with nalbuphine HC1 Img/kg. B.wt. along with ketamine HC1 @ lOmg/kg. B.wt (group C). While it was lacking in group A in which nalbuphine HC1 was used @lmg/kg.b.wt. However the quality of induction and recovery was superior in group B in which nalbuphine HC1 was given @ 0.5mg/kg B.wt. along with propofol @4mg/kg B.wt. Thus, Nalbuphine HC1, when used in combination with ketamine HC1 (group C), reduced the dose of ketamine HC1 required for induction of an anaesthesia but quality of recovery was found to be poorer than that of nalbuphine HC1 along with propofol. Moreover, nalbuphine HC1 along with ketamine HC1 caused an increased in heart rate

In conclusion, nalbuphine HC1 along with propofol can be used as safe anaesthetic agents for short surgical procedures, but propofol is more expensive than ketamine HC1. Nalbuphine HC1 alone cannot be given as anaesthetic agent.

24.7 EVALUATION OF PRE-OPERATIVE USE OF METRONIDAZOLE AND CEFACLOR IN COLONIC ANASTOMOSIS IN DOGS

BY M. HAMMAD HUSSAIN - 2002

This study was conducted to evaluate the efficacy of metronidazole and cefaclor in the colonic end-to-end anastomosis in dogs, as all colonic interventions are under the threat of postoperative infections caused by normal anaerobic faecal flora. A total of 24 dogs underwent colonic resection during this study. These dogs were divided in to four groups (Group-1 to Group-4), each having six animals. Group-1 was kept as untreated control and the dogs were subjected to surgical intervention without any prophylactic regimen. The dogs of Group-2 were treated prophylactically with metronidazole @ 50 mg/kg body weight six hours prior to surgery. Members of Group-3 were treated with combination of metronidazole and Cefaclor prophylactically @ 50 and 30 mg/kg body weight respectively, also six hours prior to surgery. The dogs of Group-4 were subjected to 5% Povidone-Iodine enema six hours prior to surgery. All these animals were subjected to same surgical intervention i.e. end-t-end colonic anastomoses. The methodology of resection and anastomoses was kept same for each individual animal. After surgery, these animals were carefully observed for evidence of any infection, temperature, pulse and respiration rates were carefully monitored till postoperative day 14. At day 14 all these animals were euthanized and postmortem was performed to find the anastomotic site and quantity of adhesions present with the other organs. The anastomotic part was then cut and subjected to recording of the gain in tensile strength, Stenotic index and faecal bacteriology. The efficacy of these antibiotics/antiseptics was evaluated in terms of their effect on stenotic index, restoration of normal tensile strength and faecal bacteriology. No significant difference was found in terms of stenotic index among different groups. Lumen diameter was significantly decreased in all the groups. A significant difference was noted in the tensile strength between all groups ($P<0.01$). Antibiotic combination (Metronidazole and Cefaclor) was found to enhance the gain in tensile strength significantly (44.94%), followed by metronidazole alone (42.85%), Povidone-Iodine enema (35.37%) and Control (27.31%). Fecal bacteriology revealed, significantly lower number of colonies in the postoperative, post-antibiotic samples of the Povidone-Iodine treated group, followed by metronidazole plus Cefaclor combination. No change was observed in the faecal samples of metreonidazole treated animals because anaerobic fecal bacteriology was not conducted. It can be concluded from the present study that to minimize the postoperative wound infection rates, increased duration and cost of health care associated with colonic surgery, adequate antibiotic prophylaxis is needed. For this purpose the combination of an aerobic and anaerobic drug should be used for the prevention of postoperative infections. From present study we can conclude that the combination of metronidazole and Cefaclor found to be more effective in preventing postoperative infections, and also resulted in higher gain in tensile strength. So the antibiotic prophylaxis with this said combination is recommended for colonic surgery.

24.8 ANAESTHETIC EFFICACY OF THIOPENTAL SODIUM AND PROPOFOL ALONE IN COMBINATION WITH PANCURONIUM BROMIDE IN DOGS

BY JAVED ALI - 2005

General anaesthesia is as an indispensable pre-requisite to most of the surgical interventions in both human and veterinary surgery since 1846. From time to time different kinds of chemical agents have been used for this purpose. It is the dire need of the hour to explore better spectrum of alternative anaesthetics for veterinarian in order to cope with a variety of surgical maneuvers. For this purpose, this study was conducted on 20 adult clinically healthy dogs of either sex, which were randomly divided into four equal groups i.e. A, B, C and D.

In group A, Inj, Pentothal sodium® (Abbott Pakistan (Pvt) Ltd.) was given intravenously @30mg/kg body weight, while in group B, Inj. Propofol® (Abbott Pakistan (Pvt) Ltd.) was administered @15mg/kg body weight intravenously. The animals of group C were given both Inj. pancuronium bromide® @ 0. Img and Inj. Pentothal sodium® @15mg/kg body weight intravenously. To group D, pancuronium bromide® and Propofol® were given @0.1mg/kg body weight and l0mg/kg body weight respectively.

The depth of anaesthesia was gauged by observing various body reflexes. The effect of above treatments on rectal temperature, respiration and pulse rates were also recorded.

The mean duration of surgical anaesthesia in group A was 30.9 ± 4.60 minutes, while it was 12.5 ± 1.97 minutes in group B. It was 38.6 ± 3.13 minutes in group C and was 32.2 ± 3.45 minutes in group D. Thus the longest duration of surgical anaesthesia was recorded in dogs given Pentothal sodium® @ 15mg/kg + Pavulon® @ O.lmg/kg body weight, while it was the shortest in animals given Propofol @10mg/kg body weight. However quality of induction and recovery was superior in Propofol anaesthetized dogs as against of anaesthetized with Thiopental.

It was concluded that Propofol can be used as a safe anaesthetic agent for short surgical procedures, but Propofol is more expensive than Thiopental. On the other hand, Pavulon (pancuronium bromide) when used in combination with Propofol and Thiopental respectively, reduced the dose and cost of these drugs required for induction of an anaesthesia, but quality of recovery was found to be rough. Moreover Pavulon caused complete apnea and an increase in heart rate after induction of an anaesthesia, so animals must be provided mechanical ventilation.

ANIMAL REPRODUCTION

1. REPRODUCTIVE PHYSIOLOGY

1.1. Buffaloes

The biometry of female reproductive organs of buffalo calves and heifers showed that in calves the average length, width and thickness of cervix was 2.3, 1.0, 0.8 cm, body of uterus; 0.7, 1.0, 0.8 cm, right uterine horn; 9.5, 0.8, 0.7 cm, left horn; 9.3, 0.8, 0.7 cm, right ovary; 1.0, 0.6, 0.5 cm, left ovary; 1.0, 0.5, 0.5 cm, respectively. Right and left oviducts each were 13.0 cm long. The corresponding values for heifers were; cervix 5.3, 2.1, 1.7 cm, body of uterus; 1.3, 2.1, 1.8 cm, right horn; 19.4, 1.4, 1.7 cm, left horn; 19.2, 1.3, 1.6 cm, right ovary; 2.0, 1.7, 1.5 cm, left ovary; 1.9, 1.7, 1.5 cm, and right and left oviduct each 17.3 cm, respectively. The number of primordial follicles for righ and left ovary averaged 47621 and 32211 in calves and 22214 and 16670 in heifers, respectively, the differences being significant. Calves possessed 51% more follicles than heifers. In buffaloes the frequency of oestrus was higher during autumn and winter and lower in spring and summer. Provision of showering or wallowing did not improve incidence of oestrus in buffaloes. It, however, did affect respiration, pulse and body temperature.

The length of oestrous cycle averaged 21 days and ovulation occurred on day II (78 %) and day III (22%). The plasma oestradiol-17Beta concentrations during met-oestrus, di-oestrus, pro-oestrus and oestrus averaged 71.1, 74.6, 97.3 and 148 pg/ml in heifers and 46.3, 51.7, 84.4 and 119.1 pg/ml in buffaloes. Heifers had higher concentration and showed more pronounced heat signs than lactating buffaloes. The plasma progesteron concentrations on day 1, 3, 5, 9, 11, 15 and 19 of oostrous cycle averaged 0.1, 0.4, 0.9, 2.2, 2.1, 3.7 and 0.9 ng/ml, respectively. These were correlated with development, growth and regression of corpus luteum.

The blood cholesterol level during pro-oestrus, oestrus, met-oestrus, and di-oestrus averaged 226, 257, 220 and 180 mg/100 ml, respectively. Corresponding values for glucose were 87, 93, 83 and 94 mg/100 ml and for total lipids 421, 448, 443 and 347 mg/100 ml, respectively. The values of cholesterol and total lipids varied during oestrus cycle but those of glucose did not. Similarly blood glucose, protein and urea concentrations did not vary among cyclic, non-cyclic and sub-oestrus lactating buffaloes. The non-cyclic buffaloes, however, had significantly lower serum cholesterol content than that of cyclic and sub—oestrus animals. Animals yielding upto 5 litre milk daily had higher blood glucose than those yielding more than 5 litres. The milk yield, however, had no effect on cholesterol, urea and protein contents.

In early pregnant, non-pregnant and repeat breeding buffaloes blood calcium contents averaged 9.6, 8.8 and 7.6 mg/100 ml, respectively, differences being significant. Low calcium and phosphorus contents may be cause of repeat breeding and low fertility in this species.

The plasma contents of calcium in buffaloes pregnant for 1-3, 4-6, above 6 months and the nonpregnant, averaged 9.6, 10.2, 10.0 and 10.1 mg/100 ml, respectively, first group differed from others. Plasma zinc contents averaged 0.74, 0.70, 0.73 and 1.08 PPM, for 4 groups, respectively, non-pregnant buffaloes showed higher zinc content than other groups. The values of Mn and Cu for 4 groups also differed non-significantly.

Within 90 days post partum, blood calcium concentration in cyclic and non-cyclic buffaloes averaged 8.1 and 6.9 mg/100 ml, respectively, difference being significant. F'or the two groups, the concentrations of P, Zn, Mn and Cu averaged 5.1 and 5.0 mg/100 ml, 2.4 and 2.6 PPM, 0.8 and 0.9 PPM, and 0.6 and 0.7 PPM, respectively, the difference between two groups being nonsignificant. During 0-30, 30-45, 45-60,

60.-75 and 75-90 days post partum blood calcium content in cyclic animals averaged 7.8, 7.6, 7.8, 8.3 and 9.1 mg/100 ml, respectively. These values in non-cyclic buffaloes were 6.6, 6.3, 6.6, 7.7 and 7.2 mg/100 ml, respectively. Blood phosphorus content in five groups of cyclic animals averaged 5.1, 5.4, 4.6, 5.1 and 5.3 mg/100 ml, and for non-cyclic these values were 5.2, 4.7, 4.8, 5.2 and 5.1 mg/100 ml, respectively. The Ca:P ratio varied significantly in cyclic and non-cyclic buffaloes, the ratio being 1.6:1 and 1.4:1, respectively.

During 90-105, 106-120, 121-135, 136-150, 151-165, 166-180, 181-195 and 196-210 days post partum calcium contents were 7.0, 8.4, 8.5, 8.4, 7.8, 9.0, 8.0 and 7.3 mg/100 ml of blood in cyclic and 6.9, 7.4, 5.8, 6.8, 7.0, 7.1, 6.6 and 7.3 mg/100 ml in non cyclic buffaloes, respectively. The values of phosphorus were 5.3, 5.2, 5.5, 5.3, 5.5, 5.5, 5.2 and 6.2 mg/100 ml in cyclic and 3.8, 3.7, 5.2, 4.2, 4.9, 5.0, 3.8 and 4.0 mg/100 ml in non-cyclic animals. Non significant difference was noted in mean concentration of Zn, Cu, Mn and Ca to P ratio in cyclic and non-cyclic animals. Concentrations of Ca and P, however, differed in the 2 groups.

The age at puberty in buffaloes averaged 1064 days, range being 530 to 2130 days. It was between 800 and 1300 days in 82% buffaloes. Age at first calving ranged from 909 to 2453 days, the average being 1411 days. In 79% buffaloes it was between 1100 and 1600 days. Services per conception averaged 2.2. The service period averaged 221 days, range was 20 to 1183 days. However, in 88% animals it was upto 400 days. The calving interval averaged 530 days, range being 324 to 1503 days. In 87% buffaloes it was between 324 and 700 days. The parity and season of calving had significant effect on service period and calving interval. The conception rate did not vary due to bulls, age of semen (fresh V one day old) and time of insemination (10-15 V 16-24 hours after onset of oestrus). It, however, varied between different insominators.

1.2. Cows

In Sahiwal cows the age at puberty ranged from 496 to 1503 days, the average being 884 days. It was 496-1097 days in 89% cows. Winter born heifers matured earlier than those born during other seasons. The age at first calving averaged 1209 days, range being 795-1890 days. The number of services per conception averaged 2.02, the conception rate being 49%. The service period ranged 25-606 days, the average being 129 days. However, 24% service periods were upto 90 days. The calving interval ranged 307-897 days with an average of 414 days. Parity and season of calving significantly affected calving interval and service period.

In Holstein-Friesian cows age at first conception,age at first calving, service period and calving interval averaged 26.3, 35.5, 6.2, and 15.4 months, respectively. Number of services per conception averaged 2.69. Maximum calvings occurred in autumn followed by winter, spring and summer. Milk yield in imported and locally born Friesian cows averaged 3779 and 3368 litres for 305 days, respectively. High incidence of mastitis and mortality were the major problems.

1.3. Buffalo and cow bulls

The average semen volume per ejaculate was 5.3, 4.6 and 6.4 ml in Sahiwal, (S), Friesian (F)_ and S x F Crossbred bulls, respectively, the difference being significant. Sperm abnormalities for 3 breeds averaged 12.2, 15.3 and 17.1%, respectively. Sahiwal bulls showed higher values for mass activity, sperm concentration and initial and post thawing motility than other two breeds. Spring was favourable season for semen quantity and quality. Semen producing capacity of mature bulls was better than that of the younger ones.

Buffalo seminal plasma exhibited higher alkaline and acid phosphatase activity (1420 and 558 I.E.U/100 ml, respectively) than that of cattle (1454 and 257 I.E.U/100 ml). Buffalo seminal plasnrn had higher

alkaline phosphatase activity but cow bulls showed higher acid phosphatase. In both species alkaline phosphataso was higher in 1st than in 2nd ejaculate. Similarly, total acid phosphatase in cattle seminal plasma was higher in 1st than in 2nd ejaculate but reverse was true in buffalo bulls. The differences in enzyme activity between bulls were significant. No correlation occurred between acid and alkaline phosphatase in buffalo but it was present in cow bulls.

The average values for volume, motility, sperm concentration and dead sperms were 3.8 ml, 62%, 672 x 106 and 21%, respectively. The initial level of fructose, citric acid, total reducing substances (TRS) and non-fructose reducing substances averaged 519, 588, 720 and 201 mg/100 ml, respectively. These values varied significantly among bulls.

Sodium concentration in seminal plasma and spermatozoa of buffalo bulls averaged 270 and 115 mg/100 while in cattle these were 256 and 104 mg/100 ml. For potassium these values were Gland 69 mg/100 ml in buffaloes and 92 and 97 mg/100 ml in cow bulls. The concentration of calcium averaged 37 and 23 mg/100 in buffalo and 21 and 15 mg/100 ml in cow bulls. Corresponding values for magnesium were C and 7 mg/100 ml for buffalo and 10 and 12 mg/100 ml for cow bulls. The chloride content was found only in seminal plasma of both species, amount being 286 and 272 mg/100 ml for buffalo and cow bulls, respectively. Sodium and calcium were more in seminal plasma than spermatozoa while reverse was true for potassium. Magnesium was equally distributed in seminal plasma and spermatozoa.

Study of microflora of buffalo and cow bull semen revealed 29 strains of *E.CoJi, 20* of *Staphy. aureus,* 16 of *Strep, faecalis* and 2 of *Pseudomonas aeruginosa,* predominating type of bacteria being *KColi* which were highly sensitive to neomycin. Staphylococci and Streptococci showed maximum sensitivity to septran, while Pseudomonas were sensitive to neomycin only.

1.4. Sheep and goat

For right ovaries of Lohi ewes average length ranged 1.25-1.75 cm, width 0.98-1.35 cm, thickness 0.64-0.93 cm and weight 0.52-1.35 gin. The corresponding values for left ovaries were 1.26-1.69, 0.96-1.28, 0.63-0.85 cm and 0.49-1.14 gm. The length of right oviduct varied from 16.9 to 18.7 cm while that of left 17.7-19.4 cm. The length and width of right horn ranged 10.1-16.9 and 1.2-1.7 cm. Number of caruncles averaged 51-53 in each horn. The length of uterine body varied 1.0-1.7 cm and width 1.4-2.1 cm. The length and width of cervix were 3.9-6.4 cm and 1.1-1.5 cm. Number of cervical rings varied 4-8. 23% organs were pregnant, of which 6% had twins. Incidence of pregnancy in right and left horn was 58 and 42%, respectively. Transuterine migration occurred in 16% cases. About 31% non-gravid organs had different abnormalities.

In Kajli ewes the age and live weight at maturity averaged 502 days and 39 kg, the range being 172-961 days and 22-58 kg, respectively. The age at first lambing ranged 384-1677 days with an average of 801 days. Season of birth had no effect on age and body weight at maturity, but it had an effect on age at first lambing. Number of services per conception averaged 1.5, with range of 1-6 services. The average post-lambing oestrus, service period and lambing interval were 142, 179 and 331 days, ranges being 3-732, 22-1094 and 168-1249 days, respectively. The twining percentage was 8.9.

In Toddy goat length of right ovaries averaged 1.3-1.7 cm, width 1.0-1,3 cm, thickness 0.7-0.9 cm and weight 0.6-1.3 gm. The corresponding values for left ovaries were 1.3-1.7, 0.9-1.2, 0.7-0.9 cm and 0.5-1.3 gm. The length of right oviduct ranged 12.9-15.9 cm while that of left 13.4-16.6 cm. The length and width of right horn averaged 8.9-14.9 and 1.2-1.8 cm respectively. These values for loft horn were 9.4-16.0 and 1.2-1.7 cm. Number of caruncles averaged 61-65 in each horn. Length and width of uterine body was 1.0-1.2 and 1.4-2.1 cm, respectively. These values for cervix were 2.2-4.1 and 1.2-1.7 cm. Number of rings varied 4-8. Single, twin and triplet pregnancies were recorded in 35, 60 and 5% organs respectively. The incidence of transuterine embryo migration was 47%. Fertilization failure/embryonic death occurred in

11% cases.

2. NON-SPRCTFIC INFECTIONS

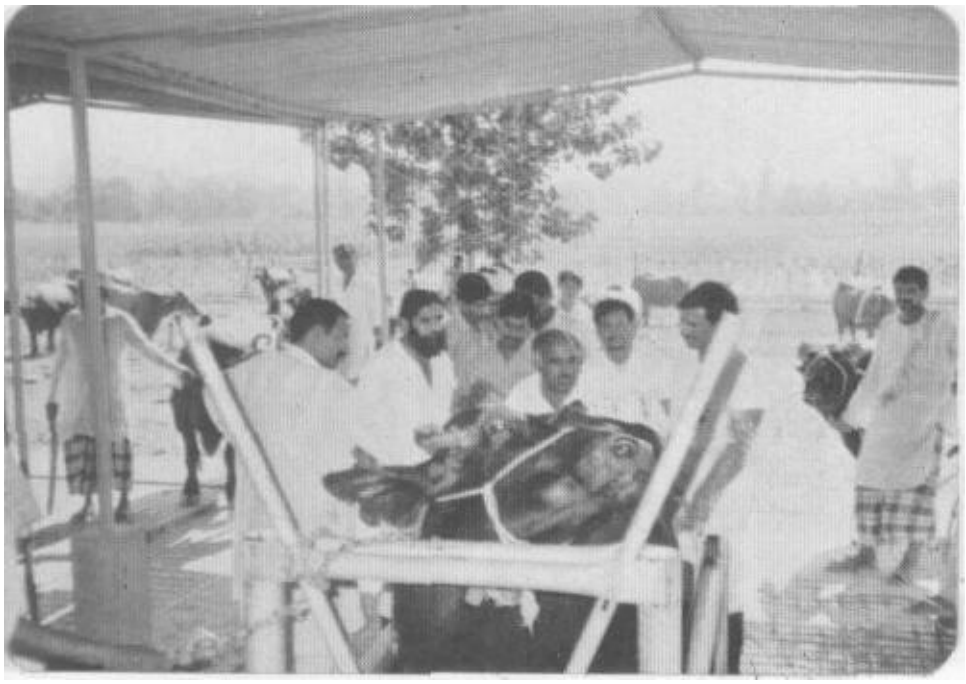
The examination of vaginal discharge of repeat breeding buffaloes showed that *E.Coli* was present in 40% cases, *Streptococcus Zoocpidemicus* in 22%, *Staphylococcus aureus* in 10%, *Bacillus mRgaterium* in 8%, *Proteus vulgaris* in 5% and V.foetus in 3% cases while 12% cases showed no bacterial growth. Combiotic was found most effective for treatment of endometritis as 40% cases were sensitive to it in vitro. It gave 97% cure rate and 72% conception rate. Streptomycin, Choramphenicol, Oxytetracycline, Penicillin and Erythromycin showed in vitro effectiveness in 27, 15, 7, 6 and 5% cases, respectively. Although these antibiotics showed high cure rates, conception rates were rather low, i.e. 64, 63, 60, 57 and 50 %, respectively. High doses gave better results than medium or low doses.

Lugol's iodine, 2-3 % solution given I/U in 2 doses at an interval of 6 days for the treatment of 2nd degree endometritis, gave 75% cure rate and 60% conception rate. Acriflavin 0.1% solution infused I/U in 4 doses at 48 hours interval showed 65% cure rate and 45% conception rate. The pH of uterine mucus was acidic (6.95) in normal animals. In 1st and 2nd degree endometriiis it was alkaline, being 7.86 and 8.04, respectively. The diffrence in pH of normal animis and of those with endometritis was significant.

3. PRESERVATION OP SEMEN

3.1. Liquid form

In the preservation of cow bull semen in liquid form, homogenised whole milk and skimmed milk showed equal results. Addition of glycerol to milk diluents adversely affected the efficiency of diluters at 37 °C but not at 40 °C. The egg yolk, on the other hand, when added to milk diluents at both temperatures, improved their storage capacity. In terms of absolute index of liveability of spermatozoa skim milk egg yolk diluent gave best results at 37oC while homogenised whole milk-egg yolk-glycerol at 4oC.



A class in Animal Reproduction Clinic

Students studying osteology

Students working in nursery

Skim milk, skim milk-egg yolk and homogenized whole milk gave similar results for preservation of buffalo bull semen at 4oC. Skim milk-glucose diluent showed the poorest results. The sperm motility for the four diluents averaged 41, 45, 43 and 11% respectively. The conception rate with milk-egg yolk-glycerol diluent was 56%. The relationship of initial motility with conception rate was 0.6.

In Barbery goat the ejaculate volume averaged 0.5 ml, pH 6.5, motility 74%, sperm concentration 6.5 xl09/ml, and the dead sperms 23%. A greater rate of decay was observed in glycerol containing diluents throughout storage at 4oC and at 37oC. After 24 hours storage diluent comprising 80% milk with 20% yolk was the diluent of choice. After 48 and 72 hours storage, the diluent containing 80% sodium citrate with 20% egg yolk also showed equal results.

3.2. Frozen form

For deep freezing cow bull semen skim milk yolk-glycerol diluent showed very good results. Addition of 5% glycerol improved efficiency of the diluent. Laiciphos did not show good results. Freezing in straws and in the form of pellets gave equal results. Although an equilibration period of 5-6 hours was recommended, the freezing technique can further be improved by decreasing this period to 2 hours. The diluent containing 56 ml lactose, 19 ml fructose, 20 ml egg yolk and 5 ml glycerol showed very good results for deep freezing buffalo bull semen.

For buffalo bull semen extender containing lactose-egg yolk glycerol showed higher post thawing motility, liveability and absolute index of liveability of spermatozoa than those containing milk-egg yolk-glycerol or lactose-fructose-yolk-glycerol. Different concentrations of spermatozoa in semen did not affect post thawing semen quality. In fresh, diluted and frozen thawed semen, sperm head abnormalities averaged 2.9, 3.4 and 5.9% and total sperm abnormalities averaged 5.3, 6.2 and 7.4%, respectively. Different extenders, sperm concentrations and equilibration periods did not affect sperm abnormalities but these increased upon extension and freezing.

Among extenders comprising either lactose or fructose or a combination of these two in various proportions, with equal proportions of egg yolk and glycerol, the one comprising fructose showed the best results in terms of post thawing motility and liveability of spermatozoa. Among four tris-based extenders the one comprising Tris-citric acid-lactose-egg yolk-glycerol showed the highest post thawing motility, liveability and absolute index of liveability. In an other study the extender containing Tris-citric acid-lactose-fructose-yolk-glycerol proved the best for successful preservation of buffalo bull semen at -196oC. The other extenders used were, Tris-citric acid-fructose-yolk-glycerol and Tris-citric acid-lactose- yol k-gl ycerol.

A comparative study of Dimethyl-sulfoxide (DMSO) and glycerol as cryoprotectants for deep freezing of buffalo bull semen revealed that extenders containing either 1% DMSO + 4% glycerol or 5% glycerol were better than extenders containing either 2X DMSO + 3% glycerol. The conception rate for extenders comprising milk-yolk-glycerol, lactose-yolk-glycerol and fructose-lactose-yolk-glycerol were 50, 46 and 39%, respectively, the difference being significant.

For deep freezing of ram semen four extenders viz A(Tris-citric acid-yolk-glycerol), B(Tris-citric acid-glucose-yolk-glycerol), C(Tris-citric acid-fructose-yolk-glycerol) and D (Tris-citric acid-lactose-yolk-glycerol) were compared. The post thawing motility averaged 49, 57, 59 and 53%, liveability 9.8, 11.6, 12.1 and 10.9 hours and absolute index 290, 362, 400 and 337, for the 4 extenders, respectively, extender C being the best.

3.3 Thawing deep frozen semen

Among three thawing temperturees i.e. 4 °C for 2 minutes, 20 °C for 1 minute and 37 °C for 3.0 seconds, thawing frozen ram semen at 37 °C for 30 seconds gave the best results.

Among three thawing temperatures for buffalo bull semen (0 , 37 and 75 "C for 2 minutes, 15 and 9 seconds, respectively) thawing deep frozen semen at 75 °C for 9 seconds showed the highest values of post thawing motility, liveability and aboslute index of liveability. Different thawing temperatures significantly affected the conception rates which averaged 50, 45 and 40% when frozen semen was thawed at 37 °C for 10 seconds, 20 °C for one minute and 5 °C for 2 minutes, respectively.

4. Popularization of AI Technique

Since its establishment in 1971, the Department of Animal Reproduction has done a lot in introducing and popularizing this technique among farmers and livestock owners of the surrounding areas. Besides training undergraduate students, in-service technicians from all over the country and Azad Jammu and Kashmir were given special training in artificial insemination. Now this technique is widely used in cows and buffaloes throughout the country.

In this technique, semen from proven bulls of outstanding genetic potential is collected by using an artificial vagina. This semen is evaluated microscopically for its quality, diluted with an appropriate extender and preserved in the liquid or deep frozen form. This semen can be stored in liquid form for 2-3 days. Before insemination, heat in the females is confirmed through rectal palpation and 1.0 ml of diluted semen, containing at least 20 million actively motile spermatozoa, is deposited in the body of the uterus using a sterile AI rod.

In deep frozen form, the semen can be stored in straws for 10-20 years, or more, without affecting the fertilizing capacity of spermatozoa. Before insemination, the frozen semen is thawed for 10-15 seconds in water bath at 37ºC. The thawed semen is deposited in the uterus of the female using a specially designed insemination gun.

(2) Preservation of semen

The artificial insemination is a very useful technique for rapid improvement of livestock. For the success of artificial insemination, effective preservation of spermatozoa in liquid or frozen form to ensure their short or long-term storage without damaging their fertilizing ability is essential. For this purpose, the semen has to be diluted with appropriate diluents. During the past 28 years, comprehensive work has been carried out on preservation of semen from male cattle and buffaloes in liquid and frozen forms. The most effective diluents were formulated and are being used in the clinic of the department.

i) Liquid form

For preservation of semen in liquid form, milk-egg yolk-glycerol extender has been developed, the composition of which is given below:

Milk	80.00 ml
Egg yolk	15.00 ml
Glycerol	5.00 ml
Penicillin	1000 I.U/ml
Streptomycin	1.0 mg/ml

ii) Frozen form

For preservation of bovine semen in deep-frozen form, a lactose-fructose-egg yolk-glycerol extender has been formulated, as given below:

Lactose solution (11.0%)	56.75 ml
Fructose solution (6.0%)	18.25 ml
Egg yolk	20.00 ml
Glycerol	5.00 ml
Penicillin	1000 I.U. /ml
Streptomycin	1.0 mg/ml

(3) Treatment of Endometritis

Inflammation of the inner layer of the uterus is called endometritis. It is the common cause of repeat breeding and infertility in cows and buffaloes. It may be caused by specific diseases (brucellosis, vibriosis and trichomoniasis) or variety of non-specific infections. It is characterized by presence of varying amount of pus in the uterine mucus. Based on the findings of various studies carried out at this department, the following lines of treatment are used for this condition:

(A) Multi-shot antibiotic treatment

This is successfully used at the clinic of this department for the treatment of moderate and severe endometritis. In this case, sample of uterine mucous/exudates are taken using a clean sterile AI rod. This sample is cultured for the antibiotic sensitivity test and intrauterine infusions of the most effective antibiotic are given for 5-7 days. The daily dose of commonly used antibiotics at this clinic is given below:

i) Combiotic	5.0 gm
ii) Combiotic + Kanamycin	5.0 gm 2.0 "
iii) Chloramphenicol	3.0 "

The desired amount of the antibiotic is mixed with 30 to 50 ml of distilled water and given intrauterine using a sterile AI rod.

(B) Single-shot antibiotic treatment

Results of studies conducted at this department have shown that a single intrauterine infusion of antibiotic 24 hours after AI is very effective for the improvement of conception rate in buffaloes with mild endometritis. For this purpose, 200 mg of gentamicin is dissolved in 30-40 ml of distilled water and given intrauterine 24 hours after AI. This is effectively used at the clinic of this department.

(C) Non-antibiotic treatment

Secretion of antibiotic drugs into the milk and their deposition in muscles render milk and meat unfit for human consumption. Therefore, attempts were made to develop some effective non-antibiotic treatment for this disease. The results indicated that stilbestrol and cloprostinol (PGF2α) were equally effective as non antibiotics in treating endometritis in cows and buffaloes. For this purpose, 0.5 to 1.0 ml of stilbestrol is dissolved in 49.0 ml of distilled water, and three infusions are given intrauterine on alternate days, starting at the metoestrus. Regarding chloprostinol, 2.0 ml (500 ug) of the drug is given intramuscularly on 9-10th day of the oestrus cycle and repeated after 14 days.

(4) Correction of uterine torsion

Torsion of the uterus is a maternal cause of dystokia in the buffalo. This condition is commonly reported in the last trimester of gestation, usually at or near parturition. The condition is mostly caused due to violent jerks and jumps during transportation of pregnant animals. Rapid rolling of the dam for the correction of torsion was being practiced for quite a long time, which involved strenuous exertion on the part of the veterinarian as well as assistants, in addition to the risk of rupture of the uterus during rolling. Plank method of rolling to correct torsion in the buffalo was found safer and less stressful for the veterinarians as well as for the buffalo than rapid rolling.

For proper application of the Plank method, the dam is laid down in lateral recumbency on the side of the direction of torsion i.e. on the right side if torsion is clockwise and on the left side if torsion is anticlockwise. The extended forelegs are tied together at the pasterns leaving 3-4 m length of rope that can be used to roll the animal in a similar way.

A plank of wood about 2.5-3.5 m long, 20-25 cm wide and 6-8 cm thick, is placed with one end on the upper flank and the abdomen of the animal and the other end of plank lies on the ground. One assistant weighing about 75-100 kg should stand on the plank to exert downward pressure while the other two pull the ropes to rotate the dam slowly in the same direction as the torsion. The idea is to increase abdominal pressure and fix the uterus. After the required rolls, the dam may be allowed to rise and the uterus examined rectally to see if torsion is corrected; or the examination may be done on the prostrate dam. If the uterine torsion is not corrected and further rolling is necessary, the dam may be returned to her original prostate position and rolling repeated.

(5) Superovulation and embryo transfer

Superovulation and embryo transfer technique has proved very useful for the rapid improvement of livestock. Comprehensive research in cattle and buffaloes has been undertaken on this subject in this department. Follicle stimulating hormone (FSH) and pregnant mare's serum gonadotropin (PMSG) can be effectively used for superovulation on days 10-12 of the oestrus cycle. However, FSH appears better in terms of superovulatory effects than the PMSG.

(6) In vitro maturation and fertilization

Development of an efficient in vitro maturation, fertilization (IVM-IVF) and embryo culture system appears to be an economical and useful technique for the improvement of productive and reproductive performance of dairy animals. Therefore, a comprehensive project was conducted to investigate the recovery, in vitro maturation, fertilization and culture of oocytes obtained from ovaries of slaughtered buffaloes.

The results have shown that scoring the ovarian surface with a surgical blade with instant rinsing and tapping the ovary to release oocytes into the culture medium is better for the recovery of good quality follicular oocytes than the aspiration or the puncture methods. Buffalo ovaries with corpus luteum yield lower number of good quality oocytes than ovaries without a functional corpus luteum. Culture media including tissue culture medium (TCM-199), bovine synthetic follicular fluid and Ham's F-10 are equally good for in vitro maturation buffalo follicular oocytes. Supplementation of TCM-199 with estrus cow serum, estrus buffalo serum or pro-oestrus buffalo serum improves in vitro maturation and fertilization rates. The development of IVM-IVF produced 2-cell buffalo embryos to morula stage can be improved through conditioning culture media with buffalo oviductal epithelial cells.

(7) Co-culture system of buffalo embryos

Buffalo is the mainstay of dairying in Pakistan. Problems like delayed onset of reproductive maturity, seasonality of breeding, low calving interval, low number of primordial follicles contribute to unsatisfactory reproductive performance of this species. The development of in vitro fertilization (IVF) and embryo transfer (ET) technology have opened up avenues for faster multiplication of superior germ plasm, conservation of extincting animal resources and useful manipulation of genetic constituents of the animals. However, poor superovulatory response and lack of proper conditions to support in vitro culture of buffalo zygotes to a transferable stage embryo are the major impediments in the successful buffalo IVF programme. An approach to overcome the developmental arrest in vitro is to culture the embryos in the presence of feeder cells to make co-culture system which provides the proper conditions that would allow high proportion of embryos to develop upto transferable stage. The present project thus was planned to study the effect of addition of feeder cells/helper cells in a culture drop to make co-culture on maturation and developmental competence of buffalo oocytes. In first part of the study the information was gathered on the method for collection of experimental helper cells, counting of cells, determination of % of live and dad cells and appropriate number of cell/culture drop. It was inferred that method adopted for collection and processing of granulose cells, cumulus cells and oviductal epithelial cells in caprine and bovines can safely be used in buffaloes. The cell suspension containing more than 90% of live helper cells should be processed. A helper cell density should be 2-3 x 10^6/ml of the maturation drop. It was also concluded that cultured drop in the presence of helper cells should regularly be checked for any change in pH, cloudiness in the medium, extracellular granularity and presence of any unidentified material floating on the medium surface to optimize the cultural conditions.

(8) Serum biochemical constituents of mare during different phases of reproductive cycle

Pakistan has an equine population of 4.4 million, including 0.3 million horses, 3.8 million asses, and 0.2 million mules. The fertility status of mares in Pakistan has been extremely low compared with the world average. As far ascertained no work has been reported in Pakistan. While attempting to delineate the causes of infertility in mares, it was felt that study of the biochemical constituents of mare serum might be helpful. The present project was therefore designed to determine the levels of some serum biochemical constituents i.e. glucose, total proteins, calcium and phosphorus in different groups (pregnant, estrual, infertile and regular breeder) of mares. This study was conducted in the Chenab Breeding Area, Faisalabad and the mares were selected from the farms where the managemental practices did not vary greatly. For this purpose forty mares in different phases of reproductive cycle were used so as ten mares

fall in each of the four groups mentioned above based on their reproductive history and rectal examination of their genital tracts. Serum glucose level was recorded at the time of blood collection with the help of glucometer. The serum calcium, inorganic phosphorus and total proteins levels in all experimental mares were determined spectrophotometically by using commercial kits. The highest glucose level (m.moles/litre) was recorded in regular breeder (5.530 ± 0.94) mares, followed by estrual (5.325 ± 0.88), infertile (4.488 ± 0.47) and pregnant (4.367 ± 0.67) mares. There was no difference ($P<0.05$) in the glucose levels between the pregnant and infertile mares and between estrual and regular breeder mares. There was a significant ($P<0.05$) difference between the pregnant and estrual mares, pregnant and regular breeder mares and between infertile and regular breeder mares and infertile and estrual mares. The serum total protein levels (grams/litre) was significantly ($P<0.05$) higher in estrual (66.5 ± 15.2) and regular breeder (67.6 ± 6.2) mares compared with pregnant (48.5 ± 16.7) mares and none significantly higher than infertile (58.7 ± 13.7) mares. The study of serum calcium levels (m.moles per litre) revealed significantly ($P<0.05$) higher calcium levels (2.56 ± 0.40) in estrual mares compared with infertile (1.98 ± 0.25), pregnant (2.19 ± 0.44) and regular breeder (1.86 ± 0.41) mares. No significant difference was found in serum inorganic phosphorus levels among the four groups of mares, however highest levels of inorganic phosphorus (1.98 ± 0.38 m.moles/ litre) were recorded in regular breeder mares and lowest values (1.51 ± 1.30 m.moles/ litre) were recorded in pregnant mares.

The study could have been more conclusive had the groups of controlled mares been available since the managemental practices did vary among individual mares, though the attempt was made to pick up the mares from the farms with similar managemental conditions. Particularly if the nutritional management could also be studied, the study could have been more useful. However, the present study does draw our attention to the fact that mares who were regular breeder and estrual at the time of sampling had higher blood glucose compared with infertile mars. Likewise, estrual and regular breeder mares had non significantly higher serum protein levels compared with infertile mares. Similarly, the mares in estrus at the time of sampling did have highest serum calcium concentrations and had a Ca: P of 1: 0.6.

It can be inferred from the present study that maintenance of physiological levels of glucose, total proteins, calcium and inorganic phosphorus are a prerequisite for optimum fertility and reproductive success. Mare is capable of considerable adjustments to variety of situations, but the extremes of accesses or deficiencies of above mentioned biochemical constituents may lead to lowered reproductive efficiency. The studies expanded to larger groups of mares and preferably with controlled managemental conditions are indicated for future investigations.

VETERINARY ANATOMY

1. METHODOLOGIES IMPROVED

The selection of methods and materials is very critical in any biological experimentation. Their choice alone may mar a research plan or make it worthwhile. An unending process of improvement and sophistication of scientific methodology is, therefore, a pre-requisite for growth and development. Following techniques were developed:-

Because of small size of the blood vessels, blood collection in the developing chick embryo requires dexterity. Fry's method was modified in such a way that egg-yolk contamination is minimized. However, serial sampling from the same egg is not possible.

Some hollow internal organs, e.g., stomah, large intestines, and the like may be transformed into most accurate dry natural models. The technique comprises of fixation and dehydration of fresh evacuated ogans in three successive weekly changes of methylated spirit; distention and positioning by inflation; drying in the tropical sun; and polishing of the exterior with transparent DDT added varnish. The technique is simple and cheap. It requires no imported materials or equipment.

A solid medium containing thiamine and caseaminoacid in agar base was found suitable for the growth of several leptospiral serotypes.

A trephine was designed which could mechanically punch circular skin samples of exactly 1 cm^2 surface area from living animals. This easy to operate technique enhanced reliability of the quantitative estimates of different parameters, e.g., hair follicle of frequency swoating capability, etc., which have a bearing on the heat tolerance mechanism.

A method for objective yet numerical estimation of cutaneous pigmentation was also evolved.

2. NASOLABIAL GLANDS (NLGS)

In some buffaloes, the muzzle skin is externally marked with a median cleft: which is surrounded by numerous small pits carrying a variable number of vibrissae. The usual layers normally found in the general body skin were more easily discernible. However, the well developed nasolabial glands remained localized in the lower dermis. The NLGS are serous, merocrine and tubulo-acinar in structure.

The colourless, odourless and easily fronthing NLGS secretion shows an alkaline pH. Its specific gfavity is 0.9799 in the buffalo and 0.9895 in the cow. Apart from proteins, it contains traces of inorganic radicles, e.g., ammonium, calcium, chloride and bicarbonates. Average amylase level in 100 ml of the secretion was 24.13 units in the buffalo and 16.10 units in the cow. This explained the so far hidden source of this diagestivo enzyme, traces of which were recorded as early as 1916,

3. EXTRA-HEPATIC PORTAL SYSTEM

In the 25 cats, the portal vein was formed by the union of large common mesenteric and small gastro-splenic veins: gastro-duodenal and right gastric veins entering in it near the epiploic foramen. However, the right and left roots of iliocecocolic trunk showed two distinct patterns with regard to their termination:-

In 40 per cent of the cats, the two roots joined with each other to form the iliocecocolic trunk which

entered the common mesenteric vein just caudate to its junction with the pncreatoduodenal vein.

In the remaining 60 per cent of the cats, the right root entered the common mensenteric vein separately: in between the caudal pancreatoduodenal and 1st jejunal veins whereas its left root showed two variations as follows:-

It entered the ventral aspect of the common mesenteric vein just cranical to the entry of the pancreeatoduodenal vein in 32 per cent cats.

In the remaining 28 per cent cats, instead it joined the gastrosplenic vein; before the later entered the common mesenteric vein (Khan & Majeed, 1970).

Communications were studied between portal and systemic circulations in 26 normal adult cats, six of which were unoperated controls; while the portal trunks of the remaining 20 cats were partially ligated. Gradual occlusion of potal veins led to a marked dilation of the normally existing but very small anastomosis between the portal system and systemic veins. The anastomosis thus formed were classified into the portoprecaval and portopostcaval parts. Portopostcaval anastomosis formed the major group of gastrosystemic communications. These were named the gastrophrenic, duodenal, volar omental, left colic and cranial rectal anastomosis. Portoprecaval communications were represented only by the cardio-oesophageal anastomosis.

In the cat. the gastrophrenic and the loft colic anasomosis were found to be the most adequate collateral pathway, which on gradual portal occasion could shunt most of the portal blood into the systemic circulation. In extreme cases, however, the cardiooesophgeal and the cranial rectal analstomosis could also play an important role. (Khan & Vitums, 1971).

4. BUFFALO SKIN; QUANTITATIVE CONSIDERATIONS

The loose, lustrous and sparsely haired buffalo-heifer skin showed epidermal folds, furrows or both forming grossly visible polyhedral configurations on its free surface which helps retain moisture after wallowing or showers.

Well developed dermal papillae enlarged the dermal-epidermal contact considerably which seemed to accelerate tissue-fluid transfer leading to insensible perspiration.

Each hair follicle was accompanied with (a) a simple tubular sweat gland showing a distinct twist near the origin of its duct, (b) a pair of PAS positive, cawliflower shapped sebacious glands, and (c) arrector pilli type smooth muscle bundles.

The two types of glands accompanying the giant hair follicles were also of compratively larger size.

Black or brown colour, its Panj-Kalyan pattern, left or right sides, and eight different locations were found to make significant differences in two, two, ten, two and fifteen of the seventeen parameters studied quantitatively. Their overall means + SE were tabulated and illustrated.

Small thickness (3.19 + 0.05 mm), deep epidermis (89.4 + 1.4u), showing well developed dermal papillae (43.0 + 0.2 X), and coarse (1221.3 + 0.7u) yet scanty (146.6 + 2.8 /mm2) hair are some of the more important structural features of the Nili-Ravi buffalo-heifer skin in summer.

Shoulder means were the first and second nearest to their respective overall means in 9 and 2 of the 15 skin parameters studied. This is therefore the most representative location for sample taking.

Maximum skin pigment was noticed at the back (2.2 units) while the minimum (0.8 units) at the brisket and lower abdomen locations.

Giant hair follicle percentage was found related to all the other seven parameters tested. These inter-relationships tend to suggest that simultaneous selection for little related parameters of skin may have resulted in the disintegration of well established breeds of buffaloes in Pakistan.

It was hypothesized that some of these characteristics may be used to predict milk yield in the buffalo.

5. TERATOLOGICAL DEVELOPMENTS

Partially or wholy Baal-formed newborns or unborn youngs, termed monstrosities, are not uncommon in domestic animals. Such abnormalities, which may be heriditary, usually lead to dystocia. The precise cause of such teratological developments is still obscure. The following were described:

- A conjoined buffalo twin with symmetrical components: Dicephalus tetrapus tetrabrachius,
- A double headed buffalo-calf: Dicephalus dipus dibrachius,
- A double-faced bovine calf: Diprosopus tetraophthalmus, diotus distomus,
- Triplets in a cow.

EFFECTS OF SEASON, LACTATION AND PREGNANCY ON PHYSIO-CHEMICAL PROPERTIES OF BUFFALO BLOOD. M. NASEEM CH. 1989

Grand Means:

Grand means ±SE of the 31 parameters studied among 320 apparently healthy Nili-Rave buffaloes were listed in Table 25.

Effects of the three variables:

Two levels each of season, lactation, and pregnancy were studied in a 12 factorial experiment on 320 buffaloes: divided randomly into eight groups of 40 animals each. Lactating pregnant, lactating not-pregnant dry pregnant and dry not-pregnant buffaloes were thus compared in the two extremes of the weather.
Of the 31 parameters studied:

Weather extremes affected 26 parameters significantly:

Raising the values of respiration rate, pulse rte, rectal temperature, specific gravity, coagulation time, lymphocyte, albumin, 'A/G ratio, cholesterol, creatinine, blood urea, PCV, MCV, AST, ALT, Na, and K in summer (17);

And those of bleeding time, TLC, neutrophil, monocyte, total proteins, globulin, pH, glucose, and Cl in winter (9).

Lactation made significant effect on 14 parameters:

Raising the values of respiration rate, rectal temperature, ESR, neutrophil, total proteins, albumen, A/G ratio, AST, and ALT in the lactating (9);

And RBC, PCV, TLC, eosinophil, and lymphocytes (5) in the dry buffaloes.

Pregnancy affected a total of 9 parameters significantly:

i) Raising the means of respiration rte, eosinophil, A/G ratio, glucose, creatinine and Na (6) among the pregnant;

ii) and those of ESR, TLC, and ALT (3) in the not-pregnant buffaloes.

Inter-relationships:

Inter-relationships, obtained with selection, in between all the 31 parameters studied showed 137 highly significant values of 'r': of which 75 were positive and 62 were negative. Their frequency distribution from the most widely correlated parameter to the least correlated of them all were classified into the following there grades:

Grade-I: Respiration rate (21); AST (20); ALT (17); pulse rate (16); pH (14); bleeding time (14); rectal temperature (12); glucose (12); PCV (12); A/G ratio (11); coagulation time (11); Na (11); total proteins (11); and K (10).

Grade-II: Globulin (9); MCV (8); Cl (8); lymphocyte (7); monocyte (7); albumin (6); cholesterol (6); creatinine (6); blood urea (5); ESR (5); neutrophil (5); RBC (4); basophil (2); eosinophil (2) and TLC (2).

Grade-III: ca (0); and specific gravity (0).

Apparently healthy Nili-Ravi buffaloes of the-subtropical planes showed following trends:

The four most widely correlated parameters of the present study, namely ripiration rate, AST, ALT, and pulse rate, were also found correlated positively with each other. This suggested that in some clinical examination findings are also reflected the results of many of the in-vogue laboratory testes.

The morning rectal temperature in summer was on an average o.810F higher: which in the absence of wallowing was relieved by exaggerated rate of respiration and mild tachycardia.

A large majority of ESR readings in the present study ranged between 0 and 2, the first hourly ESR, therefore, seem of little consequence in the buffalo. Enhanced time interval may possibly help reduce the wide variability observed in this parameter.

Higher metabolic rate which affects albumin and not globulins, was observed in summer, and among the lactating buffaloes.

Lymphocyte and neutrophils respectively form 56 and 34 per cent of the total leucocytes: the two types seem to replace each other, because when one rose the other fell and vice verse.

Globulins formed nearly two-third of total serum proteins. Every rise in globulins was accompanied by a corresponding rise in total proteins but the A/G ratio dropped.

Among other things a drop in serum glucose led to a rise in its hitrogen containing namely blood urea and creatinine. But higher creatinine level in turn would lower serum glucose, although serum cholesterol was raised. The latter could raise the creatinine level further and a further drop in glucose. The whole cycle was thus restarted.

Following haematological indices were derived:

RBC (million /mm3) = PCV (Per cent)/7
MCV (um3 or f1) = PCV (Percent) x 10 /RBC (Million/mm3)

Following the example of the cow one may deduce that higher TLC because of marked increase in neutrophils but significant drop in lymphocytes in winter may be due to a inter stress. But what changes are anticipated in response to stress first needs to be specifically ascertained in the buffalo.

MORPHOMETRIC EVALUATION OF THE HEART, KIDNEYS AND ADRENAL GLANDS OF CAMEL-CALVES (CAMELUS DROMEDARIUS) USING IMAGE ANALYSIS SYSTEM. SARMAD REHAN, 2005.

The present macroscopic, histological and histometrical studies were conducted on the heart, kidneys and adrenal glands of 26 apparently healthy one-humped camel-calves aged between 30-36 months. Samples were collected in winter and gross anatomical data was collected immediately after slaughter, while the histological studies were conducted in the laboratory, on the samples of the organs taken immediately after slaughtering. Histometry was done with the help of semi automated image analysis software AutoCAD®.

Macroscopic studies on the heart of camel-calves revealed that it weighed 1.14 Kg, 19.54 cm long, 14.60 cm wide, having 36.34 cm coronary circumference and was cone-shaped. The left ventricular wall was significantly thicker than the right one. The right and left kidneys of camel-calves weighed 0.68 and 0.72 Kg. The right and left kidneys were 15.05 and 15.54 cm long, 10.75 and 10.98 cm wide, having 25.41 and 25.93 cm longitudinal circumference and were bean-shaped. The mean thickness of renal cortex was recorded as 1.26 and 1.35 cm and of the renal medulla was found as 4.4 and 4.19 cm, respectively. The adrenal glands of camel-calves weigh 18.97 and 16.58. The right adrenal glands (5.81 cm long, 3.84 wide) were significantly ($p < 0.05$) longer and wider than left ones (5.15 cm long and 3.33 cm wide).

Microscopic studies on the heart of camel-calves revealed the average volumes of nuclei of cardiomyocytes of right atrium, left atrium, right ventricle and left ventricle were 141.87, 138.76, and 151.58 and 151.78. Mean intramural connective tissue percentages of right atrium, left atrium, right ventricles and left ventricles were recorded as 7.98, 7.73, 7.26 and 6.80. Microscopic studies of the kidneys showed that the diameters of subcapsular glomeruli (102.61 and 117.4µm) of right and left kidneys were significantly ($p<0.05$) larger as compared to those of juxtamedullary region (86.96 and 87.59 µm). Similar was the case for the volume of subcapsular (1020.78±65.9 and 1635.14 ± 94.3µm3 x 103) and juxtamedullary (616.17±30.6 and 643.79±35.7µm3 x 103) glomeruli. Microscopic studies of adrenal glands showed that mean thicknesses of zona glomerulosa, zona fasciculata and zona reticularis of right adrenal glands were 1139 µm (10.7%), 5354.4 µm (50.5%), 4112.1 µm (38.7%). The same parameters were recorded in left adrenal glands as 1166.92 µm (11%), 5302 µm (50%) and 4053.65 µm (38.2%), respectively. Mean diameters of nuclei of zona glomerulosa of right and left adrenal glands were found as 7.3±0.08 and 7.17±0.1 µm while, mean volumes were recorded as 93.83 and 88.68 µm3.

MORPHOMETRIC EVALUATIONS OF HEART, KIDNEYS AND ADRENAL GLANDSOF BUFFALO (BUBALUS BUBALIS) USING AUTOMATED IMAGE ANALYSIS SYSTEM. RIAZ HUSSAIN, 2005.

The present macroscopic and microscopic study was conducted on the heart, kidneys and adrenal glands of Nili-Ravi buffaloes (Bubalus bubalis) of two age groups viz., young (n=20) and adult (n=20) of either sex. Macroscopic anatomical parameters were studied immediately after slaughtering at the abattoir. For microscopic investigations the samples of various organs were fixed in neutral buffered formalin, tissues were processed by the routine tissue preparation technique for light microscopy. The tissues were stained with haematoxylin and eosin.

The absolute heart weight in adult buffaloes (1606 ±53.86g) were significantly ($P<0.01$) higher than the young ones (2561.37 ± 71.57g).While average relative heart weight of young buffaloes (0.4322 ± 0.0047

%) was significantly (P<0.005) higher than the adult ones (0.4159 ± 0.0044 %).the mean values of width of heart in adult (19.8852±.0344) was significantly higher than young ones (15.180±4.13). The mean values of circumference of heart in adult animals (39.103±0.791) was significantly (P<0.01) higher than young ones (3087±0.922). The mean values of thickness of well of right atrium of adult buffaloes (1.654±0.032) was significantly higher than young ones (1.33±0.51). The mean values of thickness of wall of left atrium in young and adult animals were (1.741±0.43) and (1.863±0.42) respectively. The average absolute weight of both the kidneys in adult buffaloes was significantly higher (2561.37 ± 71.57g) as compared to the young ones (1606 ± 53.86g) while relative kidney weight of young buffaloes (0.2501 ± 0.0027 %) was significantly higher than the adult ones (0.2102 ± 0.0045 %).The mean values of length of right and left kidney in young and adult animals were 18.60±3.15, 19.565±0.318 (right kidney) (young and adult) and 18.548±450 and 21.965±.272 (left kidney) (young and adult) respectively. Statistical analysis showed that length of right kidney in adult animal was highly significantly higher in adult animal than young animal. The mean values of width of right and left kidney in young and adult animal were 12.218±0.148 and 13.462±0.261 (right) and 12.445±0.212 and 13.585 ± 0.246 (left) respectively. The absolute adrenal gland weight was significantly (P<0.01) higher (33.85 ± 1.173g), as compared to the young ones (23.70 ± 1.115g) while the relative weight of adrenal glands of young buffaloes (0.063 ± 0.001%) was significantly higher than the adult buffaloes (0.055 ± 0.001%).The average absolute weight of both adrenal glands was 33.85 ± 1.173g in adult and 23.70 ± 1.115g in young buffaloes. The mean values of length of adrenal gland in young and adult animal were 5.034±0.51 and 6.691±0.042 (right) and 5.171±0.082 and 6.848±0.100 (left) respectively. Statistical analysis showed that length of right and left adrenal gland were highly significantly (P<0.01) higher in adult than young ones.

The microscopic studies on heart of buffaloes revealed that the long diameter of nuclei of cardiomyocytes (11.32 ± 0.13 µm) was significantly (P<0.05) longer than the long diameter of nuclei of younger ones (10.88 ± 0.12 µm).And the short diameter of nuclei of cardiomyocytes of adult ones (3.93 ± 0.02 µm) was also significantly (P<0.01) higher than their younger counterparts. The volume of cardiomyocytes of adult buffaloes (91.71±1.67µm) was significantly (P<0.01) longer than their younger counterparts (74.25 ± 1.89 µm). The intramyocardial connective tissue content in right and left ventricles of adult buffaloes was significantly (P<0.01) higher (7.20 ± 0.19%) as compared to the younger ones (5.09 ± 0.16 %). The long diameter of renal glomeruli (146.89 ± 3.10µm) and short diameter (93.25 ± 1.79) of glomeruli of cortical region of adult buffaloes was significantly longer than their young counterparts (132.45 ± 3.89 µm) and (84.95 ± 1.39) respectively. The volume of renal glomeruli (839.59 ± 50.43 µm×103) was significantly longer than the younger ones (628.31 ± 41.14 µm×103). The microscopic studies of adrenal glands revealed that there was non-significant (P>0.05NS) difference between the average values of long diameter of cells of Zona glomerulosa of adult buffaloes (6.97 ± 0.08µm) as compared to young ones (6.96 ± 0.23 µm). The average values of short diameter of nuclei of zona glomerulosa cells (4.92 ± 0.05 µm) of adult buffaloes was significantly (P<0.01) higher than the young buffaloes (4.61 ± 0.05 µm). The volume of nuclei of cells of zona glomerulosa (88.96 ± 2.82 µm3) of adult buffaloes was significantly (P< 0.05) higher than the volume of nuclei of zona glomerulosa (78.03 ± 3.64 µm3) of younger ones.

GROSS ANATOMY AND HISTOLOGY OF THE MAMMARY GLAND OF ONE HUMPED CAMEL (Camelus dromedaries) UNDER DIFFERENT PHYSIOLOGICAL CONDITIONS, RAZIA KAUSAR 2001

In the present studies, the samples of mammary glands from 24 apparently healthy female one-humped camels (Camelus dromedaries) under different physiological conditions were investigated for their gross- and light microscopic anatomy. Different groups were comprised of equal number of immature heifers, mature heifers, and lactation and non-lactating camels. The gross anatomical data was collected before slaughter, whilst tissues for histological studies were collected immediately following slaughter of animals.

The gross studies on the mammary gland of female camels revealed that the udder of the camel cow had four quarters with its own teat. The colour of the mammary gland showed brown to black tinge in colour.

The shape of the mammary gland was cone-shaped in both immature and mature animals, however, the conformation of teats changed markedly with change in physiological state: in lactating females, the teat turned noticeably round at the tips. The length of teat varied significantly among the four different groups studies. The circumference and diameter of teat increased from tip to base. The most striking feature observed was the presence of two streak canals in all four teats of female camels. The streak canal was found longer cows when they were lactating. The number of Furestenberg's rosette ranged from 11.6 to 13.6 in the present study.

The microscopic studies revealed that two teat canals were separated from each other with the thick layer of connective tissue. The streak canal was lined by stratified squamous epithelium with keratinization that was partially extremely thin in some parts. The cutaneous layer of teat presents few hair follicles and these were entirely absent at mid associated with sebaceous glands, not with the sweat glands. The apocrine sweat glands were less coiled, which showed a wide acinous element forming the part of excretory duct.

Glomusorgans (Hoyer-Grosser's) occurred in the stratum profundum of the corium as well as the subcutis in the present study. The glomus organs also presented many variations present both in structure and size.

These results strongly suggest that udder and teat morphologies may be associated with the low incidence of mastitis in camels.

ANATOMICAL STUDIES ON MAMMARY GLANDS OF NILI RAVI BUFFALOES (Bubalis bubalis). UZMA ANJUM, 2000

A total of 30 samples of mammary gland 10 each of heifer, lactating and nn lactation buffaloes were collected from Faisalabad slaughter house. According to schema Gross anatomical observation revealed that the shape of mammary gland was tucked up and hanged. Teat of mammary glands were pointed and round.

The mammary glands of buffalo consisted of for distinct quarters. This division was however not visible from outside.

Weight and teat length varied significantly with the lactating and non lactating buffaloes. Thickness of teat wall was significantly different in all three physiological groups. Diameter of streak canal in the groups under study was significant different. Length of the streak canal of non lactating buffalo differ significantly from heifer to lactating.

Histological studies revealed that the buffalo teat skin was found to be rich in melanin pigment and devoid of hair follicle.

The histological examination of mammary gland which were taken from apex, middle and base of teat regions (heifer, lactating and non lactating). No consideration was given to age and side of teats.

The streak canal was lined by stratified squamous keratinized epithelium as reported earlier by Nigam and Tyagi (1970).

The mammary gland consists of aggregates of small and large follicles of different shape. in the present study, the follicle cell shape was oval, round or piriform. These follicles were bigger in the lactating and non lactating than the mammary glands of heifers.

In the present studies the average cell heights were (3.29, 5.15 and 3.52 µm in heifer, lactating and non

lactating buffalo respectively. The mean values of number of fold of Furestenberg's rosette were (9.70±0.23, 30.5±0.23 and 29.0±0.23) in heifer, lactating and non lactating buffaloes, respectively. The mucosal fold was less in teat cistern than in Furestenberg's rosette. It was lined by layers of cuboidal to columnar epithelium.

The sub-epithelial connective tissue was thrown into folds rich in blood vessels and nerve fibers. The connective tissue folds were projecting towards the lumen.

STUDIES ON THE HAEMATOLOGICAL PARAMETERS OF LOCAL PEACOCK (Pavo cristatus), SAIMA MASOOD 1999

Forty adult and young local peacocks were divided into four equal groups of adult males, adult females, young males and young females. The blood samples were collected from wing vein of the birds. All birds were cage-birds, kept at Government and private farms at Faisalabad. The blood samples were analysed for erythrocyte sedimentation rate (ESR), Packed cell volume (PCV), Haemoglobin concentration (Hb), total red blood cell count (TRBC), Total leukocyte count (TLC), the Differential leukocytic count (DLC) and erythrocyte indices (Mean corpuscular volume (MCV), Mean corpuscular Haemoglobin concentration (MCHC) and Mean corpuscular Haemoglobin (MCH).

Analysis of variance revealed that sex and age exerted a non significant effect on the erythrocyte sedimentation rate, packed cell volume percentage, total erythrocyte count, differential keukocyte count and erythrocyte indices. However interaction between sex and age groups showed significant difference in some parameters including ESR, TLC, heterophil percentage, while this interaction was highly significant for eosinophil and monocyte percentages and mean corpuscular haemoglobin (MCH).

STUDIES ON THE HAEMATOLOGY AND BIOMETRY OF GASTROINTESTINAL TRACT OF BROILER CHICKS. SALEEM QAISAR, 1995

The study was conducted to establish the normal haematological, biochemical and biometrical changes with increasing age among the three genetic stains of broiler chicks. For this, a total of 150 day-old broiler chicks of three different strains i.e. Arbor Acres, Hubbard and Lohmann (50 birds of each strain) were raised to 60 days of age. From each strain, 10 birds were taken at days 1, 15, 30, 45 and 60 to conduct the haematological, biochemical and biometrical studies. All the managemental conditions were provided to an optimum level.

Haematological studies revealed that red blood cell count, erythrocyte sedimentation rate, hemoglobin, packed cell volume and mean corpuscular volume showed a non-significant difference among the three strains, while man corpuscular hemoglobin, mean corpuscular hemoglobin concentration, total leukocytic count, lymphocytes, monocytes, heterophils, basophil and eosinophil percentage significantly differed among the strains throughout the study.

Biochemical studies disclosed that total protein, glucose and phosphorus differed non significantly among the strains while albumin, globulin, albumin/globulin ratio and calcium level showed a significant difference among the strains.

Body weight of birds significantly incrased with the increasing age in all the three strains. Length, diameter and weight of proventriculus, gizzard, duodenum, ilueum, ceca and rectum showed a significant difference among three strains. Length and weight of the esophagus also showed a significant difference in all the three strains. However, diameter of esophagus differed non significantly among the strains.

There was a significant increase in all the parameters with the advancement of age within same strain.

EFFECTS OF SEX, AGE IN MALES AND SOME PHYSIOLOGICAL STATES IN FEMALES ON THE BLOOD OF ONE-HUMPED CAMEL (Camelus dromedarius) IN SUMMER, SARWAR, A. 1989.

Effects of sex, age in males anf some physiological states in females on the blood of 56 clinically healthy one-humped camels (Camelus dromedaris) in summer. Twenty-eight of these were males aged 4, 5 to 6, 6 to 7, and more than 7 years. The remaining 28 comprised heifers, not-pregnant dry, pregnant-dry, and not pregnant lactating camels. Each of these groups thus contained seven animals.

Analysis of variance revealed that:

Monocytes were found significantly ($P<0.05$) higher in males (5.21 ± 0.30) than females (4.17 ± 0.28). Na was higher ($p<0.05$) in females than in males.

There were no differences for any parameter among male age groups.

Creatinine was the only parameter found significantly ($P>0.05$) higher in pregnant dry females (1.06 ± 0.07 mg/dl) when compared either with heifers (0.81 ± 0.04 mg/dl) or not-pregnant dry (0.79 ± 0.05) females. Heifers had higher ($P<0.05$) AST levels than pregnant dry and non-pregnant dry females. Non-pregnant dry females had higher ($P<0.05$) K levels than non-pregnant lactating females. Pregnancy does not appear to affect AST in dry females but serum K levels are affected by lactation.

It may be concluded that in camels:
unlike other domestic animals, albumin was the predominant serum protein fraction, thereby raising A/G ratio to more than one.

Non lactating females when pregnant showed significantly hither creatinine value.

Interrelationships between studied parameters of blood were ascertained in terms of correlation coefficients or 'r' values among 56 one-humped camels of both sexes and varying ages in summer. Important findings included: RBC and PCV (r=0.542**), RBC and Hb (r=0.482**) and PCV and Hb (r= 0.356**) are correlated positively with each other and so are MCH and MCV (r= 648*), MCH (r= -0.412**), and Hb and MCHC (r= 0.310*). This is because RBC is inversely proportional to MCH (r= 0.858**) and MCV (r= -0.696**), PCV with MCHC (r= -0.585**) and MCH (r= -0.394**) and eosinophils (r= -0.445*) are negatively correlated with lymphocytes. Therefore, a fall in the later is made god jointly by Neutrophils and eosinophils and vice versa. As total proteins are correlated positively not only with globulins (r= 0.849**) but also with albumin (r = 0.661**), therefore, the two fractions join hands in raising the level of serum proteins. But A/G ratio rises when globulins (r = -0.725**) and/or total proteins (r= -0.849**) but also with albumin (r=0.661**), therefore, the tow fractions join hands in raising the level of serum proteins. But A/g ratio rises when globulins (r=-0.725**) and/or total proteins (r=-.725**) and/or total proteins (r=-0.471*) fall. A rise in serum ALT level raises serum globulins (r=0.301*) as well as total proteins (r=0.313*) whereas AST lowers serum globulins (r=-0.298*).

STUDY OF BLOOD SUPPLY TO THE BUFFALO BRAIN WITH SPECIAL EMPHASIS ON RETE MIRABILE CEREBRI. JAVED IQBAL, 1988

Extra and intra cranial circulation was studied in 27 specimens: 24 heads from adult buffaloes and 3 head-cum-neck obtained from 8-10 months old buffalo-calves. Gross dissection (19), simple vinyl resin casts (3), compound vinyl resin casts (1), and vinyl resin cast with intact skeletal structures (4), were the four techniques applied. Salient features. Include:

The common brachiocephalic trunk after giving off left subclavian artery continued as the brachiocephalic trunk. The later terminated into right subclavian artery and two common carotid arteries. Distinct bicarotid

trunk was not seen in any of the three calves studied.

At each intervertebral foramen the vertebral artery gave off spinal twigs, which after branching and anastomosing with their fellows of the other side give rise to dorsal and ventral spinal arteries. The latter supplied the cervical spinal cord and its meninges.

The external carotid artery appeared to be a direct continuation of the common carotid artery.

The internal carotid artery arose caudal to the origin of the occipital artery. In all the twenty-four adult specimens it lacked lumen and resembled a fibrous cord. But in the three calves it was patent; bilaterally in two and unilaterally in one case.

The arterial blood supply to the brain was provided by:

Rostral rete mirabile cerebri was formed by:

Internal maxillary artery through a single ramus anastomosticus and 10-12 arteria anastomotics,. Internal carotid artery.

Caudal rete mirabile cerebri was formed by:

Occipital artery through its anterior terminal branch: the condylar artery.

Vertebral artery.

The post-retial part of the internal carotid artery emerged from the rete mirabile cerebri on its rostromedial aspect; perforated the duramater and divided into rostral and caudal communicating branches which formed the well developed circle of willis. The latter gave rostral, middle and caudal cerebral arteries.

The caudal communicating branches of the post-retial internal carotid artery gave; rostral cerebellar artery which after uniting its fellow of the other side gave rise to the basilar artery. The basilar artery gave3-4 pontine branches, caudal cerebellar artery, branches to medulla oblongata, and continued caudally as the ventral spinal artery.

RECENT SELECTED PUBLICATIONS

Shah, M. G., M. Reißmann, A. Sarwar and H. J. Schwartz, 2005. Sequencing and Mutation Screening in Exon 1 of Camel Tyrosinase Gene. Proc. Deutscher Tropentag, October 11-13, Hohenheim, Germany.

Tyrosinase (TYR) is an important enzyme and involved in coat colour determination as well as hormone production. The gene consists of 5 exons and 4 introns resulting in a coding sequence of about 1600 bp. The length of introns varies from some hundred to over 20,000 bp. Over 150 different mutations are reported in the investigated mammalian species. By reason of its position in the metabolism and its variability the tyrosinase is a gene of great interest in farm animals.

Shah, M. G., A. Sarwar, Reißmann, and H. J. Schwartz, 2005. MC1R in the camels (Camelus dromedarius). Proc. Deutscher Tropentag, October 11-13, Hohenheim, Germany

Mutations in MC1R have previously been shown to result in coat color in various species of mammals as well as in birds. Sequence analysis of MC1R from six camel breeds revealed a SNP (C to T) at position 901 after start codon. Camel MC1R found to have the highest homology with that of pig. Pro/Leu variation was detected only in Kohi camel breed. Based on the analysis of the Polymerase chain reaction

restriction fragment length polymorphism (PCR-RFLP), Kohi breed showed the frequencies of TT, TC and CC genotype animals 0.64, 0.14 and 0.22 respectively, where as, all other breeds showed only CC genotype animals. All three genotyped animals showed considerable differences in their coat color appearance. We can only postulate that C901T mutation plays a role in the coat color in Kohi camels. The camel MC1R showed 83%, 85%, 85%, 88%, 86%, homology with that of cattle, goat, sheep, pig and horse respectively.

Sarwar, A. and H. Enbergs, 2005. A note on lysozyme activity in the milk of dromedaries during early lactation period. . J. Camel Prac. Res., (India). 12(1):69-70.

The aim of this study was to investigate the changes of the lysozyme activity (LZA) in the milk of one-humped camel (Camelus dromedarius) cows during early lactation period. Moreover, the influences of parity, age and sex of calf on the lysozyme activities in milk were analysed. Milk samples were collected from 29 camel cows on alternative days between the 1st and 59th day post partum (p.p.). The activity of lysozyme was measured by turbidimetric method using Micrococcus lysodeiktikus as substrate assay. The lysozyme activity ranged between 7,365 U/ml and 2,936 U/ml with an average of 4,542 U/ml. The lysozyme activity maintained an average of 5,380 U/ml + 1,760 U/ml up to 11th day p.p. and than declined abruptly to a 20-30% lower level. After words there was a slight decrease until the end of study. The lowest LZA was recorded on 57th day p.p. Multipare, old and cows those received male calves showed significantly ($P<0.05$) higher LZA as compared with their counterparts. These data indicate that non-specific immunity in the milk plays an important role in the neonatal health during early lactation period.

Sarwar, A., and H. Enbergs (2005). Haematologic, metabolite and hormone responses to weaning in foals of different breeds. Pferdheilkunde (Germany). 13(2): 93-99.

Eighty-four foals of different breeds (Thoroughbred, Standardbred, German Warmblood), aged 5-6 months, were used in a longitudinal study to evaluate the effects of weaning, sex, breed and farm on haematological, metabolic and hormonal parameters. Weaning raised the values of leukocytes, neutrophils, red-blood cells, haemoglobin, packed-cell volume, platelets, γ-GT and cholesterol, cortisol (a 51% increase) and thyroxin (a 40% increase) on day 1 after weaning compared to day 1 preweaning and eosinophils, lymphocytes and serum triglycerides decreased. These parameters returned to preweaning values by day 14 postweaning except for serum cholesterol, which was still decreased on day 14 postweaning. Serum alkaline phosphatase was lower on day 14 than on day -1. Females had higher mean corpuscular haemoglobin concentration and cortisol concentration than males. German Warmblood foals presented a less altered picture following weaning than Thoroughbreds and Standardbreds. We concluded that foals respond immediately to weaning with what appears to be a physiologic “stress” response.

Mughal, I., A. Qureshi, A. S., S. Tahir (2004). Some histological observations on the postnatal growth of Adrenal gland in rat with progressive age (A HRLM study). Int. J. Agri. Biol. 6(2): 413-417.

The present work elucidates postnatal cytological changes in the adrenal gland with regard to their cortical zones, cell count, nuclear size and lipid contents with advancing age. Thirty six litter mates of 9, 11, 13, 15, 17 and 19 days of age (postnatal were used by dividing into six groups). Adrenals were dissected free, fixed in glutaraldehyde, post fixed in osmic acid and then stained with 1% toluidine blue solution to study under the light microscope. The adrenal gland which is surrounded by a well developed fibrous capsule, showed a decrease in connective tissue fibers with a steady increase in capsular cells from day 9 to day 19. The capsule showed a decrease in the mitotic activity with advancing age. The cortical tissue showed three cortical zones, i.e., zona glomerulosa, zona fasciculata and zona reticularis. The zona glomerulosa was well developed. The radial columns in zona fasciculata and zona reticularis became more distinct on 13th day onwards. The medullary cells in groups were found to invade from

capsular region to the zona glomerulosa and then to zona fasciculata. Predominance of dark cells over the light cells was observed in all groups. There was an overall little increase in size of the inner zones, which might be attributed to the disappearance of many of the medullary cells. The intracellular lipid content in the zona glomerulosa was significant. In the zona fasciculata, the lipid content was little with very meager amount in the juxtamedullary portion too. The medulla appeared distinctly on day 9 of postnatal life covering a larger area. There was predominance of dark cells over the light cells in the medulla throughout the study. It is concluded that functional zonation which characterizes the cortex of the adult rat extends back to neonatal period and that the cells in both the zona glomerulosa and fasciculata actively secret in the infant adrenal.

Sarwar, A., M. A. Majeed, G. Hur and I. R. Khan, 2004. Two transferases and four electrolytes in normal one-humped camel serum. J. Camel Sci. (Syria), 1(1): 57-61.

Two serum transferases and four electrolytes were studied in 56 dromedary camels in eight equal-sized groups (four male groups based on physiological status). Overall means and standard deviations were: AST 47.8 ± 2.58 lU/l, AST: 4.3 ± 0.12 lU/;, Na: 178.4 ± 2.86 mEq/l, K; 5.41 ± 0.11 mEq/l; Cl: 175.80 ± 2.02 mEq/l; and Ca: 5.64 ± 0.10 mEq/l. Na was higher ($p<0.05$) in females than in males. There were no differences for any parameter among male age groups. Heifers had higher ($P<0.05$) AST levels than pregnant dry and non-pregnant dry females. Non-pregnant dry females had higher ($P<0.05$) K levels than non-pregnant lactating females. Pregnancy does not appear to affect AST in dry females but serum K levels are affected by lactation.

Sarwar, A. and H. Enbergs, 2001. Influences of homeopathic preparations of Sausurea lappa roots on the lymphocyte proliferation, phagocytic activity and interferon-gamma in goats. Biol. Med. (Germany), 30(2): 72-76.

The aim of this study was to investigate whether the seeds of N. sativa prepared according to the homeopathic principles have any influence on different immune parameters. The tested parameters included leukocyte phagocytic activity and lymphocyte proliferation. Leukocyte phagocytic activity was measured by flow cytometry and lymphocyte proliferation was assayed by MTT. The required blood samples were obtained from 16 clinically healthy female goats ranging in age from 2 to 10 years. Respective dissolving mediums were used as control. The results revealed that D4 and D8 dilutions of N. sativa prepared in ethanol exerted an inhibitory effect on leukocyte phagocytic activity, maximal effect was observed with 1µl (highest dose) and 0.1µl (lowest dose) doses of D4 and D8 dilutions, respectively. In contrast all doses of D6 dilution of N. sativa enhanced the leukocyte phagocytic activity in dose-dependent manner. The maximum stimulating effect (median: 8%) was observed by the highest dose (1µl) of D6 dilution on leukocyte phagocytic activity, which was significantly ($P<0.05$) different from other doses. Various doses (10µl, 2µl, 1µl, 0.5µl) of all dilutions (D4, D6, D8) of N. sativa under trial stimulated lymphocyte proliferation with decreasing dose. A maximum stimulating effect (median: 6.94%) was observed by the lowest dose (0.5µl) of D4 dilution of N. sativa, which was found significantly ($P<0.05$) different from other doses tested. These data suggest that seeds of N. sativa have a great therapeutic potential to be used as an immuno-modulator in various conditions involving immune deficiency.

Sarwar, A. and H. Enbergs, 2000. Lysozyme activity in milk in Jenny (Equus asinus) milk during early lactation period in relation to reproductive and hormone status and environmental factors. Am. J. Repro. Immunol. (USA), 43(2): 318

The aim of this study was to elucidate the effects of reproductive and hormone status and certain environmental factors like parity and age on the course of lysozyme activity in jenny's milk during early lactation period. Milk samples were collected from 23 jennies on alternative days during first 60 days postpartum. The lysozyme activity (LZA) was measured with modified turbidimetric method using Micrococcus lysodeiktikus as substrate. Progesterone profile in milk was determined by a comparative

enzyme immunoassay (EIA). LZA ranged between 203 278 and 34 340 U/ml with an average of 93 023 + 28 128 U/ml. Lysozyme activity remained very high until the end of foal heat in all jennies. These values declined abruptly to a 25% lower level at the end of foal heat and followed a linear trend until 50th day p.p. and afterward, these values stabilized until the end of study. Jennies conceived in foal heat showed 15000 U/ml LZA higher than those, which had not conceived in foal heat, intil the end of foal heat. Lysozyme activity and progesterone content showed a significantly (P<0.001) negative correlation during foal heat as well as in subsequent heats. Multiparous and old (>10 years) jennies had higher (P<0.001) LZA than primiparae and young (<10 years) counterparts. It is concluded that considerably higher lysozyme activity in milk can firstly be considered as a protective factor for the newborn and secondly, for the low susceptibility of jenny's udder to infections. Moreover, an optimal functional non-specific immunity might play an important role in an intensive and rapid postpartal regeneration process of uterus in jenny. This, consequently, improves the conception chances during foal heat.

Sarwar, A. and M. A. Majeed, 1997. Interrelationships between 30 parameters of blood in normal one humped camel in summer. J. Camel Prac. Res (India). 4, 39-41.

Interrelationships between 30 parameters of blood were ascertained in terms of correlation coefficients or 'r' values among 56 one-humped camels of both sexes and varying ages in summer. Important findings included: RBC and PCV (r=0.542**), RBC and Hb (r=0.482**) and PCV and Hb (r= 0.356**) are correlated positively with each other and so are MCH and MCV (r= 648*), MCH (r= -0.412**), and Hb and MCHC (r= 0.310*). This is because RBC is inversely proportional to MCH (r= 0.858**) and MCV (r= -0.696**), PCV with MCHC (r= -0.585**) and MCH (r= -0.394**) and eosinophils (r= -0.445*) are negatively correlated with lymphocytes. Therefore, a fall in the later is made god jointly by Neutrophils and eosinophils and vice versa. As total proteins are correlated positively not only with globulins (r= 0.849**) but also with albumin (r = 0.661**), therefore, the two fractions join hands in raising the level of serum proteins. But A/G ratio rises when globulins (r = -0.725**) and/or total proteins (r= -0.849**) but also with albumin (r=0.661**), therefore, the tow fractions join hands in raising the level of serum proteins. But A/g ratio rises when globulins (r=-0.725**) and/or total proteins (r=-.725**) and/or total proteins (r=-0.471*) fall. A rise in serum ALT level raises serum globulins (r=0.301*) as well as total proteins (r=0.313*) whereas AST lowers serum globulins (r=-0.298*).

COLLEGE OF VETERINARY SCIENCES LAHORE

ANIMAL HUSBANDRY SECTION

1. BROILER PRODUCTION

Broiler growth and feed conversion ratio under variant lighting i.e. 24, 18, 12 hours and natural day light were studied. The results revealed that after 5th week of age 18 hours light group gained significantly more weight as compared to other light groups. Feed conversion ratio in the group given 18 hours light was significantly better as compared to other light groups. A study on the effect of various floor spaces on feed efficiency, weight gain and dressing percentage of broilers kept on litter system was carried out. The chicks were placed at densities of 0.5, 0.75 and 1.0 sq. ft. per bird upto 8 weeks of age. The differences due to the effect of various floor spaces were found to be non-significant.

An experiment was conducted on broiler chicks to study their performance under the oral administtation of stilbestrol. The results revealed that the best feed conversion ratio and higher fat in meat were observed in the birds treated with 10 nig of stilbestrql per pound of feed. A study was conducted to see the performance of broilers, separate sexes versus combined in cages. The results reveled that at the end of 8th week, males gained higher liveweight than females and mixed sexes with a feed conversion ratio better in males than in females and mixed sexes groups. The differences in the weight gain were significant. However, a non-significant difference was found in feed conversion ratio. The performance of broilers kept with different stock densities and depths of litter was studied by providing floor spaces of 750 or 500 sq. cm. per bird and litter depths of 8 or 16 cm. No signiicant difference was observed in body weight, feed consumption, feed conversion ratio and dressing percentage among the treatments.

2. QUAIL PRODUCTION

In an experiment on Japanese quails fed 24, 26, 28, 30 and 32X proteins containing 2800 kcal/kg M.E. upto the age of 8 weeks, non-significant differences in body . weight, feed consumption and feed conversion ratio were found at 26 and 28% protein levels. The birds fed 26X protein gave the highest dressing percentage (70.2). Best feathering was observed in the group fed on ration containing 26%, protein. A study was conducted to soo the effect of natural day ligKt, 6 hours light and 18 hours darkness, 10 hours light and 14 hours darkness and 14 hours light and 10 hours darkness on the performance of quails. No significant difference was observed for dressing percentage in all the groups.

3. LAYER PRODUCTION

The effect of different housing systems on the performance of White Leghorn layers under prevailing climatic conditions was investigated. One group was housed in Californian type battery cages and the other group was placed on the floor with rice husk as litter material. Results indicated that the caged birds had highly significantly (P/ 0.01) better egg production as compared with the birds kept on floor. Egg breakage was significant (P< 0.01) in the floor housed birds than those of the caged birds. Both feed consumption and feed conversion of tho caged group was highly significantly lower (P< o.Ol) than the floor birds.

The effect of artificial insemination on fertility and hatchabilily of eggs in poultry at the ago of 56 wooks was noted. Skimmed milk was used in five different dilutions comprising 1:5, 1:10, 1:15, 1:20 and 1:25; undiluted semen served as control. Tho hatchability of eggs was maximum • in the control group and was statistically significant <P< 0.01) than all other competotive treatments. Tho skimmed milk dilution gavn

poor hatchability, although hatchability increased with reduction in dilution ratio. The results further showed that the hatchability of eggs in treatment with undiluted semen and whole milk diluted semen were substantially higher than the skimmed milk group. The whole milk proved to be a statisfsctory dilutent for fowl somen.

ANIMAL REPRODUCTION SECTION

1. MALE ANIMALS

Studies concerning post-natal development of the reproductive organs and other related endocrine glands in male Nili-Ravi buffalo calves were conducted. The male Nili-Ravi calves ranging in age from 0 to 7 days were included in the study. After detailed clinical biometrical examination of reproductive organs accessory sex glands were examined after slaughtering. Studies were conducted on libido and mating behaviour of buffalo bulls maintained at SPU, Qadirabad. Fifteen bulls were declared unfit for use in A.I. and fifteen bulls were declared excellent or very good for both the traits of semen production and sexual behaviour. On pooling of these traits, four bulls came out as the best.

The effect of different equiliberation times and extenders on the deep freezing of buffalo bull semen was studied. It was concluded, that tris-yolk-glycerol (TYG) extendr and equiliberation a period at 7 hours were best for the successful preservation of buffalo spermatozoa at -196 °C. The effect of different extenders on the ext= racellular release of GOT and GPT from buffalo bull spermatozoa was also observed. The basic theme of research was to correlate the presence of Glutamic oxaloacetic transaminase (GOT) & Glutlamic pyruvic transaminase (GPT) enzymes (abundantly found in spermatozoa), in semen of buffalo bull with the selection of suitable extender and preservation technique of semen, becuse the level of activity of the; enzymes in semen is indicative of extent of membrane trauma and integrity of spermatozoa. A significnt correlation for GOT activity with age was found. The analysis revealed significant ($P < 0.01$) differences between the extenders SMEYG to LEYG but non-significant differences were found between TEYG and LEYG for the release of GOT & GPT. Motility percentage of spermatozoa with GOT, GPT was also studied. According to the results of this research, TEYG was found to bothe most suitable extender for the preservation of semen of buffalo bull maintain high motility percentage of spermatozoa along with the minimal enzymes release.

A study was conducted on tlie effect of thawing at ambient temperature on the quality of frozen buffalo semen. It was concluded that to achieve maximal post-thaw seminal quality (fertility) nnd to avoid sperm cell damage with cold shock, thawing of frozen buffalo bull semen be carried out at water bath temperature of 40 °C for 15 and 30 seconds during winter and summer, respectively.

2. FEMALE ANIMAL

The study was carried out to determine the serum enzyme activities in clinically healthy female buffalo calves and heifers. The enzymes GOT and GPT exhibited an increasing trend with age, while this situation was reverse in case of ALP and inconsistent in .case of ACP. However, these variations were nonsignificant, statistically.

A study was Conducted on micro-elements in female buffalo calves blood serum during various stages of growth upto maturity. Non-significant differences, except for manganese, were observed for calcium, phosphorus, copper and zinc in all the groups. Significant correlation was observed for phosphorus with the size of the graffian follicle while corrrelation for calcium, copper, zinc, and manganese was negative.

MEDICINE SECTION

1. BUFFALOES AND COWS

One hundred and fifty cows and buffaloes suffering from oedema and congestion of udder, were studied for clinico-pathological picture and etiological factors. Eleven, 59, 18, 19 and 42 out of 150 were diagnosed to be suffering from myocardml asthesis, milk fever, mal-nutrition, adrensil hormonal imbalance, mastitis and physiological udder odema, respectively. A survey of 1987 buffaloes revealed that 130 were suffering from post-parturicnt haomo-globinurea. In another survey, ono thousand milk samples from 250 bufflaoes and cows were collected. Out of 198 buffabcs, 90 were posivive and out of 52 cows, 20 were positive for mastitis. Bactroiological examination of buffalo milk showed that more than 31% wore from mastitic animals. The slike aggluti-nalion and tube agglutination tests showed that 6.4% and 1.2% buff Iocs and 3.6% and 2.0% cows, respectively, were positive for brucellosis. Milk ring test showed 8.3% samples as positive.

Buffalo calves showed 42% infestation due to ascariasis. Piperazine being more effective was recommended for field use.

2. SHEEP AND GOATS

Five hundred blood samples collected form goats revealed that 5.2X were positive to the micro-scopic slide agglutination test and 1.2% to tube agglutination test for brucellosis. Of 159 milk samples subjected to milk ring test, 5.03% were found positive. Lung worm infection was observed in 153 out of 400 faeces sample of sheep. Nilvorm was found to be most effective as anthelmintic. Efficacy of trodex, za+nil and distodin when determine on the basis of eggs per gram did not significantly differ^ between the treatments in sheep.

3. HORSES

Efficacy test of rintal, thiabendazole, systamax and piperazine on the basis of eggs per gram showed rintal to be highly effective against strongyles in horses.

4. WILD ANIMALS

Sixty-six wild felidae were examined for round worms and hook worms; 44 were found positive. Rintal, combantrin, and ketrc were administered. The efficacy of the drugs was determined on the basis of reduction in the number of ova discharged in the faeces. Ketrex was found as a drug of choice.

5. POULTRY

One hundred and fifty layers aged 27 weeks, naturally infested with *Ascaridia galli* were treated with piperazine phosphate and monsonil. There was no significant difference between the treatments. One hundred and sixty, day-old broiler chicks were orally inoculated with oocysts of *E, tenella* and *E. nicatrix.* Uarvisul, sulphadimidine sodium and ESB3 were tried. The results showed ESB3 to be the most effective. Chicks experimentally infected with *A. galli* were treated with santonin, levemisolc nnd piporazine. Santonin was found to be comparatively better. One hundred and twenty, 150 days old chicks were experimentally infected with embryonated eggs of A *galli* and // *gallinarium.* When treated with phenothiazine, piperazine, levemisol and babaring, levemisol was found to be the most effective. Birds infected with *Mycoplasma galliscptimum,* were given streptomycin, furazolidon and oxytetracycline. Oxytetracycline was found to bo the most .suitable.

MICROBIOLOGY SECTION

1. LARGE ANIMALS

A study on the incidence of glanders was made. One horse gave positive reaction out of 200 horses examined at Lahore SPCA Hospital through intradermal pelpebral mallcin tost. Immungcnic studies revealed that tissue culture rinder-pest vaccine prepared on mono-layers of primary bovine kidney cells was immunogcnic for Pakistani buffaloes and cattle. Incidence of *P. multocida* carriers in buffaloes and cattle was observed to be 2.83% and 3.3%, respectively. Serum neutralization and agglutination test proved to he quite satisfactory for determining the immunogcnic response in rabbits and cow calves, vaccinated with black quarter disease vaccine (*Clostridium chauvoei).* The bacteria involved in the causes of delayed uterine involution in post-partum buffaloes, were observed to be *Staphylococcus aurcus, h'. coll, Poroteus vulffaris, Streptococcus pyogenos* and *Corynobncterium Pyogenes.* Comparative efficacy of Rose Bengal plate test and serum agglutination test revealed that Rose Bengal plate test was better than serum agglutin;ition test when applied on 1068 serum samples from buffaloes and cattle.

2. SMALL ANIMALS

To study the incidence of avian vibrionic hepatitis in Lahore, 2568 specimens were collected. All attempts to isolate vibrio were unsuccessful. However, *E.coli,* Staphylococci, Streptococci and *Ifacillusf subUis* were found to be associated with the cases of avian hepatitis. Fluorescent antibody technique was .found to be a very useful diagnostic method for enterotoxaemia in goats. Studios on tho occurrence of rabies virus in saliva of 214 apparently normal dogs in Lahore revealed 15 positive cases. Romanian sheep pox virus prepared in milk teeth susceptible sheep using Borrel technique showed a titer of 10^{-5} whereas tissue culture sheep pox vaccine (Lamb testis and kidney cells) had a titer of 10^{-4}-^{5}. Tissue culture vaccine was found to be better than the vaccine prepared in vivo. Studies on the isolation and serotyping of Salmonellae from 500 faocal samples of sheep and goats from different markets and abattoirs were conducted in Lahore. *Salmonella typhimurium. Salmonella hoidelberg, Salmonella dublin* and Salmonella 0 rough strain were the identified serotypcs.

3. POULTRY

Pseudomonas aoruginosa was isolated in 15.43% birds and 12.55% spoiled eggs. The fowl pox vaccine was observed to be better than pigoon pox vaccine as it produced higher levels of immunity in the vaccinated birds. The technique for the preparation of fowl pox vaccine in tissue culture proved quite safe and successful for the development of vaccine for immunizing birds against fowl pox.

A study on the bacteriology of chronic respiratory disease in poultry in Lahore was conducted. Out of 500 sepcimens of internal organs of poultry, *Kcoli,* Staphylococci and *B, ifiibtlis* were isolated.

An accurate diagnosis of New Castle disease was made in less than 2 hours by fluorescent antibody technique as compared to other mot-hods. The role of maternal antibody in determining an effective Now Castle disease vaccination programme w;is determined. The chicks responded to vaccination when their maternal antibody 1IAI titers were 2^{3} or less at the time of vaccination and responded partially when the IlAI liters were 2^{3} or 2^{5}. At higher levels the response was nil. A comparative study regarding the immunogenicity engendered by throe strains of New Caatle disease vaccine virus through'drinking water/subcutaneous route was made. Both the routes proved satisfactory for immunization of the birds using Mukteswar, La Sota, Komarov strains as vaccines. In a study on the Epizootology of New Castle disease, out of 100 birds examined for each species, five isolates of New Castle disease virus were recovered from parrots, two from doves and none from quails.

Epizootology of New Castle disease in free flying, birds in Pakistan revealed that out of 105 birds, 24.86%

of pigeon, 25.71% sparrows and 21.90% starlings were positive for ND through IIAI test. Three strains of ND virus were isolated. A comparative study on the efficacy of two New Castle disease vaccines, administered through aerosol methods on the basis of haemaggluti nation inhibition test revealed that both the vaccines were equally useful for inducing adequate immune response in tho vaccinated birds.

E.coli as poultry pathogen was isolated in fifteen percent of the birds examined. The serogroups identified were 026, K60, 0111, K58, 0119, K69, 018a, 018c, K77, 020a, 020b and K84 based on the reaction with polyvalent antisera. On the basis of "0" antisera, the serogroups identified were 086, 018ab, 018ac and 044. A study on the incidence of Salmonellosis in poultry in and around Lahore was made. The organisms isolated included S. *gallinarum* and *B.pullorum* and their comparative incidence was 83.33X and 16.67%, respectively. The serotypes out of 100 poultry birds examined included *Mycoplasma gallisepticum* and *M.Synoviae.*

PARASITOLOGY SECTION

1. POULTRY PARASITES

Guts of six hundred broilers between the age of 6 to 10 weeks were examined for the presence of helminths. It was observed that 50% of the young broilers were infected with one or more species of helminths and that the incidence increased to 60% in the broilers at 10 weeks of age. The species of nematodes and cestodes identified were *Ascaridia galli, Heterakis gallinarum, Subulura brumpti, Railliotina tetragona, Raillietina costicillus, Cotugnia diagnopora* and *Choanotaenia infundibulum.* The incidence and worm load was lower in young chickens and it increased progressively with age, which was attributed to constant contact and rearing of birds on old litter.

Therapeutic trials were conducted against poultry nematodes using Embella seed and piperazine phosphate. Seventy worm-free chicks were experimentally infected with embryonated ova of *Ascaridia galli* and *Hoterakis gallinarum.* Embella seed (Babarang) at the dose of 500 mg/kg body weight was 18%, 15% and 20% effective against second, third and mature stages of *Hetcrakis gallinarum,* respectively. Piperazine phosphate at 300 mg/kg body weight was found to be 81%, 72% and 100% effective against the second, third and mature stages of *Ascaridia galli* while. 42%, 45% and 58% against the third,' fourth and mature stages of *Heterakis gallinarum,* respectively.

The effect of sulphaquinoxaline medication on the bone marrow cells in young chicks medicated at levels of 0, 0.012, 0.025 and 0.05% in drinking water over a period of 7-11 days was studied. The medication produced severe anaemia and affected the maturation of cells in the bone marrow. A significant decrease in erythroblasts, thromboblasts and granuloblasts was observed. The bone marrow was pale in colour and had a fatty appearance.

One hundred and fifty chicks were medicated with Embazine, Esb3 and Amprolium at 0.0125% continuously in the drinking water from 28th day upto the age of 56 days. It was observed that the Coccidia became resistant to Amprolium. It was concluded that the additon of Amprolium to chicken feed for the last so many years has produced Amprolium resistant strains.

2. RUMINANT PARASITES

The incidence of different species of helminths in cattle and buffaloes in Lahore area was studied between 1976 and 1982. A total of 1773 buffaloes and 726 cattle of different ages, sexes, breeds and weight were examined. The rate of infestation was found to be the highest for trematodes, being 35.76% in buffaloes and 38.01% in cattle and the lowest for cestodes, being 0.50% in buffaloes and 0.27% in cattle, whereas it was 12.79% in buffaloes and 5.09% in cattle for nematodes. The parasites identified were Fasciola spp, *Nooascaris vitulorum Paramphistomum corvi, Dictyocaulus* spp. *Moniezia expansa; Trichuris spp; Haemonchus spp.* and *Moniezia bonedeni.*

A survey was carried out to estimate the incidence of trematodes in sheep slaughtered at Lahore abattoirs. The overall incidence was observed to be 59.37%. The species of trematodos found were Paramphistomum cervi, Cotylophoron cotylophorum, *Fasciola gigantica* and *Dicrocoelium dendriticum.* The incidence of *Paramphistomum cervi* was significantly more than all of the other species of trematodes found. Similarly, *Cotylophoron cotylophorum* was also significantly higher than *Fasciola hepatica, Faaciola gigantica* and *Dicrocooliuum dendriticum.* No significant difference was observed as regards the incidence of *Fasciola hepatica, Fasciola gigantica* and *Dicrocoolium dondriticium.*

A study was carried out to determine the incidence of hydatid cysts in buffaloes and c&ttle slaughtered in the Lahore Municipal Corporation abattoir. The incidence was found to be 20.39 and 21.96% in buffaloes and cattle, respectively. Liver was the organ most commonly affected.

Keeping in view the economic importance of parasitic bronchitis, the level of lung worm infestation was assessed in animals. A total of 4500 faecal samples collected from buffaloes, sheep and goats were examined. The overall level of infestation was recorded to be 13.7%. The intensity of infection was greater in sheep and goats as compared to the other species of animals.

The efficacy of some coccidiostatic drugs available in the market was determined. Nitro-furazone, sulphaguanidine, and terramycin were used to treat naturally infected lambs aged 2-3 months. Nitro-furazone was found to be the most efficacious drug in reducing the faecal oocyst counts and the treated animals showed maximum body weight gains. The weight gain and faecal oocyst counts in animals treated with sulphaguanidine and terramycin differed non-significantly.

The total cholinesterase activity in the subcelluar fractions of *F.hepatica* and *F. gigantica* was investigated and the microsomal fraction was found tto contain the least cholinesterase activity. The cholinesterase occurred both in particulate and soluble forms.

PATHOLOGY SECTION

1. POULTRY DISEASES

Most of the research efforts were focussed on the recognition, treatment or prevention of viral, bacterial and protozoan diseases affecting poultry.

A study was undertaken to find out whether indigenous fowl was resistant to avain leukosis complex as compared to White Leghorn fowls. It was not possible to infect one day-old indigenous chicks by intraperitoneal inoculation of infective material. However, avian leukosis complex could be transmitted to White Leghorn chicks. Transmission experiments were undertaken in 21 day old White Leghorn chicks. Only one bird showed enlarged liver, spleen and gonads. Microscopic examination of the affected organs revealed necrotic changes, cellular infiltration with lymphocytes in the surrounding areas. In another experiment, 3 out of 72 inoculated birds showed necrotic foci in the heart and liver.

An investigation was done to compare the clinical and pathological findings of the parentally induced disease of Ranikhot to various age groups of broiler and layer chicks with a view to diagnose quickly and correctly. The incubation period increased with age while the mortality rate was reduced with the increase in age. Macroscopic examination of provontriculus, intestine, heart and brain revealed haemorrhages. In addition liver, spleen and kidneys showed necrotic foci. The nasal passages were full of catarrhal exudates. Microscopic appearances of trachea, lungs, proventriculus, liver, heart, kidneys and spleen showed lymphocytic infiltration. , The blood vessels were dilated. The necrotic changes were prominent in all the organs.

The incidence of colibacillosis in poultry and the pathological lesions caused by the pathogens isolated from birds of different ages were studied. *Eschcrichia coli* was isolated from the cloaca of 191 out of 235 birds suffering from diarrhoea, brought to the poultry clinic. Thirty-five out of 191 isolates from birds of imported breeds proved to pathogenic in guinea pigs. No pathogenic *I'^coli* was isolated from 44 birds of local breeds. The overall percentage of pathogenic isolates from both the imported and local birds was 14.93. In day-old chicks it was observed that the infection of 5 groups of E.coli given intraperitoneally caused fatal colisepticaemia at the percentage rate of 100, 90, 100, 60 and 70, respectively. Postmortem findings observed were fibrinous pericarditis, fibrinous perihepatitis, peritonitis and congestion of kidneys. In 8 weeks old chicks it was observed that infection of 5 groups of E.coli given intraperitoneally caused fatal colisepticaomia at the percentage rate of 33.3, 11.1, 33.3, 0 and 0, respectively. The postmortem changes observed were of chronic nature and apparently healthy chicks also showed fibrinous pericarditis, fibrinous hepatitis and peritonitis.

An experiment was undertaken to record the incidence, macroscopic and microscopic lesions in breeding flocks and experimentally infected young chicks. Spot agglutination whole blood rapid test was conducted on 8453 birds from breeding stock at various poultry farms at Lahore and 427 (5.64%) birds reacted positively. Liver and ovaries of adult carrier birds were used for successful isolation of *Salmonella puliorum.* Pullorum disease was produced in chicks of various age groups through differen;-routes of inoculation.

Four weeks old White Leghorn chicks were subjected to vaccination against *Eimaria tenella* with varying doses ranging from 100 to 500 sporulated oocysts. No untoward reaction was seen. Some of the birds when challenged fifteen days post-inoculation with a massive dose of 100,000 sporulated oocysts, did not suffer from the disease which showed that they had acquired the immunity. The vaccinated birds when challenged again three months post-immunization did not show coccidiosis syndrome. The immunity was developed with smaller as well as with larger doses of sporulated oocysts of *Eimcria tonella.* The study suggested that a single dose of 100 sporulated oocysts of L'imeria tenella can produce a protective immunity at least for three months.

The adverse effects of coccidiostatic sulfa drugs Polycox, Darvisul and I';sh3 on the blood components were seen on liver and kidneys of the chicks. The coccidiostatic sulfa drug medication produced severe anemia characterized by decrease *of* erythrocytic count, leukocytic count, haemoglobin contents and hematocrit values. Heterophils, lymphocytes and monocytos decreased significantly. The coccidiostatic sulfa drugs also affected the maturation of the cells in the bone marrow and produced a significant decrcease of immature stages of erythrocytic, granulocytic and thrombocytic scries. Erythroblasts, polychromatic erythrocytes, thromboblasts, immature and mature thrombocytes and granuloblasts decreased significantly by coccidiostatic sulfa drugs.

2. BUFFALO AND CATTLE DISEASES

An experiment was designed to find out the incidence of staphylococcal mastitis in buffaloes and effectiveness of <i group of antibiotics against these organisms. Different organisms isolated were *Staphylococcus aurous, 46; Staphylococcus epidormidis, 6; Streptococcus agalactiae, 22; Streptococcus dysag.ilactiae,6; Efschen'chia con, 19; Corynobactcrium pyogonos, 11; and Pwiidomona aoruginosa, 3.* Chloromycetin was proved to be the most effective drug against *staphylococcal mastitis* followed by ampicillin, oxytotracyclino, neomycin and penicillin. Majority of the isolated sirains of Staphylococcus aureus were resistant to sulphadiazino.

Gross lesions of the ovaries, oviducts, uteri and cervices, and histopathological changes of the morbid tissues of the ovaries, oviducts, uteri and cervices were studied on the internal genitalia of buffalo heifers. In additon, *E. coli* was isolated and identified from tho animals routinely slaughtered at the slaughter house. The macroscopic lesions recorded from the ovaries and bursae consisted of cystic follicles in 8 (5.3%), parovarian cysts in 9 (6.0%), hypoplasia in 7 (4.0%) and ovaro-bursal adhesions in 8(5.3%) cases. The gross lesions of fallopian tubes were mucomotra 5(3.33%) and haemorrhages were also seen in 5(3.33%) cases. Tho cervices revealed no pathological abnormality. HistopaLhological changes confirmed the gross pathological changes. *KKcherichia coli* was isolated from the uterine horns of 31 out of 150 buffalo heifers.

Tho incidence of diseases causing digestive problems was recorded in buffaloes, cows, bullocks, fat tail rams and camel. Only 51 woro found to be the cases of simple indigestion. The rest of animals were suffering from dietetic errors, impaction of rumen, tympany, traumatic gastritis, traumatic pericarditis, anaemia, ketosis, polycythemia and parasitic infestation.

A study was conducted to record different haematological and biochemical parameters of healthy buffaloes from birth to 13 years of age. A significant variation in the values of haemoglobin, total orythrocyte count and packed cell volume was seen between animals below 12 months of age and above 12 months of age. Animals below 12 months of age showed significantly higher haemoglobin contents, total erythrocyte count and haematocrit values. The animals below 12 months possessed significantly higher blood glucose level. The cholesterol level in lactating animals was higher compared to non-lactating animals.

One hundred clinically normal and healthy cattle from birth to adult age were studied for different haematological and biochemical parameters. It was recorded that significantly high values for haemoglobin, total erythrocyte count, packed cell volume and glucose were seen in animals below 12 months of age as compared l,o older age groups. Significantly higher cholesterol level was seen in lactating compared to non-lactating animals. There was no significant variation in the total and differential leucocyte counts of animals below and above 12 months of age.

3. SHEEP AND GOAT DISEASES

Blood of one hundred goats experimentally inoculated with rinderpest, virus was examined. The blood picture of infected goats showed a decrease in lymphocytes and neutrophils. Postmortem examination showed congestion of gastro-intestinal tract with ulc-eration and evidence of necrosis in the abomasum, intestines and spleen. Dcgenrativc changes were noticed in the liver, kidneys, heart, and mesenteric and mediastinal lymph glands.

An investigation was done to find out the incidence of pustular dermatitis in sheep and to study the pathogenicity of causal organism in experimental animals. Shoop numbering 'II,555 were examined for the evidence of contagious pustular dermatitis in Lahore. As many as 2,417 cases were suffering from contagious pustular dermatitis and showed characteristic lesions of the disease. The pathogenicity of the etiologic virus was studied in rabbits and in developing chick embryos. The lesions of the disease consisted of oedematous, swollen, prominent papuio-vesicular wrupt.-ions and a wide zone of erythema around them.

4. DOG AND CAT DISEASES

The histopathology of brain and salivary glands of dogs suspected for rabies was done. Out of ;K) stray dogs the impression smears of three hippocampus and one cerebellum were doubtful for Negri bodies and all the mandibular salivary glands were negative for rabies in all stray dogs. The impression smears from thirty dogs suspected for rabies, showed Negri bodies in twelve hippocampus, seven cerebellum and all the mandibular salivary glands were found negative for Negri bodies. Seventeen dogs out of 30 were biologically positive for rabies. Histopathological changes were observed in hippocampus and cerebellum in fourteen cases.

PHARMACOLOGY SECTION

1. INDIGKNOUS DRUGS

1.1. Anthnlmintics

Therapeutic trials of Embellia seeds wore conducted against the tapeworms in poultry. At dose rate of 246 mg/kg, the drug was found to be safe and 100 per cent effective against the common tapeworms of poultry.

1.2. Ilypoglycaeim'c effects of plant compounds

The effect of a mixture of plant compounds including *Bergnia Ugulata* bed, *Asteracantha longifolia* • /Tal Makhana^, *Cinnamonum cusum fTa^and Argyria cuncater.* (Samundar Sokh) was determined on normal alloxan diabetic mice. It was observed that feeding mixture of plant compounds significantly decreased the blood glucose levels as compared to that of control. It was observed that *B-Japonica* significantly reduced the blood glucose in dogs. Itypoglycaemic effect of *Cuminum niffrum* was observed in four dogs of a local breed. It was observed that *Cnminum nigrum* feeding significantly reduced the blood glucose levels.

1.3. Use of rompun

Field trials to determine the effective dose rate of rompun in the laboratory animals (rabbits) and zoo animals (monkeys) revealed that it caused no sedation when given i/m in rabbits. At the dose rate of 0.3 ml per animal I/V it had an anasthetic effect on rabbits. In monkeys, an I/M injection of 2 ml was sufficient to produce anaesthesia.

The effect of anasthesia stress showed that there was a significant increase in blood glucose, but no significant difference was observed in plasma calcium concentration. Phosphorus, however, significantly increased.

PHYSIOLOGY SECTION

1. BLOOD PROTEINS AND AFLATOXINS

Disc eloctrophoresis of eight mainmalin.n sera was carried out. The resultant protein patterns wore found to be specios-specific with best resolution in goat, dog and man sera. Disc. eloctrophorctic patterns of buffalo, dog and horse plasma proteins were al.so found to bo species-specific.

Milk and eggs and meat from buffalo, cow, sheep and chicken were found to contain aflatoxins. The extracts contained aflatoxin B1, B2 and GI and G2 or metabolic products as Ml, 14, 17 and 1H.

2. SEX HORMONES

A study on female broilers revealed that injection of estrogcn and androgen combined or androgen alone had positive effect on body weight gain. However, progesterone showed an adverse effect. Progesterone plus androgen gave significantly better comb development and wattle size. Kstrogen and androgen when given together, increased the weight and secretory ability of ovaries.

3. HAEMATOLOGY

For the haematology of local birds, adult partridge, pigeon, quail and broiler were used. On an average, partridge blood had 4.9 and 4.86 million RBC/c.mm;-WBC, 6439 and 5880/c.mm, lib, 11%; PCV, 27%; and l';SR 4 mm/hr. Pigeon blood revealed 3.81 and 3.75 million RHC/c.mm and 17625 and 16512 WBC/c.mm by using conventional or chick diluents, respectively, Mb, 16%; PCV '11%; and ESR 6mm/hr. In poultry 3.42 and 3.18 million RBC/c. mm; 26700 and 27600 WBC/c.mm., counted on the chamber under the microscope by using the two diluents as mentioned above. The Hb in broiler was 12%, PCV 33% and RSR 5 mm/hr. The chick diluent and acetic, acid showed significant differences for WBC counts but RBC counts were similar. The chick diluent was better for ease of distinction between the cell nuclei.

SURGERY SECTION

1. ORTHOPEDICS

Fractures which are difficult to handle with remote methods of repair can successfully be dealt with modern techniques. An ovor-riding, short oblique mid shaft fracture of a canine femur was repaired by a stainless steel intramedullary pin which was introduced into the medullary cavity using roterograde method of pinning. The fracture healed in due course of time. Another study was undertaken to ascertain comparative efficiency of intramedullary pins and plates in nearly transverse mid-shaft experimentally produced tibial fractures. The fractures wore immobilized by stainless steel intramedullary pins and the plates. The results indicated that pinning was a better choice in the above mentioned fractures.

2. SOFT TISSUES

Scrotal hernia in a horse with a history of occasional colic symptoms was treated by covered method of castration. An additional complication in this case was strong adhesions between tunica vaginalis and the inner most lining of th scrotal sacs. This case was reported to have adhesions. Tho horse recovered very well after surgery. The prolapsed bowels as a result of road side accident were treated by a surgical technique. The post-operative care resulted in uneventful recovery.

Comparative efficacy of pyloromyotomy and pyloroplasty was ascertained as a means of relief from increased gastric emptying resulting from hypertrophy of circular fibres of pyloric sphincter in dog. In pyloromyotomy a longitudinal incision was given on the pyloric canal going through the serous and muscular layers only allowing the mucosa to bulge out. Pyloroplasty consisted of giving a longitudinal incision through all the layers and suturing the defect transversely thereby increasing the pyloric canal diameter. Pyloroplasty was found to be a better procedure compared to pyloromyotomy.

A study on the comparative efficiency of different sites of cacsarian section in goats revealed that the flank method of operation was better than right abdominal wall method. Hernia of the gravid uterus in the udder, was manually handled in a goat at a late stage of pregnancy. The gravid uterus in the udder was gently pressed with the left hand while the right hand in the vagina dilated the cervical os after delivery. Necropsy of the goat revealed a 4-inch tear in the abdominal wall forwards from the os pubis.

Proteolytic enzyme as an adjuvant to antibiotic treatment of surgical wounds in the dogs significantly enhanced the therapeutic value of antibiotics in the delayed treatment of contaminated wounds. The effectiveness of trypsin was enhanced by prolonged applications. Cpntact of the enzyme with the wound for ten minutes prevented the development of infection and limited the bacterial growth.

ANIMAL NUTRITION SECTION

1. RUMINANT NUTRITION

1.1. Molasses

It was found that 50% of the cereal grains of the fattening ration of Sahiwal calves could be effectively replaced by molasses without significantly affecting the growth rato and feed utilization of the fattening calves.

1.2. Oil cakes

Different levels of rapeseed cake were used in calf fattening rations substituting cottonseed cake on protein equivalent basis. The results indicated that rapeseed cake effectively replaced the cottonseed cake upto 50% on protein equivalent basis. Similar findings were recorded in fattening lambs.

1.3. Urea

It was observed that the urea could be used as a partial substitute of vegetable protein source upto 0.5% level of the concentrate ration (14 gm per 100 kg body weight per day) without significantly impairing the milk production, milk composition and general health of the lactating buffaloes.

1.4. Straw and roughage utilization

The effect of 3.3% sodium hydroxide treatment on the digestibility of sugarcane bagasse, oat straw, wheat straw and rice straw was determined. The crude fibre digestibility was significantly higher for all the four treated roughages as compared to the untreated ones. There was no significant difference in the digestibility of crude fibre of the four roughages in cattle and buffalo. A fattening trial was conducted on male lambs of Lohi breed to study the effect of ammoniation on the nutritive value of wheat straw and sugarcane pith. There was a significant imporvement in the weight gain and feed efficiency of the lambs fed ammonia treated roughages as compared with the non-treated roughages.

2. POULTRY NUTRITION

2.1. Grains and their by-products

A study was initiated to see the extent to which maize could be replaced with wheat in broiler rations. The birds gained maximum weight when 50% of the maizo was replaced with wheat and least response was observed when 100% of the maize was replaced with wheat.

The effect of feeding different levels of rice middlings as a source of energy in poultry rations was studied. It was observed that maize could effectively be substituted by rice middlings in broiler rations without affecting the growth rate and feed utilization.

2.2. Oil cakes/meals

Solvent extracted sunflower oil meal (SFOM) was used at different levels substituting soybean meal on protein equivalent basis. The results indicated that increasing SFOM levels in the ration progressively reduced the growth rate. The chicks fed on SPOM supplemented with L-lysine improved the nutritive value.

A study conducted in laying chicks indicated that cottonseed meal and til cake produced better growth

when used in different combinations than when used alone as a sole source of vegetable protein. Til cake was incorporated to substitute cottonseed meal on protein equivalent basis in chick ration. The results showed that til cake had a better quality of protein as compared to cottonseed meal.

Different levels of indigenous soybean meal were incorporated in the experimental ration to substitute sesame meal on protein equivalent basis. The growth rate and feed utilization of the broiler chicks, was pro-portionately reduced as the level of the soybean meal increased in the experimental ration. A significant pancreatic hypertrophy was also observed in the chicks fed ration containing higher levels of soybean meal.

Almond cake was incorporated at 5.0, 7.5, 10.0, 15.0 and 20.0% of the experimental rations substituting sesame cake on protein equivalent basis. The results showed that there was a proportionate and significant depression in the growth rate and feed utilization of the chicks as the level of almond cake increased in the experimental rations. The feeding of almond cake also caused hypertrophy of the thyroid gland indicating the presence of cyanophoric compounds in the indigenous almond cake.

The effect of autoclaving and amino acid supplementation on the nutritive value of indigenous poppyseed cake showed that autoclaving was ineffective, whereas supplementation of lysine and methionine significantly imporved the nutritive value of indigenous poppyseed cake. This indicated that lysine and methionine might be the limiting essential amino acids in poppyseed cake.

FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

AGRICULTURAL ENGINEERING (Structural & Environmental Engineering)

1. TRACTION EQUIPMENT

1.1. Comparative performance of two-wheel and four wheel tractors

The studies on wheat cultivation reported here indicated that operations with power tiller and garden tractor were slow and their costs of operation per hectare were upto three times the cost of a general purpose tractor. Further, their ability to penetrate through the soil for reducing its strength was limited. No differences were, however, noted between the emergence of wheat seedlings for operations with garden and general purpose tractors. It was explained that soil, crop and machine variables were important in addition to economics for selecting a suitable size tractor. It was concluded that an integration of such variables could lead to an optimal solution for the power required to perform farming operations under Pakistani conditions.

1.2. Prediction of forces for traction equipment

The importance of mechanics in traction has been recognized for many years by engineers concerned with the problems of design, construction and operation of off-the-road locomotive equipment. Accurate mechanics would provide a method by which the forces applied to such equipment could be predicted and controlled by their design and construction.

In our studies an effort was made to present and test the mechanics for predicting the forces applied to tractive equipment such as bulldozers and tractors. The prediction equation developed from the mechanics was found to be a function of weight of tractive device, density, cohesion and angle of internal friction of soil. A comparison of measured and predicted forces indicated a mean difference of 10X of the measured data considered in this study. The disparities were referred to the soil strength parameters (cohesion and angle of internal fricltion of soil) which due to practical difficulties were not determined under exactly the same stress conditions as experienced by the tractive device.

2. TILLAGE IMPLEMENTS

2.1. Comparative performance of tillage implements

The use of improper and heavy implements produced soil compaction that could greatly upset the balance between air, soil and water components of soil. The reduction in the aeration of soil may obstruct the metabolic activities of the roots. The compaction may increase the shear strength of soil so that could imped the root growth of crop. However, compaction is needed to gain good contact between the seeds and soil during planting. The degree of compaction, penetration resistance, shear strength, moisture, etc, needs to be determined so as to evolve a relationship between the emergence and yield of crops.

A comparative study of tillage implements like subsoiler, disk harrow, disc plow, mold-board plow and field cultivator was carried out with a view to assessing their performance for a given soil and crop. The crop and soil parameters considered were emergence, yield of wheat, moisture content, bulk density, penetration resistance, strength of soil and emergence force exerted by seedlings. The results on sandy loam soil indicated that different tillage implements had different effects on the emergence and yield of

wheat. Further, different tillage operations had different effects on soil physical properties such as density, moisture content and penetration resistance. However, such properties of soil could not clearly explain the difference in emergence and yield resulting from different tillage operations. In the last analysis, shear strength of soil and emergence force exerted by seedlings were considered proper parameters in understanding the effects of different tillage implements on the emergence and yield of wheat.

The last two parameters established the superiority of operations with disk harrow under the conditions specified in this study. Operations with such an implement resulted in highest yield and lowest emergence force and shear strength of soil. It is noted with interest that the emergence force exerted by wheat seedling varied from a minimum of 13 grams for disk harrowing to a maximum of about 80 grams for operations by subsoiler and mold-board plow.

Since many combinations of tillage implements used in this study are possible, disk harrow alone may not be guaranted as optimum type tillage tool. However, the combinations used in this study are appropriate for field operations.

Further, there is a need to assess the performance of such an implement with respect to cost of operation.

2.2 Development and Comparative Performance of a Cultivator with Sweep Shovels

The number of plowings required for an ideal seedbed may be reduced if narrow tines of the currently used cultivator are replaced by 25.4 cm wide-sweep shoels. Thus it was considered imperative to develop a cultivator equipped with sweeper shovels (named hereinafter sweep cultivator) to reduce number of plowings and the expenses of tillage. The sweep cultivator in reducing soil strength, promoting germination and yields of wheat and maize crops was compared with disk harrow and the narrow tine cultivator.

Excessive plowing with currently used narrow tine cultivator was considered detrimental to soil structure with serious consequences on soil compaction, air exchange and drainage characteristics of soil. In order to reduce the number of plowings wide-sweep type shovels were developed and attached to standards of the cultivator. This implement, sweep cultivator, was tested regarding its power requirement for adaptation in the country. Further, the effectiveness of sweep cultivator in improving soil-crop parameters, was compared with the narrow tine cultivator and disk harrow. Disk harrow and sweep cultivator were well comparable with respect to soil tilth. However, the disk harrow surpassed in emergence and yield of crops. The different responses were explained in the light of soil/machine variables. Operational costs of different tillage treatments were also determined. Under the conditions of this experiment disk harrow appeared to be more attractive in respect of yield. However, a higher initial cost of disk harrow, unavailability of spare disks, etc, are the constraints which discourage popularity of disk harrow among the farmers. Sweep cultivator was considered a better choice for seedbed preparation.

2.3. Effects of different tillage practices on soil characteristics and emergence of wheat seedling under irrigated conditions

A comparison of seedbed preparation operations by tillage implements like disk plow, disk harrow and field cultivator was made with a view to determine their suitability for a given soil and crop under irrigated conditions. The parameters considered were emergence, moisture content, bulk density, shear strength of soil and emergence force. The results on sandy loam soil indicated that different tillage implements had different effects on the emergence of wheat seedlings. No significant differences were, however, found between the level of soil moisture at a specified depth for different tillage operations. Although different operations had significant effects on the bulk density of soil, the latter could not clearly explain the difference in emergence. However, shear strength of soil and emergence force exerted by seedlings were

considered to be proper parameters in understanding the effects of different tillage implements on the emergence of seedlings. The last two parameters established the superiority of operations with disk harrow followed by field cultivator, under the conditions specified in this study. Operations with such implements recorded higher emergence and lower emergence force and shear strength of soil. The emergence force exerted by a wheat seedling was interestedly noted as 600 grams on field plots operated by disk harrow and field cultivator.

2.4. The mechanics for predicting draft of tillage equipment

The importance of mechanics in tillage has been known for many years. In one study, an effort was made to develop the mechanics for predicting the draft of tillage equipment. The prediction equation thus developed was tested experimentally measuring the draft forces under different soil and operating conditions. The percentage differences between the measured and predicted values of draft varied from 0.112 % to 113.5% with a maximum mean value of 21% of the measured values, over the range of data studied.

2.5. Effect of introducing leading shallow tines in combination with winged subsoiler

The equipment used in this research consisted of soil disturbance measuring apparatus, force measuring apparatus and a winged subsoiler. The soil disturbance was measured with profilemeter.

The force measuring apparatus consisted of an extended octagonal ring transducer equipped with strain gauges. It contained three four-arm bridge circuits and measured the horizontal force (Fx), the vertical force (Fy) and the moment (M). The output signals from the strain gauges were transmitted to an amplifying unit and recorded on an ultra-violet (U.V) oscillograph.

The soil disturbance was measured by following the procedure mentioned above with the help of the profilemeter. The profile was then drawn to a small scale and the area of the soil disturbed was found by means of a planimeter.

To measure the draught, the amplifying unit and the U.V. recorder were placed on a jeep and a long cable was used to connect the transducer to the amplifying unit. The traces obtained from the U.V. recorder were used for the determination of draught.

A study of soil disturbance and draught for different treatments and depths was made on a sandy loam soil with almost a constant dry density with depth.

The results showed that soil disturbance was more in sandy soils than that in clays, keeping the depth constant in both cases. This is because sandy soils are subjected to more shattering as they are noncohessive as compared to clays, which have greater value of cohesion. The soil disturbance was found to increase as the depth of pass increased.

The results of soil disturbance caused by winged subsoiler with two leading shallow tines for different treatments and depths are shown in Table 1. The results indicated that the effect of shallow tines caused a significant increase in loosening the area of the soil with no increase in the total draught.

The soil disturbance per unit draught increased by 60 per cent by introducing two leading shallow tines 0.50 meter apart and 0.17 meter deep, when the winged subsoiler was 0.24 meter deep. The corresponding increase reduced to 25 per cent when the leading shallow tines spaced 0.50 meter and 0.12 meter deep. This showed that soil disturbance per unit draught increased when the leading shallow tines attached with the winged subsoiler were deeper.

Soil disturbance caused by two winged subsoilers spaced at 0.45 meter and 0.25 meter deep with three leading shallow tines spaced at 0.51 meter and 0.13 meter deep was also measured. The results shown in Table 2 indicate that leading shallow tines caused a significant increase in the area of the soil loosened with no change in the draught. The increase in the area of the soil loosened was 41 per cent.

The results (Table 1) showed that draught decreased by introducing two leading tines with the winged subsoiler, with an appreciable increase in soil disturbance. It was also obvious from the results that draught was less when the leading tines were deeper, because they loosened the soil surface at depth, and it became easier for the subsoiler tine to lift the soil with less draught.

Statistical analysis depicted that the decrease in draught-soil disturbance ratio, caused by introducing three leading shallow tines with two winged subsoilers was significant at 5 per cent level.
The following conclusions are drawn from this study:

1. For the same depth, soil disturbance in sandy soil is more than that in clay.
2. Soil disturbance is directly proportional to the depth of subsoiler tine and leading tines.
3. The ratio between soil disturbance and draught is increased by 60 per cent by introducing two leading shallow tines in combination with winged subsoiler.
4. Draught .is directly proportional to the depth of subsoiler tine.
5. Draught decreased by introducing two leading shallow tines in combination with winged subsoiler, with a sufficient increase in soil disturbance,
6. The ratio between draught and soil disturbance decreases significantly by introducing three leading shallow tines in combination with two winged subsoilers.

3. SOIL-PLANT-EQUIPMENT RELATIONSHIP

3.1. The mechanics of penetration equipment

A study was undertaken to develop and test the mechanics of penetration equipment for predicting soil resistance under different conditions. Penetration tests were carried out in clay loam soil at different moistures and densities with a penetrometer of 0.115 inch diameter and a cone angle of 60 degrees. The resistance of soil was found to increase linearly with the density of soil at different moistures and decreased with the moisture of soil generally following a quadratic relationship at various densities under nondrying conditions.

Table 1. Soil disturbance and draught at various depths caused by different treatments.

	Draught (KN)			**Soil disturbance (cm^2)**		
Depth of operation (cm) Treatment	16	24	32	16	24	32
By winged subsoiler	4.85	9.21	18.58	420	830	1700
By winged sub-soiler+two leading shallow tines spaced 50 cm, depth 17 cm.	-	8.64	-	-	1250	-
By winged subsoil+two leading shallow tines spaced 50 cm, depth 12 cm.	-	9.14	-	-	1110	-

Table 2. Soil disturbance and draught at 20 cm depth caused by different treatments.

Treatment	**Block No.**	**Draught (KN)**	**Soil disturbance (cm^2)**

By two winged subsoilers 45 cm apart	1	20.20	2150
	2	21.08	2500
	3	18.89	22.50
	Mean	20.05	2400
By two signed subsoiler 40 cm apart+3 leading shallow tines 50 cm apart, 30 cm depth	1	17.92	1600
	2	21.59	1730
	3	20.64	1770
	Mean	20.05	1700

The prediction equation for the penetration resistance of soil, derived from the analysis of forces acting on the penetrometer was found to be a function of depth of penetration, soil density, cohesion (c), angle of internal friction, soil to metal friction (k), and penetrometer diameter. The soil strength parameters (c, and k), were determined with the help of the shear box. The parameters were substituted in the prediction equation to predict the resistance of soil. The mean value of the percentage differences between the measured and predicted values of resistance was computed as-27.88 per cent, the negative sign indicating over-prediction by the prediction equation. One of the major reasons for the differences was that the soil strength values were not determined under the same stress conditions as induced by the penetration equipment.

3.2. Soil resistance and emergence of seedling

A study was undertaken to establish relationships between the resistance of soil and the emergence of seedlings for different levels of soil moisture, density and planting depth under nondrying conditions. The resistance of soil was determined by a penetration device. It was observed that at different moistures, the soil resistance increased and the emergence decreased linearly with the density of soil further. The soil resistance increased and the emergence decreased in nonlinear fashion with the depth of planting.

The resistance of soil, affecting the emergence of crop seedlings was found to increase linearly with its density at different moistures and decreased with its moistures following a quadrate relationship at different densities under nondrying conditions. It was further found to increase with the area of the penetrating device (used to measure soil resistance) and dryig time.

A general prediction equation was developed employing Housel's approach to describe the penetration resistance of soil within the measured ranges and was given by:

$$F = Ar\,(0.0586M^2 - 2.778M + 37.122)$$
$$Ad\,(5.66\,r + 11.578M - 94.1)$$

Where F is penetration resistance of soil (lb), A is area of the penetrating device (in^2). M is initial moisture of soil (%), d is drying time (days) and r is unit weight of soil minus unit weight of water (Ib/cft). The first term represents the resistance under nondrying conditions and the second term incorporates the effect of air drying. This quation was least accurate for low moisture contents and low density of soil, and the measured and predicted values for the most part did not lie within 95% confidence bands. However, the error of prediction ranged from about 0.68% to 35% (with a mean of 5.6%) excluding low-moisture, low-density data.

3.3. The effect of soil environment on the emergence of seedlings

Laboratory investigations were undertaken to describe the conditions of soil conducive to plant growth in physical, mathematical, and engineering terms. Specifically, this study established relationships showing the effect of soil physical conditions such as moisture, density, temperature and planting depth on the emergence of soybean seedlings under non-drying conditions. The relevant information is needed to

serve as a basis for the development of farm equipment and their operation at proper times in order to enhance plant production. The investigations revealed a curvilinear relationship between the temperature and emergence of soybean seedlings. The optimum temperature for emergence varied from 22°C to 27°C for different soil moistures and densities considered in this study. At lower moisture contents, the emergence of seedlings decreased linearly with the density of soil; whereas at higher moisture content, the emergence was high and slightly affected by the density of soil. Further it -decreased with the depth of planting in a non-linear fashion.

4. DRILLING/PLANTING EQUIPMENT

4.1. Optimum design specifications for planting equipment

Research experiments were conducted for determining the optimum depth of planting and soil impedance for a particular soil and wheat crop. The relevant values for the optimum depth of planting wheat seeds and soil impedance, determined with the help of a computer program, were. found to be 5.5 cm and 2.2 kg/cm^2. The method outlined in this study could be used for determining the relevant optimum values for different soils and crops. Such an information may then be used for incorporating adjustable type furrow openers in the planting equipment for placing seeds and developing proper press wheels for affecting suitable compaction pressure in order to maximize the emergence of crop seedlings.

4.2. Effect of direct drilling techniques, crop residue and earthworms on seed/seedling performance in a wet soil

Five opener types and a surface broadcasting treatment were tested. Best results (in terms of barley seedling emergence) came from surface broadcasting on the untilled soil in all residue and earthworm conditions, and a winged opener (inverted "T" shaped groove) in the presence of both residue and earthworm conditions. A hoe opener ("U" shaped groove) in these latter conditions was marginally inferior to the winged opener in this respect. In the absence of both residue and earthworms there were few opener effects although the increased mechanical disturbance of power-till opener (100 mm wide "U" shaped groove) gave the highest seedling emergence of all other "true" opener types in these conditions. The worst results involved a punch (discontinuous "U" shaped holes) and a triple disc opener ("V" shaped groove) in almost all conditions.

Crop residue conditions resulted in significantly higher numbers of emerged seedlings and greater root/shoot weights than no-residue conditions, under both simulated rain and temporary high water table conditions.

Long residue (200 mm) showed a significantly larger number of emerged seedlings than short residue (40 mm) or bare soil (no residue). Two opener types (winged and hoe) benefited from the presence of crop residue whereas with a triple disc opener the presence of crop residue was a disadvantage. This was because the function of the winged opener kept the residue over the soil surface and the hoe opener swept it aside, whereas the triple disc opener pushed the residue down inside the groove and seed/residue contact appeared to have phytotaxic effects on seeds and seedlings. The performance of the triple disc opener was improved when residue was artificially removed from inside of the grove.

The narrow discontinuous "U" shaped holes created by a punch planter opener, the wide "U" shaped groove of a powered power-till opener and a surface broadcasting treatment did not appear to be influenced by the presence or absence of crop residue. Because precipitation was artificially regulated in these experiments, the latter technique was felt to be of limited practical importance, for untilled soils, because of the uncertainty of natural weather conditions following seedling in the field and otherwise poor potential for seed/soil contact.

In the presence of residue there were higher oxygen diffusion raters (ODR) and lower soil bulk densities, together with increased earthworm populations and activity around the groove profiles of the winged, hoe, power-till and punch planter openers than under no-residue conditions. With the triple disc opener grooves, this trend was reversed, possibly because of compaction and smearing created by this opener.

The presence or absence of earthworms had a marked effect on seed/seedling performance. In the absence of earthworms the contrasting crop residue conditions and opener types had little or no effect on seedling emergence and seed/soil environment were in fact adversely affected by the absence of earthworms. The compacted and smeared groove of the triple disc opener showed lower numbers of earthworms around the groove profile than all other opener types under both residue and no-residue conditions. It was found that a high soil bulk density (1.4 g/cm^3), and to a lesser extent a heavy smear were detrimental to earthworm activity.

The absence of earthworms resulted in 7-9 fold lower cumulative infiltration around the groove profiles than where earthworms were present. Opener effects on infiltration strongly favoured the winged design in the presence of earthworms, but only when infiltration was measured to a depth of 100 mm.

It is therefore recommended that where surface residue and earthworms are present, use of a winged or perhaps hoe or power-till type opener is preferred in soil conditions likely to remain saturated during the germinations and emergence phases. A power-till opener is preferred where residue or earthworms are absent. Use of triple disc or punch planter openers in any of these conditions is not recommended.

4.3. Modification, testing and evaluation of Korean rice transplanter

During initial trials Korean Rice Transplanter gave comparatively satisfactory results, however, the performance of this transplanter was not as desired by our farmers. The number of missing hills was excessively high (30-35 per cent). After modification the machine was able to transplant paddy seedlings in a depth of water 8-12 cms and rate of missing was 8-12 per cent. The number of seedlings per hill were 2-3 in ideal conditions and 3-4 under normal conditions. However, it requires adequate setting of soil particles in a leveled field and seedling with short roots grown by dry method. Comparative performance of the transplanter after and before necessary modifications has been depicted in Tables 3 and 4.

4.4. Soil moisture sensing and signal evaluation for planters

The principal objective of this study were:

1. To evaluate three types of electrical resistance probes, in both two and four electrode configurations, for voltage sensitivity.
2. To determine the effect of soil temperature, soil density, salt contents and soil physical character on the magnitude of voltage between electrodes and
3. To determine the response time of the probes when detecting the change in soil moisture content.

The potential between two electrodes placed in the soil will depend upon the electrical resistivity of the soil layers, contact resistance between soil and electrodes, current flowing from one electrode to another, and depth which has a nonlinear relationship with the moisture content. Therefore, soil having a moisture gradient has a medium of nonhomogeneous ohmic resistivity which makes the problem much more complicated, if not impossible. In order to simplify the problem, the following assumptions were made in developing the theoretical equations:(a) the soil consists of three homogenous ohmic mediums (considering each 25 mm soil layer as a medium of homogenous resistivity by taking the average

moisture content of the 25 mm soil profile), (b) current flow between the electrodes is constant, and (c) the electrodes are assumed to have sufficient low contact resistance so that soil resistance is all that is seen between the electrodes. Under the above assumptions, Laplaces's equation solves the problem.

This study was designed to evaluate the feasibility of using the electrical resistance of soil as a means of providing a signal for controlling depth of seed placement for better seed germination and emergence. An a.c. regulated current of 1000 Hz was passed between the electrodes and the resulting potential drop was rectified and was then displaced on a strip chart recorder. Both two and four electrode probe techniques were studied in detail. Disk, J shape and Knife type electrodes were employed in this study. Four different soils, namely, sandy loam, silty clay, loam and silty clay loam were used during the course of this research. The following conclusions were drawn:

Table 3. Performance of the various transplanter before modification

Test conditions			
Seedling age (days)	33 dry	37 wet	42 wet
Water depth in the field (cm)	10-18	10-18	10-18
Soil sedimentation (days)	2	2	2
Seedling preparation	Washing only	Washing and trimming of roots	Trimming 2-5 cm.
Machine performance			
Korean transplanter			
Average number of plants per hill	6.00	7.00	7.00
2. Missing hills (%)	15-25	25-35	25-35
Manual transplanter			
Average number of plants per hill	10	13	13
2. Missing hills (%)	10-15	15-20	15-20

Table 4. Performance of the Korean transplanter after modification

Test conditions			
Seedling age (days)	33 dry	37 wet	42 wet
Water depth in the field (cm)	10-18	10-18	10-18
Soil sedimentation (days)	2	2	2
Seedling preparation	Washing only	Washing and trimming of roots	Trimming 2-5 cm.
Korean transplanter			
Average number of plants per hill	2.00	3.00	2.00
Missing hills (%)	5-8	8-10	10-15

1. The voltages picked up by two as well four-electrode probes were fairly constant when the moisture content was fixed in the top 75 mm soil layer. This demonstrated that soil depth does not affect the voltage between electrodes if moisture content is fixed with depth. However, the four-electrode probes picked up relatively lower voltages than the two-electrode probes.
2. The voltage change with a change in moisture content was found quite substantial. The typical voltages measured across the two-electrode knife probe were 13.4 volts and 0.50 volts for approximately four percent and 22 percent soil moisture content for sandy loam soil. Even though the statistical analysis showed no difference between types of probes, the two-electrode knife probe was considered better than others due to a slightly higher voltage gradient.

3. Soils containing 0.3% salts resulted in little or no change in soil resistivity. However, in the case of soils containing 0.5% salts, the electrolytic effect caused a decrease in the soil resistivity. This requires that the reference signal should be set at a lower value for moderately saline soils than normal soils for the same moisture content.
4. For soils containing more than one percent salts no change in resistance was observed from saturation to near wilt. In view of this fact, the control of seeding depth in such soils seemed futile.
5. The moisture content sensed by a two-electrode will change by an amount of ± 1 percent for a corresponding change in soil temperature of ± 5.7°C.
6. The voltage between two electrodes decreased with an increase in the soil density. The overall effects of soil density on the voltage response of two-electrode probes were, however, small in magnitude.
7. The soil resistivity varied considerably from one soil type to another for the four soils used in this research, namely, sandy loam, loam, silty caly and silty clay loam. Therefore, the desired reference signal for each soil had a different value, as expected since each soil had different moisture requirements for seed germination and emergence.

Finallly, with the soils and levels of moisture content worked with, the electrocal resistance change with a change in soil moisture content was found sufficient to be used as a signal for controlling depth of a grain drill. A sensor consisting of an a.c. current feedback amplifier, full wave bridge rectifier with filter and two-knife shaped electrodes can provide a signal proportional to soil miosture content. An error signal of positive polarity or negative polarity would occur if the probe is above or below the soil zone having desired moisture content used as a reference respectively, provided a moisture graident exists in the soil at the time of seeding operations.

The response time of this sensor to a step change in the moisture content is about 75 milliseconds. The sensor response would be more than adequate to drive a depth control mechanism installed on a grain drill.

5. Adaptation and Development of a Low and Medium Pressure Sprayer

The objectives of the study were as follows:-

1. To test locally available nozzles and pumps for their performance.
2. To develop and test a small scale model of sprayer for use in the laboratory, so as to obtain necessary information on spraying perameters, such as pressure, droplet size, nozzle orifice dia etc.
3. To select an appropriate nozzle and pump, based upon the above information for spraying herbicides and- insecticides on different crops.
4. To develop a tractor operated sprayer using the above nozzle and pump.

A small scale model of the sprayer fitted with electric motor as prime mover was developed in the laboratory for carrying out initial investigations. Locally made nozzles, pumps and other parts were procured for assessing their performance. Nozzles imported from Italy (Allman's type) and available with Millat Tractors Ltd. were also procured for comparative study.

The following conclusions have been drawn from this study:-

1. A laboratory model of the spraying equipment was developed so as to test nozzles and

pumps. The equipment was then installed on the tractor for assessing its performance. Locally made nozzles were found unreliable in spray pattern and delivery rate.

2. Locally made rotary type pump could not develop desired pressures beyond a certain limit. Diaphragm type pump, however, performed better.

3. An equation showing the relationship between the droplet size and significant variables was evolved .

4. Allman's type nozzles (imported as well as locally adapted) performed satisfactorily.

5. Discharge increased, parabolically with pressure, as given by the following equation:

$$Q = 45 + 31 P - 0.104 P^2$$

Where: Q = Discharge in cc/min.
P = Pressure in psi.

6. Droplet size of the spray decreased parabolically with pressure, as given by the following relation:

$$d = 329 - 9.43p + 0.1378 P^2$$

Where: d = droplet size in microns (10-6 meter)
p = pressure in psi.

7. Droplet size decreased with pressure upto 30psi (with a nozzle orifice dia of 0.2 cm) and then remained constant for pressures from 30 to 40 psi.

8. Optimum size of the droplet for the pressure range of 30 to 40 psi is 170 microns.

9. The discharge per nozzle of 0.2 cm dia was about 10 gal/hour at 30 psi (or 45 litres/hour at 206820 Newtons/meter^2).

10. When the orifice size of the nozzle was increased from 0.2 cm to 0.234 cm, the discharge increased from 10 gal/hour to 21 gal/hour at 30 psi with the increase of droplet size from 171 to 220 microns.

11. Allman's type nozzle of 0.2 cm dia with hollow cone spray pattern was adapted.

12. The above nozzles 20 inches (50 cm) apart provided an overlap of 50% or more.

13. Weber and Mach Numbers (Surface tension and compressibility effects of fluids) were not considered important in the prediction of the droplet size.

14. Reynold's Number, which contains the effects of the nozzle orifice dia, properties of fluids, and velocity of the droplet, was considered the dominant parameter in predicting the droplet size.

15. Droplet size decreased parabolically with Reynold's Number, as given .by the following equation:

$$d/D = 2240 - 0.27 R + 1.231 \times 10\text{-}5 R^2$$

where: d = droplet size in microns
R = Reynold's Number
V = Velocity of flow

16. The droplet size was found stable and constant for the values of Reynold's Number between 8000 to 13000.

17. Low pressures of 12 to 15 psi with the above nozzle produced droplet sizes upto 170 microns suitable for insecticide applications.

18. Medium pressures from 30 to 40 psi produced droplet sizes of 250 microns suitable for

herbicide applications.

19. Slight differences in performance between the imported and locally made allman's type nozzle were observed. The discrepancies were attributed to the differences in material, manufacturing processes and workmanship.

20. The final model of the tractor mounted sprayer consisting of locally fabricated diaphragm type pump, adapted nozzle of Allman's type with plastic body, rubber hoses, pressure gauge and other accessories performed satisfactorily.

21. The pump pressure limits the length of the boom. In case of locally manufactured pumps, the length of the boom for pressures upto 50 psi is limited to 160 inches or 408 cm with 8 nozzles 20 inches or 51 cm apart. In case of imported pump, the length of the boom can be extended upto 20 ft (610 cm) using 12 or more nozzles.

22. The efficiency of the local pumps is required to be improved by using appropriate materials and designs.

23. Synthetic or ceramic materials may be considered for fabricating the nozzles.

24. Further work on the establishment of necessary relationships and improvement of equipment has been suggested.

6. HARVESTING MACHINERY

6.1. Harvesting and threshing losses of wheat with mechanical and conventional methods

Mathematical models were developed for the harvesting and threshing losses of wheat in the field. The harvesting losses with manual operations increased linearly with time, ranging from 3% in the first week to 7% in the third week, after the ripening of crop, indicating that a delay of two weeks in harvesting can seriously affect crop yield. Further, grain losses from the conventional winnowing operations were as high as 10% decreasing in a nonlinear fashion with distance, and becoming negligible beyond a distance of 2.50 meters. With mechanical threshers, the grain losses ranged from 2% to 6% for the different locally made winnowers.

The cost of harvesting with reaper-binder and mechanical thresher is half that of harvesting with manual labour and threshing with bullocks and flail. Mechanical harvesting and threshing required 4 hours as against 48 man/bullock hours. However, these models have yet to be studied carefully for their technical suitability and acceptability under Pakistani conditions.

6.2. Design and development or self-propelled multicrop reaper

Wheat harvest season lasts only for 10-15 days and a machine designed only for wheat harvesting will not be attractive to a traditional farmer. What is needed is a multicrop harvesting equipment which could cut wheat, rice and forage crops which he can use practically year round.

A multipurpose, multicrop, self-propelled reaper to overcome the above mentioned problems was designed and developed at the University of Agriculture, Faisalabad.

The main frame of the machine is supported on two front driving wheels and one rear supporting wheel with pneumatic tires. The power for cutting operation and for forward travel of the machine is provided by a 6-8 h.p. light weight gasoline engine fixed to the rear of the machine. A V-belt drive and bevel gear mechanism provide the necessary reduction of the engine speed from 1250 r.p.m. to 350 r.p.m. at the crank wheel to which the pitman shaft's head is fixed. This produces 700 strokes per minute of the cutter bar. A roller chain and spur gear reduction mechanism has been provided to avoid slippage losses and to

run the front driving wheel at 30 r.p.m.

The conventional mower cutter bar has been adopted to form the cutting unit. Two jaw clutches are provided on each of the front wheels.

Only one operator is required to control and operate this machine. Two control levers accessible to the operator, one for cutter bar control and the other for forward travel control, are provided. The operator can walk or sit on the seat provided for this purpose. Two additional workers are necessary for tying bundles of the cut crop or removing it from the field and taking it to a threshing yard.

With the adjustable cutter bar the crop can be cut at a desired height with a maximum of upto 33 cm and by detaching the cutter bar from the main assembly. The machine can be used as a small power tiller to hitch seed and fertilizer drill. The prime mover of this machine can be independently used to power small grain thresher designed by IRRI in Pakistan and also to power irrigation pumps. One hectare of wheat, rice and forage crops can be harvested in 2.5 hours.

6.3. Design and development of jute decorticator

A "Two Roller" and a "Three Roller" jute decorticators were designed and developed. The three roller machine proved to be better and more economical than two roller machine. Overall preparation of jute fibre by decorticating method has given a net saving of Rs. 23/- per 40 kg of dry fibre. It is expected that with the introduction of these machines the area under jute cultivation will increase considerably.

7. REPAIR OF FARM MACHINERY

An Assessment of Capacity of Workshop and Farmers to Repair and Maintain Farm Machinery in District Faisalabad.

The study was conducted in District Faisalabad of Punjab province, Pakistan, from July 1978 to March 1979. Complete census was carried out during July through August 1978 in the district, and all tractor workshops, spare parts shops were enlisted and mapped. In addition 40 randomly selected villages dispersely situated throughout the district were selected, to form full acquaintance with the repair and maintenance problem of tractors and other farm machinery. One hundred and twenty nine (129) tractor owning farmers of the selected villages, 153 tractor workshops and 76 spare part shops constituted the universe for the purpose of this study. It was also considered appropriate to include a representative number of farm machinery manufacturers into the sample to know about the repair and service facilities they were providing to the farmers. Eighty eight (88) tractor farmers (68%) 47 private workshops (32%), 3 cooperative workshops (100%), 2 dealers workshops (67%), one Government workshop (100%), 16 spare part dealers (21%) and 12 farm equipment manufacturers constituted the final sample. The investigations included the comprehensive data relating to the objective of the study for the year 1978 and the data was edited and transferred on sorting strips in July 1979. The final analysis was completed by December 1979.

Major Tractor breakdowns reported in the year 1978 were 59% percent. Average period between breakdown and repairs was estimated to be about 4 days per tractor. Six percent repairs were carried over at farms and 2 percent by farmers. Frequency of breakdowns was maximum between 2 to 5 years of working age. Major tractor disorders were in hydraulic system, fuel pump, Dynamo, clutch, stearing and water body. Tubewell breakdown was related to the burning of electric motors. Twenty six (26) percent threshers observed major breakdowns during operation in the year 1978, 65 percent threshers repaired at farms and 3 percent by farmers. Unwise use of tractor by poorly skilled operators (33 percent) was the main cause of breakdown. Sub-standard spares and their high prices were the major hurdle in timely repairs. Farmers knowledge was poor about agricultural machinery maintenance schedules. All

manufacturers provided after sale-service. Tracer dealers workshops were found to be better equipped. Private tractor workshops were not fully competent to perform all the needed job works of tractor repairs. Government workshops and cooperative farm service centres were best equipped but trained manpower provided very little services. Twenty seven percent workshops specialized in particular tractor repairs. Sixty percent workshops reported excess capacity of 120 fast moving parts, maximum availability was reported to be 28 to 41 percent in Faisalabad city shops and 1 to 15 percent at rural shops with prices high in rural areas.

Operational guides and manuals should be provided in Urdu. A kit of fast moving parts should be provided with the tractor. Mobile teams for repairs at farms should be constituted. Standardization process should be strictly followed for all types of machines, equipments and spare parts.

8. ELECTRIC POWER AND PROCESS ENGINEERING

8.1. Automatic control in agriculture using microwave sensors.

General specifications imposed on microwave and other electrical sensors for monitoring and control of non-electrical quantities require that the measuring should be nondestructive, contactless and continuous. The measurements should be carried out over the entire volume of the material, while the sensor should be capable of withstanding the environmental conditions of the monitored process.

Applications of microwave sensors to monitoring and automatic control of several non-electrical quantities in agriculture are described. The basic principles of operation and potential agricultural applications of common microwave sensors are presented and two new concepts are suggested. These include a novel application of microwave dielectrometers for monitoring and control of the residual water content in agricultural products and an application of the doppler radar for monitoring and control of the flow of particulate solids.

8.2. A mass flowmeter for particulate solids

There are several valuable features of the microwave Duppller radar technique for monitoring the velocities of particulate solids. The measurements are contactless and the sensor does neither obstruct the flow nor disturb the monitored process. Being remote in principle, it is particularly applicable to hostile environment and inaccessible situations. The response of the system is fast and data processing is relatively easy which makes the instrument particularly suitable for automatic control systems.

The technique is based on the principle of measurement of linear velocity and density of the flow field with a continuous wave (CW) microwave radar. At a fixed viewing angle, the velocity in a given direction is directly proportional to the Doppler frequency.

Since the wavelength of the transmitted signal is known and the angle of incidence can be measured to a high degree of accuracy, the overall uncertainty of velocity measurement depends basically upon the uncertainty of the signal processing system.

As shown above, the frequency of the Doppler signal at the out-put of the radar carries information about the flow field velocity. Similarly, it can be shown that the average rms value of the Doppler signal carried information about average density of the particulates in the flow field.

The microwave Doppler flow monitor described here provides an inexpensive means of monitoring the velocities and densities and, therefore mass flow rates of particulate solids in flow fields. Measurements are contactless and the parameters of the flow can be monitored without causing any obstruction in the flow path of the material. Instrumentation based on this principle is a viable industrial monitor of the mass

flow rate of particulate solids.

9. IRRIGATION AND DRAINAGE

9.1. Modeling of farm irrigation and drainage structures

Investigations were undertaken to develop prediction equations from models for the estimation of flow in irrigation and drainage systems. The following systems were considered:-

1. Pumping machine
2. Open channels
3. Porus media
4. Pipes and sewers.

In order to develop models for the above hydraulic structures and machines, Buckingham Pi theorem and dimentional analysis were used. The design conditions were established for tho models and prediction equations were evolved for predicting flow characteristics.

A study on modeling of irrigation and drainage structures was undertaken with a view to develop prediction equations with the help of the principles of similitude for predicting the performance of pumping machines, open channels porous media, underground drains, pipes and sewers. It was found that viscous forces for pumping machines, gravitational forces for open channels and pressure head with gravity for underground drains are the most important parameters for making predictions.

9.2. Evaluation of evaporation for consumptive use by theory of extreme values

The effects of temperature, humidity, wind velocity, vapor pressure and solar radiation on the consumptive use of crops have been studied. Useable evaporation records of eleven stations available for 15 or more years were included in this study. Daily evaporation data of all station had been taken with a 4-foot weather bureau class A pan.

Evaluations were made by applying the theory of extreme values (Fisher-Tippett type distribution) and the equations for the best fit lines describing each function were obtained by method of least squares.

The objective of this study was its application to design capacity for irrigation systems. The useable soil moisture reservoir capacity for any soil is insufficient to last a month during the peak consumptive use period. To examine the extreme evaporation functions from one day to 30 consecutive days, analyses were made to determine annual extreme quantities for 1, 2, 3, 4, 5, 7, 10, 20, 25, and 30 consellcutive day periods. The frequency of occurrences examined were arbitrarily selected as 2, 5, 10 and 20 years.

To study the similarly of evaporation extreme functions different stations were arbitrarily divided into two groups, one group with warm and high evaporation values and the other with cooler and relatively lower evaporation rates.

As these eleven stations were located in irrigated, semi-dryland and dryland environments, the original evaporation recorded were adjusted to an irrigated evaporation environment to bring the data on comparable basis. For this purpose the evaporation values at dryland and semi-dryland stations were multiplied by 0.775 and 0.887 respectively.

For comparison of the extreme functions for different stations, the 10-day extremes were used. This choice was based on the thought that 10-day was a sufficiently long period to minimize influences caused by possible error in a daily observation but not so long as to observe variations real for a relatively short

period. The correlation coefficient (r) was determined between every two stations of a group to determine if the trends were similar. Evaporation values for 10 day extremes for 2, 3, 4, 5, 6, 7, 8, 9, 10, 15 and 20 years, frequency of occurrence were computed. These eleven values formed a sample for on station. Similar samples were found for all stations and the values of correlation coefficient (r) between different stations were determined.

Confidence intervals were established on the mean values for 1-day extremes for each station at 0.1, 1, 5, and 10 per cent levels of significance to establish whether the stations in a group belonged to the same population. Samples were the same as used to determine correlation coefficients. Each station interval was compared with every other station in the group and functions whose intervals overlapped belonged to the same population. Those whose intervals did not overlap belonged to different populations at the specified level of significance.

Extreme evaporation occurrences were evaluated for eleven stations where 15 or more years of useable records had been taken. Evaluations were made by applying theory of extreme values (Fisher-Tipet Type I distribution), and the equations for the best fit line describing each function were obtained by the method of least squares. These functions can be interpreted into design capacities of irrigation systems.

The above mentioned eleven stations at the 10 percent level of significance fell into three sub-groups having the same extreme evaporation functions.

9.3. Comparison of climatological methods for consumptive use with gravimetric method

Out of the several climatological methods, the Radiation, modified Blaney-Criddle and Evaporation methods were employed in this study to predict evapotranspiration (ET) for wheat during Rabi Season. To determine the accuracy of climatological methods, the ET of wheat was also measured by soil moisture depletion which was one of the field method. The following were the objectives of the study:

1. To determine ET (evapotranspiration) of wheat by soil moisture depletion (Gravimetric) method.
2. To estimate ET by climatological methods based on Radiation, temperature and evaporation.
3. To evaluate the accuracy, simplicity and suitability of each climatological method.

The Actual Evapotranspiration (ETA) of wheat crop was measured by Gravimetic method under local field conditions and the ETp of Rabi season crops were determined by various climatological methods.

The Actual Evapotranspiration of the crop was worked out by Gravimetric measurements of soil moisture depletion. It was calculated by adding the water loss between soil sampling (after and before irrigation), plus pan-evaporation for three days after each irrigation, plus rainfall plus evapotranspiration estimated from soil moisture graph for the days not otherwise 'accounted for. These days included water, loss from the time of last sampling before each irrigation to the field capacity after irrigation. Out of these Pan-evaporation for three day had already been included above. Dividing the total water used in each month by the number of days in that month, the Actual Evapotranspiratin (ETA) per day was calculated.

Table 5. Average daily ET by gravimetric method and ET by various climetological methods.

Months	Gravimetric	Blaney-Criddle	Radiation Haise	Pan-Evap.	Jensen-
	(mm day^{-1})	(mm day^{-1})	(mm day^{-1})	(mm day^{-1})	(mm day^{-1})
Nov.	0.87	2.71	2.77	1.79	3.30
Dec.	1.37	2.08 '	1.98	1.54	2.26

Jan.	1.71	1.64	1.87	1.66	2.07
Feb.	2.91	2.29	2.62	2.37	2.98
Mar.	4.67	3.92	4.10	4.16	4.58
Apr.	3.99	5.46	5.54	5.54	6.73

Potential Evaportranspiration (ETP) defined at "The rate of evapotranspiration from an extensive surface 8 to 15 cm tall, green grass cover of uniform actively growing, completely shading the ground and not short of Water" was calculated from four meteorological techniques. The application procedure for those of Blaney-Criddle, Radiation & Pan—evaporation were taken from Doorenbos and Pruitt (1977) and the procedure for the Jensen-Haise's equation was obtained from Jensen (Edt. 1973).

The potential Evapotranspiration (ETP) estimated by all the four climatological methods and Actual Evapotranspiration (ETP) measured from Gravimetric method were given in the Table.

The following trends were observed regarding the behaviour of ETP with Actual Evapotranspiration in the analysis of four climatological methods.

ETP values in Pan-evaporation method closely followed the ETA except during the months of November and February. Peak ETP was estimated as 4.16 mm/day during the month of March, whereas the ETA was 4.67 mm/day during that period. It showed an under-estimation of 11%. The calculations were relatively simple. The data needed for this method consisted of daily evaporation, relative humidity and wind velocity. The only constraint was that evaporation data at most climatological stations was not available. Evaporation measuring instrument is to be installed at meteorological stations, which could be done with a small investment.

ETP estimates in Radiation method were higher than Actual Evaporation in November and December, lower .in February and March. Peak ETP value was 4.10 mm/day during the month of March. It gave an under-estimation of 12% compared to the peak values. Calculations made were tedious as compared to Pan-evaporation method. The data required for this method was that sunshine hours, temperature, relative humidity and day-time wind velocity. The sunshine hour data was available at a few station and, further, the data was of short duration. Sunshine recorders needed to be installed at the meteorological station, are cheap but required skilled labour to take reading.

ETP values by the Blaney-Criddle’s method were over-estimated in November and December, close in January, and under-estimated in February and March. Peak ETP value" was 3.92 mm/day which showed under-estimation of 16% at the peak period.

The procedure of calculating ETP was simple. The data needed were possible sunshine hours, mean daily temperature and different estimated levels of ratio of sunshine hours, minimum humidity and wind velocity. Such data are generally available on meteorological stations.

KTP estimates with Jensen-Haise method were much above the measured ETA values during all the season except P'ebruary and March. The peak ETP value was 4.58 mm/day in the month of March. It gave an under-estimation of 2%. The procedure for determining the KTP was relatively laborious. The data needed worn sunshine hours, and maximum and minimum temperatures. The temperature data was easily available, whereas a recorder have to he put to get sunshine hours. The investment for the recorder will be a small, however, it would need skilled labour for Liking readings. In the presence of this recorder, the data for the Radiation and Jensen-Haise methods will become available.

1) For estimating water requirements of wheat based on peak values under arid, dry conditions with low wind velocity, the results could be put as under.

2) Jensen-haise method would give value close to peak. For Pan-evaporation, Radiation and Blaney-Criddle's methods, peak values be increased by 11%, 12% and 16%, respectively, so as to become equal to peak value of Gravimetric method.

3) The rate of change of Actual Evapotranspiration during tho season was closely matched with Pan-evaporation, followed by Radiation, Blaney-Criddle and Jensen-Haise, respectively.

4) Seasonal estimated depths of water in case of Pan-evaporation, RIaney-Criddle, Radiation and Jensen-Haise were 404.47, -123.50,446.46 and 510.10 mm, respectively. The actual sesonal measured depth of water by Gravimetric method was 394.67 mm. The error in the case of Pan-evaporation, Blaney-Criddle, Radiation and Jensen-Hsaise was 2.48, 7.38, 12.6, 29.74, percent, respectively.

10. SOU-STABILIZATION

10.1. The effect of sodium chloride on the compaction characteristics of silly loam soil

The materials used in this study were sodium chloride (rock salt) and silty loam soil from the University of Agriculture, Faisalabad. The compaction tests are very common type of tests.

The equipment and procedure used for these tests are described in R.S. 1377.

The moisture/density relationships were obtained for natural and stabilized soils with 0.5, 1.0, 1.5 and 2.0 per cent sodium chloride contents. The pre-determined weights of air dried soil and salt were mixed in the mechanical mixer for three minutes to get an homogeneous mixture. The required amount of distilled water was then added and wet mixing continued for about seven minutes. The soil was then compacted in the mould at the modified AASUO compaction level and its moisture content and bulk density were obtained. The dry density was calculated by the following relationship:

$$\text{Dry Density} = \frac{\text{Bulk Density}}{1 + \text{moisture content (\%)}}$$

The results of the compaction tests carried out to develop the relationships between dry density and optimum moisture content for natural and treated soil mixes indicated that the maximum dry density values obtained by the addition of sodium chloride (from 0.5 to 2.0 per cent) were all higher than the maximum dry density of the untreated soil.

The increase in density is attributed to the lubricating effect of sodium chloride solution present in the soil. This can be explained by the fact that sodium chloride fills the void spaces between soil particles; in other words it causes a dispersed soil structure that allows a closer particle orientation and thus greater density.

The results show that the value of dry density of treated soil increases with an increase in salt content up to 1.5 percent, afterwards there is a slight decrease at 2.0 per cent salt content. The reason is the flocculation behaviour of clay (present in soil) at that salt content. The optimum moisture contents of treated soil at different salt contents were less than that of the natural soil, the increase being more prominent at 0.5 per cent salt content. The reason is that the addition of sodium chloride decreases the thickness of the adsorbed layer which requires less water to bring about maximum dry density.

10.2. Moisture-movement characteristics of silty loam soil stabilized with sodium chloride

To determine the erodibility of salt-stabilized and natural soils, a rainfall simulator of the drop former type

was used. It consists of a box (1 x x x 0.15m) made from 6 mm thick perspex and is supported by an angle iron frame. Hypodermic needless (number =10,000, diameter =2mm and spacing = 10 mm) were used as drop formers, producing a rainfall of 5-110 mm per hour intensity, depending on head or depth of water in the box.

The soil specimens after weighing, were subjected to a rainstorm of 62 mm per hour intensity for two hours. The surfaces of the specimens were maintained at 2 per cent slope to the horizontal, which is the general value of the cross slope in pavements. This slope also helped to prevent ponding during the test. The amount of eroded soils (natural and salt-treated) were collected separately.

The relationship between the amount of erosion (kg/m'/hour) and salt content (0 %) revealed that the treated soil is less credible than the natural one at 0.5 and 1.0 per cent salt contents. The reason is an increase in dry density and crystallization of sodium chloride (caused by dry-curing) at the surface of the specimen, which cements it into a dense hard crust. It is also obvious that the addition of salt at higher salt contents (i.e. 1.5 and 2.00 per cent) is not very effective in reducing erosion as compared to lower salt contents (i.e. 0.5 and 1.0 per cent).

The values of water absorption (0 %) and soil permeability (mm/sec) decreased gradually with an increase in salt content. The decrease becomes very small when the salt content increases from 1.5 to 2.0 per cent.

The results show that, in general, the drying rate is rapid in natural soil sepcimens as compared to treated ones owing to the ability of sodium chloride to lower the vapour pressure of the water in which it is dissolved. The decrease in vapour pressure (the tendency of a substance to pass from the liquid or solid into the gaseous state) results in a decrease in the drying rate. Surface tension also affects the rate of evaporation in such a manner that a solution possessing high surface tension tends to vaporize less rapidly than the one having low surface tension. The sodium chloride present in soil-water mixtures causes an increase in the surface tension of water, thereby decreasing the moisture evaporation rate. The property of moisture retention is valuable in reducing the comparative effort and retaining the moisture content at high temperatures so as to reduce cracking of the road pavement.

The main conclusion drawn from these moisture-movement characteristics is that saline soil can be used to construct low-cost road pavements in rural areas where intensity of traffic is not very high.

10.3. Use of soil-cement mixes for farm structures

In this study the compressive strengths of different sandy soil-cement mixes were determined. These soil-cement mixes can be used for low-cost rural roads and farm buildings in the rural areas. Sandy soil was treated with cement. The dry density/moisture content relationships were developed for natural and cement-stabilized soil mixed. The cylinderical specimens (102 and in diameter and 114 mm long) were prepared at different cement contents and were moulded at their respective optimum moisture contents. The compressive strengths of these specimens were determined after 7 and 14 days of curing. It was concluded that compressive strength of soil increased as the cement content increased. The compressive strengths of the specimen treated with 4 per cent cement content was double than that of the natural soil while the ratio of the compressive strengths was 3 with an 8% cement content. The curing period was limited to 14 days in both the cases.

These results encourage the use of sandy soil-cement for the construction of low-cost roads and as amortar/plastering material in farm buildings. It can also be used for the preparation of bricks for the construction of farm houses.

FARM MACHINERY AND POWER

Mapping Water Table Depth by Electromagnetic Induction

Currently most citrus groves are managed uniformly in large blocks, despite significant spatial variability in soil and water properties that influence the long-term viability of perennial citrus trees in Florida's poorly drained Southern Flatwood soils. Detailed georeferenced water table maps would be useful to select suitable land for new citrus grove development, drainage system design, or to identify and manage drainage problems in existing groves. The objective of this study was to develop a new precision agriculture application, using ground conductivity measures with the EM-38 electromagnetic soil profiler for the estimation and mapping of shallow water table depths in Florida's citrus groves. Calibrations were developed and tested in five different months and two sites to evaluate the spatial and temporal accuracy of water table predictions. Three automated mobile surveys of water table depth were then conducted in the same groves, using a differential glob positioning system (DGPS) for georeferncing the ground water conductivity data. The spatial variability of water table depths was mainly determined by soil type and the temporal variability was influenced strongly by the seasonal rainfall pattern. The vertical dipole (EM_v) of the EM-38 instrument was better than the horizontal dipole (EMh) for estimating water table depths because of its greater sensing depth.

Accuracy, calculated as root mean square error (RMSE) ranged from 4.1 to 13.9 cm on a given day. Significant bias was, however, evident when comparing calibrations developed on different sites which were 12-km apart. Global calibrations incorporating a rainfall index as well as EM_V were much better predictors of water table due to the added temporal information.

Variable Lime Application Based on Within – Field Variation in soil pH

The variability of soil pH, texture and organic matter was studied with the prospects of varying application rate of lime by precision farming techniques. Soil pH varied greatly across the uniformly managed field at the farm of University of Newcastle, England. Soil samples were taken on a regular grid of 20m x 40m using differential Global Positioning System (DGPS). The spatial analysis showed that the range was large, resulting in maps having a uniform pH. The large areas or uniform ph would allow differential application of liming material. A uniform application of lime, based on an average pH for the entire field was shown to be less effective than spatially targeted applications. Only 9% of the field was at the mean pH value of5.9 (± 0.1), which would be limed using the conventional approach. The results suggest that variable application should become common practice to increase the agronomic and environmental efficiency.

Potential of Precision Fertilization of Fields with P and K Based on Spatial Variation in Nutrient Content and Crop Yield

Different models used for calculating nutrient requirement were compared taking precision farming system as standard. Half of the field area received incorrect amount of fertilizer using conventional method whereas 20% improvement was observed in area correctly fertilized by suing average yield and variable soil nutrient index method. Little more improvement in variable soil nutrient index and mean yield for each soil index method was noted than average yield and variable soil nutrient index method. However, even using the gird (20 m x 20 m grid) precision farming system as standard compared with others, this system is not perfect. For P and K, the result of ignoring within-field variations is that high-yielding parts of the field are inadequately fertilized, while soil nutrients tend to accumulate in low-yielding areas.

Planning Variable Tillage Practices based on Spatial Variation in Soil Physical Conditions and Crop Yield using DGPS/GIS

The conventional tillage practices include use of mould board every year for deep ploughing followed by power harrow combined with drill for seedbed preparation and crop sowing. The inefficiency of this method, based on results from Welton Field Nafferton Farm, Newcastle upon Tyne University, UK is demonstrated. Two third of the field area had soil strength less than critical limit (> 1500 kPa) in both seasons after harvesting and would normally receive excess cultivation. Using variable tillage practices there is a reduction in cultivation cost by £25/ha while the cost of the strength measurements was only £4.30/ha. With variable rate cultivation 6.7l/h diesel hr can be saved in low strength areas, so environmental pollution can also be reduced due to decrease in CO_2 emissions by 39 %. It is also very cheap and quick to measure spatial variation of soil physical properties in a field with automated cone penetrometer and time domain reflectrometry, for example, only 0.5 hr/ha is needed to take measurements for soil strength. Differential Global Positioning System (DGPS) was used to locate the exact position of soil and crop samples within field. Spatial variation in soil and crop parameters was quantified using Geographical Information System (GIS). Based on the knowledge of spatial distribution in soil physical properties and crop yield, division of the field into sub-field regions may be appropriate for developing a differential management strategy for appropriate cultivation for the next crop.

Remote Sensing and GIS Technology for Performance Evaluation of the Reclamation Program of Salt Affected Soils

Integrated remote sensing and GIS technology in assessing and monitoring degraded lands have shown great promise of enhanced speed, accuracy and cost effectiveness. This study implements a collative approach to evaluate salt-affected and waterlogged soils comprising of satellite and ground truth data. The wetlands appeared in bluish tones whereas salt-affected soils appeared in white and dull whites tones on the false color imagery. Apart from routine digital image classification, principal component analysis (PCA) and band combinations (rationing) are proposed for their potential in bringing out the temporal and spatial changes in salt-affected soils. The result indicates that the first principal component and the rationing of band 2 and band 3 yield substantial information associated with the spatial behavior of saline-sodic soils.

To have a better insight into the existing pattern of land cover, the areas is categorized as 1) high productivity area, 2) medium productivity area and 3) low productivity area. Based on the probability density of salt-affected soils, the overall occurrence pattern of salt-affected soils is calculated. Large-scale seepage from canals, irrigation channels and obstruction in natural drainage have caused water table to rise resulting in waterlogged soils. The analysis exhibited that the incidence of high water table was directly linked with distance to canal within 2-km radius of influence and a gradual decreasing pattern was found with increasing distance form the canal network. Evidence shows that the re-use of poor quality groundwater and the failure of a few drains are likely to disturb the water balance resulting into increased risk of water logging and salinity.

Precision Maintenance of Landscape Plantations with Mechanical Means

The maintenance of gardens, lawns, parks and roadside plantation is labor intensive and expensive business. The machines / implements such as Seedbed Finisher, Shredder, Slasher and Fertilizer Broadcaster have been designed to undertake cost-effective and efficient maintenance work. The mechanized operations have the added advantage of precision in the operations.

The implements were tested and evaluated for performance, efficiency, labor requirement and operational cost. The use of these implements for maintaining gardens, lawns and parks reduces labor and

operational cost along with precision in work. The seedbed finisher is used in combination with cultivator for preparation of fine seedbed. Its field capacity is one hectare/hr and purchase price is US-$ 300. The shardder / chipper is used to make compost of tree leaves, branches and other plant waste. Its output is approximately 200 kg/hr, labor requirement is one man-hr/200 kg and the purchase price is US-$ 200. The rotary slasher is used to cut and shave the grassy plots and parks and is operated with 50 HP tractor. Its field capacity is 0.2 ha/hours and purchase price is US-$ 700. The trimmer/culter is operated with 0.25 HP petrol engine and its performance is 70 m^2/hour. The fertilizer broadcaster is a tractor mounted PTO driven machine used to spread fertilizer and farm yard manure (F.Y.M) uniformly and efficiently. Its field capacity is 1.5 to 2.0 hectare / hour and purchase price is US-$ 300. The design of all machines is flexible to suit the given conditions. This study encompasses the design and operational features as well as the cost of the implements.

Regression Modeling the Leaching Behavior of Agricultural Chemicals

Environmental impacts of agricultural chemicals are being studied all over the world and Pakistan is no exception in this regards. Fertilizer having maximum use in crop husbandry is affecting crop-soil-water matrix. Wastage of fertilizer in the form of leaching is a burning issue of today's irrigated agriculture and presents a threat to the natural environment of the soil and ultimately the sub-surface water. Several studies have been conducted on different aspects of nitrate-nitrogen management at different research stations all over the Pakistan. Few of them conducted at the University of Agriculture are presented in this paper. Data from these studies were used to develop mathematical relations for identifying the parameters affecting fertilizer leaching in order to understand and predict nitrate mobility in the soil causing ground water contamination. The quadratic regression models were considered suitable for predicting the contents of leachates and the extent of environmental pollution of soil and water within the sampled soil depth.

Performance Evaluation of Imported and Locally Manufacture Alkatheline Emitters

The study has been undertaken to compare the performance of locally manufactured trued Alkatheline emitters with the imported Alkatheline emitters in order to assess their use in drip irrigation system. All the emitters were tested at pressure of 63,84 105,126 and 147 kPa with four replications of each emitter and the corresponding discharges were measured volumetrically. The discharge of the two local and on imported emitters were 2.7, 6.5 and 3.84 lph, respectively at standard pressure of 10 kPa fulfilling the required criteria. The coefficient of manufacturing variation, emission uniformity and coefficient of uniformity for local and imported emitters were 2.5, 91.5. 97.6 and 2.1, 93.6 and 93.9%, respectively. The results depict that the locally manufactured emitters fulfill the standard criteria of fitness and are considered suitable for use in drip irrigation system. The locally manufactures emitters are 90% cheaper than the imported ones.

Wheat Harvesting Losses in Combining as Affected by Machine and Crop Parameters

Two combine harvesters with three forward speed levels were used to harvest two wheat varieties having three grain moisture levels (26%, 20% and 13%) to monitor the harvesting losses. The analysis showed that Pak 81 is a better choice regarding losses during harvesting compared with Punjab 85. The grain damage was lower for Punjab 85. Separation losses were reduced at lower moisture level but shattering and quality losses increased.

Comparative Performance of Direct Drilling and Conventional Tillage Practices under Rice-Wheat Rotation System

A field study was conducted to compare zero tillage sowing technique with the conventional sowing techniques. In zero tillage method wheat was sown directly in rice harvested plots, whereas in

conventional tillage method, plots were prepared by 3 times and 6 times ploughing followed by planking. The difference of grain and straw yields was slightly higher in conventional tillage but was found statically non-significant with zero tillage. Higher moisture retention and 13% higher income were calculated in case of zero tillage.

Development of Deep Well Jet Pump for Orchards

An attempt has been made to develop a manually operated centrifugal jet pump. The pump can lift water upto a suction head of 55 ft. The discharge of the pump is about twice that of conventional hand pump, with a nominal maintenance cost provided that the labor is not to be hired. The pump can command an orchard of four acres considering a two hour operation per day and using trickle irrigation. It is hoped that information provided here will encourage more research to use this device.

Interrelationship Between Crop and Machine Parameters Responsible for Wheat Harvesting Losses

To establish machine crop factors inter-relationships and to evaluate the comparative performance of John Deere and Claas combines, the present study involved experiments with three speeds of the combines, two wheat varieties (Pak-81, Punjab-85) and three grain moisture levels (26, 20 and 13%). The data collected were analyzed to study the variations due to interactions of parameters. Significant interactions occurred for variety-moisture content, variety-machine, moisture content-machine as well as variety-speed. The machine-speed and moisture content speed interactions appeared to be non-significant. It is suggested that John Deere is beneficial for moisture level of 26% and 20%. The “Claas” combine can only be employed at 26% grain moisture for minimum losses. John Deere is recommended at second and third speeds while Claas can only be used at first speed taking into account minimum separation losses. Punjab-85 shows less quality losses compared with its counterpart.

Effect of Different Levels of Compaction on Rice Grain Yield

Field experiments were conducted to study different compaction levels on rice growth. Surface compaction treatments were given at two levels of dry bulk density with the help of steel roller. It was observed that the rice yield was significantly higher at 1.65 Mg m^{-3} compaction level, compared to the control. However, water use efficiency and cost benefit ratio of surface compaction were increase considerably compared to puddled field as the yield was 19% higher at 1.65 Mg m^{-3} surface compaction than that from the puddle field.

Sunflower Oil: An Anticipated Diesel Fuel Alternative

The physico-chemical properties of sunflower oil and its methyl ester were examined and compared with No. 2 diesel fuel. The fuel performance characteristics of the sunflower oil were investigated by operating a Buda diesel engine.

The kinermatic viscosity, cloud pour, flash and boiling point of sunflower oil and its methyl ester are higher than those of the No. 2 diesel. The cetane rating and calorific value were lower when compared to the diesel fuel. Over all the sunflower oil maintained almost the same power output and thermal efficiency as the No. 2 diesel fuel but the specific fuel consumption was about 6% higher than the reference fuel. About 14 times higher viscosity and low volatility of the sunflower oil do not favour its use in unmodified diesel engines.

Vegetable Oil Derivatives: Fuel for Diesel Engines

Several vegetable oils have been investigated. So far in different parts of the world to determine their

suitability as fuel in diesel engines. Those efforts have shown that except for a few, all the vegetable oils can be used as fuel with some reservations. The most detrimental properties of oils are high viscosity, low volatility, poor atomization and auto-oxidation. Methyl and ethyl esters from vegetable oils with alcohol can result in fuel material with properties fairly similar to No. 2 diesel. Engine performance tests with esters of sunflower oil have indicated less exhaust emission and satisfactory thermal efficiency and power development.

Potential Pathways of Pesticide Transport

Being a conservative solute, bromide was used to trace potential pathways of pesticide transport under conservation tillage in sloping lands. The maximum concentration of bromide (30 ppm) was found at a depth of 40 cm at the top and back slope positions compared to 20 ppm found at a depth of 80 cm depth toe-slope position after 360 days of simulation. Bromide at the toe-slope position moved deeper than at the top and back-slope positions. The potential of groundwater contamination beneath top-slope position is minimum due to lateral transport of the bromide at this slope position.

Modeling Transport of Metribuzin in Sloping Lands

The differences is soil hydraulic properties in sloping landscapes are believed to control the rate and movement of infiltrates water which influence the transport of herbicides. The impact of slope positions on transport of metribuzin was simulated using one-dimensional computer kodel “HYDRUS”. Model simulations showed that metribuzin moved deeper at the top and back-slope positions than at the toe-slope position. After 630 days of simulation, the solution concentration of metribuzin below 40 cm was almost zero at all slope positions. Metribuzin did not seem to be sensitive to dispersivity.

Scope of Vegetable Oil esters as a Farm Fuel

Research indicate that highly saturated vegetable oils could be used in a blend with diesel fuel in emergencies, however, engine life would be reduced and maintenance costs would be increased. Vegetable oil esters are possibly a direct substitute for diesel fuel; low temperature operation and corrosion are problems. Vegetable oil esters are more expensive than petroleum base fuels at the present time. The encouraging thing is that vegetable oils and their esters do have excellent potential as a replacement for diesel fuel, especially in any emergency situation of petroleum shortage. Future research priorities are discussed.

Effect of Slope Position on Transport of Bromide under Dry Land Farming

Differential rate of erosion from different slope positions of Palouse region have changed physical, biological, and hydraulic properties of the soil. The differences in soil hydraulic properties are believed to control the rate and movement of infiltrated water which influences the transport of agrochemicals. Leaching plots were sprayed with bromide at the tip and bottom slop positions to assess the impact of slope positions on the vertical and horizontal movement of a conservative solute. The simulation of computer model (FEMWATER) that the lateral flow is dominant at the top-slope position indicating low potential of groundwater contamination. Because of lateral flux at the top-slope position, significant amounts of bromide had moved about 7 m down-slop outside the leaching plots. Downward movement at the bottom slope positions was predominant which increased the potential of bromide leaching to groundwater.

Impact of Precision Land Leveling on Water Saving and Drainage Requirements

Modern agriculture is heavily dependent on four inputs namely biological, chemical, hydrological and mechanical. Although the mechanical input is an input to other three inputs, emphasis had always been

given to the use of first three inputs while the role of mechanical input has been undermined. Precision land leveling is one of the few mechanical inputs which can help to reduce seepage and deep percolation and consequently daring requirements of soil. Irrigation water in Pakistan is becoming scarce day by day and therefore, it needs to be conserved and managed. This paper presents the results of study conducted at Cotton Research Station, Vehari which besides other benefits showed that precision land leveling can save about 27% of water applied to the land along with the benefit of no drainage requirement. Precision land leveling minimize the deep percolation and uneven storage of irrigation water in soil profile hence it should be adopted to contain drainage problem and to save precious water resource and foreign exchange involved in drainage installations.

Effect on Constant Flow Valves on Performance of Pesticide Sprayers

In Pakistan, Knapsack and tractor mounted boom sprayers are mostly used to spray pesticides onto crops. A major problem with these sprayers is the specified nozzle pressure which does not remain constant during spray. This leads to loss of pesticide due to dribbling/drift during application. These phenomena not only add to cost of production but also cause environmental pollution and imbalance in natural echo system. To combat these problems three sets of Constant Flow Valves were used with nozzles of Knapsack and boom sprayers. The valves gave very encouraging results in terms of maintaining uniform nozzle pressure and discharge and 2 to 3 times decrease in physical fatigue required to operate Knapsack sprayers. Constant Flow Valves are cheap and can easily be attached with the convention sprayer, so their use among the farmers should be promoted.

Techno-Economic Feasibility of Combine Harvester (Class Denominator) A- Case Study

Techno-economic feasibility of using combine harvester (Class Denominator) was carried out by determining harvesting losses, timeliness of harvesting, field capacity, fuel consumption, noise and dust pollution, frequently of repair/maintenance and operating cost of the machine. The results indicated that combine had an average harvesting losses of about 1.25% of wheat yield. Grain breakage losses (5.7%) were bit higher. The machine was able to harvest 2.5 to 3.0 acres in an hour. The fuel consumption of the combine was found to be 15 L of diesel per acre. As the machine as not equipped with a proper cab, dust and noise pollution posed threat to he operator's health. The machine needed only two to three persons for its operation and costs about Rs. 860/acre to the user. The combine is an efficient, economical, labor and time saving machine but its initial cost is quite high. To promote this high cost technology, it is suggested that the District Governments of present set up should make arrangements at Tehsil Council level to provide combine to the farmers on rental basis.

Study of Mechanical Noise of a Selected agro-Based Industry and its Impact on Worker's Health

Faisalabad city is famous for its agro-based industries which vary from textile to farm machinery manufacturing units. There are hundreds of small and big textile industries located in the populous areas of the city. The noise level of these industries not only affects the healthy of the worker but also the neighboring residents of the area. To estimate the attenuation in noise level of textile industries, the weaving unit of Chenab Fabrics, Limited, Faisalabad was selected. A digital sound level meter was used to record the noise leveling during 12 hours shifts. The noise level of the weaving unit was found to vary from 88 to 102 dB (A) which was very high as compared to International Standards Organization (ISO) limit of 87 dB (A) set for eight hours working shift. To conducted. It was found that 10 workers working in the Chenab Fabrics for the last 14 to 40 years, have suffered from different stages of Binaural Sensor neural hearing impairment. In the light of these results, it has been suggested that the factory owners should provide ear protectors to their worker and decrease their exposure time form 12 to 8 hours.

Performance Evaluation of Modified Self Leveling Boom Sprayer

Cotton farming has become a popular agribusiness in Pakistan that has ranked the country as the fifth largest cotton producing country in the world. Cotton is one of the major cash crop and surface of edible oil for the people of Pakistan. The farmers are consuming about 70% of total pesticides for cotton crop only. According to Central Cotton Research Institute, Multan, Pakistan, about half of the pesticide sprayed is wasted during application which not only adds to the cost of the production but also degrades the surrounding soil, water, and air environment. A major reason for such a pesticide loss is inefficient spraying machines, which are unable to maintain specified nozzle pressure, nozzle discharge, spray pattern, droplet size, spray uniformity, etc which results in dribbling or drift during spray operation. Dribbling and drift both result into wastage of pesticides or in other words wastage of precious foreign exchange. To combat these problems a Self Leveling Boom Sprayer was adapted by developing it locally which needs to be tested both in the laboratory and field conditions before it is recommended to the farmers and pesticides companies.

Development of Opacimeter to Monitor Diesel Engine Performance and Environmental Pollution

The role of internal combustion engines is very vital in the development of modern world. Engine ignites hydrocarbon fuel (petrol/diesel) and emits CO, CO_2, SO_2, Nox, HC, smoke, etc into air. The composition of these gases depicts the health of the engine i.e. poorly maintained or properly maintained. Excessive smoke from diesel engines is a sign of poorly maintained and inefficient engine. Excessive smoke indicates higher operating costs, low fuel economy, higher maintenance costs, and shorter engine life.

Engine emissions are estimated to be responsible for about 60% of air pollution. The exhaust emissions carry gases which are toxic for human healthy, animal health and plant lives when they exceed the safe limits for quick diagnose of diesel engine smoke, a device called “Opacity Meter” has been fabricated using local material and workmanship. The meter was calibrated with the help of a commercially available DX. 210 diesel tune smoke meter. Opacity meter measures the opaqueness of vehicular exhausts by passing a beam of light through the smoke. The darker and thicker the smoke greater is the opacity. The results of the meter are comparable with commercially available smoke meter after applying proper corrections for effective optical path length and wave length of blue photo diode.

Effect of Different Slope Positions on Flow Processes in Variably Saturated Soil

The Missouri Flat Creek watershed is a part of the Palouse region and an important watershed in the Pullman-Moscow area. Differential rates of erosion from different slope positions have changed physical, biological, and hydraulic properties of the soil. The differences in soil hydraulic properties are believed to control the rate and movement of infiltrated water which influences the transport of herbicides. The site was divided into top, back, foot, and toe-slope positions to represent spatial variation in the soil hydraulic properties. A two-dimensional finite element computer model (FEMWATER) was calibrated against observed water table, moisture content, and surface runoff. Recharge (downward flow) of about 2 and 26 cm was predicted for upper and lower slope positions, respectively. Lateral (subsurface) flow in the top 80 cm of soil profile was predicted at the top and back-slope positions of the site. Lateral flow and back and foot-slope positions was considerably greater than from the top and toe-slope positions. Recharge at the foot and tow-slope positions was found to be more sensitive to saturated hydraulic conductivity than at the top and back-slope positions where deeper water table existed. Lateral flow and seepage at the top and back-slope positions are also very sensitive to saturated hydraulic conductivity. The results of the model are consistent with field observations and indicate a definite effect of different slope positions on the flow phenomena.

Improved Surface Coverage with Environmentally Effective University Boom Sprayer

The effect of spray coverage on bollworm mortality was measured on mature cotton variety CM-495-PB planted at Post-graduate Agricultural Research Station (PARS) experimental fields, University of

Agriculture, Faisalabad. Spray coverage was found directly related to mortality of cotton bollworms. Conventional over-the-row sprayers achieve very little deposit on leaves near the ground and on the underside surfaces of leaves throughout the canopy (2-5%). Water Sensitive Papers were installed on three levels of plants (top, middle, and bottom) on both sides of the leaves to examine the spray coverage. The greatest spray coverage values on upper and lower leaf surfaces were 49.67% and 65.87% respectively at $V_2P_2O_2$ treatment, while for conventional system it was 35.6% on upper sides of leaves and 0.4% on lower sides of the cotton leaves. The relationship between spray coverage and bollworm mortality was established for drop-pipe university boom sprayer. Hundred percent mortality of American and spotted bollworm occurred after one week for a surface coverage of 52% and 61.75% respectively. A software programme was developed to analyze spray coverage on the computer in Java language.

Efficacy of Environmentally Effective University Boom Sprayer for Bollworm Mortality

The efficacy of the University Boom Sprayer was tested for mortality rate of bollworms on cotton variety CM-496-PB planted at Post-graduate Agricultural Research Station (PARS) experimental fields, University of Agriculture, Faisalabad. Both the booms (over to top conventional and upward spraying nozzles) washed the cotton leaves thoroughly and helped to kill bollworms lying in buds, squares, flower, bolls and on leaves. The boom height and drop pipe angle (45^o backward w.r.t. boom axis) were adjusted so as the drop nozzles hung between the rows in the middle of the upper half dense canopy prevent the crop and machine breakage. At the time of first spray, the only bollworm seen was spotted, while at second spray Spotted as well as American bollworms were seen. At first spray, bollworm mortality was evaluated at three intervals after spraying (24 hr – 72 hr) while at second spray mortality rate measurements were made one day and one week after spraying. The mortality rate of spotted bollworms was found significantly affected by sprayer velocity, spraying pressure and spraying angle of drop nozzles. Greatest bollworm mortality was achieved 72-hr after spraying in case of first spray and one week after in case of second spray at 4.0 km/h field speed, 400 kPa pressure, and 30^o upward angle of drop nozzles w.r.t. horizontal.

Development of an Energy Efficient Wheat Planting Machine

Pakistani farmers use conventional tillage/planting systems in rice-wheat zones. Under rice-wheat rotation system, wheat crop is delayed due to delayed harvest of rice or labor-shortage and because of the extensive tillage operations. Tillage is a time, energy and most cost consuming production process. Scientist/engineers at the Farm Machinery Institute, Islamabad and University of Agriculture, Faisalabad had demonstrated through experiments for many years that wheat crop could be successfully produced with minimum tillage without any yield loss, provided other inputs are properly managed in time. For successful adoption of till plant technology under varying field soil conditions, a technically suitable and economically feasible tractor drawn 7-row zone disk tiller drill has been developed, fabricated and tested under farmers field conditions in paddy growing areas of Sheikhupura and Faisalabad divisions of Punjab, Pakistan. It cuts and pulverizes a 50.8-cm wide and 10.16-cm deep soil zone in front of each furrow opener of zone disk tiller drill. The new system of planting saved on an average 46l/ha of diesel fuel energy and increased crop grain yield 1.2 ton/ha compared to the conventional method of wheat planting. Moreover, huge amount of savings in labor and irrigation water are expected. The machine has been commercialized by the University of Agriculture, Faisalabad for farm level adoption and is available for Rs. 60,000/-.

Development of a Drop-pipe Type University Boom Sprayer

A drop-pipe tractor mounted university boom sprayer has been developed and tested for mortality rate of attacking sucking insects which cause the severe damage to cotton crop and reduce the yield. This sprayer has upper and lower two booms to spray the cotton crop both form above and below the leaves.

The lower boom has drop-pipe s on the lower ends of which are mounted nozzles, which have the ability to be rotated and adjusted in 360^o both in horizontal and vertical planes. Drop-pipes have also the facility to be adjusted at any angle from 0^o – 90^o with respect to vertical position to avoid crop damage when there is more vegetative growth at later stages of crop growth of growing season. The nozzles can be adjusted at any angle to directly hit the sucking insects lying on the undersurfaces of leaves. The upper auxiliary boom has been designed to spray from top to bottom as in the conventional boom sprayer. The performance of newly developed drop-pipe boom sprayer was found best at 4-km/h field speed 400 kPa pressure fluid pressure, and 0^o a nozzle angle with respect to boom axis than those at other speeds, pressures and nozzle angles.

Harvesting and Threshing Losses of Wheat with Mechanical and Conventional Methods

Mathematical models were developed for the harvesting and threshing losses of wheat in the field. The harvesting losses with manual operations increased linearly with time ranging from 3% in the first week to 7% in the third week, after the ripening of crop, indicating that a delay of two weeks in harvesting can seriously affect crop yield. Further, grain losses from the conventional winnowing operations were as high as 10% decreasing in a non-linear fashion with distance, and becoming negligible beyond a distance of 2.50 meters. With mechanical threshers, the grain losses ranged form 2% to 6% for the different locally made winnowers.

The cost of harvesting with reaper-binder and mechanical thresher is half that of harvesting with manual laborer and threshing with bullocks and flail. Mechanical harvesting and threshing required 4 hours as against 48 man/bullock hours. However, these models have yet to be studied carefully for their technical suitability and acceptability under Pakistani conditions.

Implications and Prospects of Farm Mechanization in Pakistan

This paper describes the present status of farm mechanization, implications and future strategies of adopting the mechanical technology for boosting agricultural production. Tractor and field labour population is increasing whereas bullock power is decreasing with the passage of time. Fragmentation of land into small pieces has been found a major constraint in the adoption of agricultural mechanization. By the year 2009, the total available power per hectare is expected to be 1.47 horsepower which is quite adequate. In order to implement this technology, custom hiring services should be encouraged to provide adequate and timely services to the small farmers who cannot afford to own farm machineries.

Design and Development of A Grain Dryer Using Sand as Heat Medium

The increasing population rate in Pakistan demands saving of agricultural products for a longer period. Grain crops are considered as food and cash crops. Food, fibre and shelter are the main necessities of life. Food grains represent most of the food crops. Therefore, due attention is required in saving the grains after harvest. As high as 20% losses have been recorded during sun drying and storage of grains. To avoid such a big loss, a grain dryer was designed which can save drying and storage losses. Drying of grains using this dryer is easy and time saving. The moisture removed by this dryer is proportional to the initial temperature of heat transfer medium (sand). Moreover, moisture removal rate and the drying efficiency of this dryer is maximum at 6.0 sand-to-grain-mass-ratio (SGMR).

Draft Requirements of Selected Tillage Implements

The draft requirement of tillage implements has a great concern for designing tillage implements and deciding suitable tractor size. In this study an effort was made to determine the draft requirements of selected primary and secondary tillage implements at the field speed of 2.5 km/h in silty clay loam at 13.2% moisture content. The experimental results indicate that the draft consumed by cultivator, chisel

plow and sub soiler increased linearly with the increase in the depth of cultivation whereas disc implements demonstrated a curvilinear relationship. However, the draft needed by cultivators and disk harrow were close to each other at shallow depth. Since the disc harrow required less draft, therefore, it was recommended for seedbed preparation for shallow rooted crops. Maximum power consumed in this study was found in the case of chisel plowing which was 40% of 35.43 kW, tractor.

Design and Development of A Continuous-flow Rotary Grain Dryer

A continuous-flow grain dryer employing heated sand as heat transfer medium was designed, developed and tested for drying shelled maize. The machine performed well in drying, separating, re-circulating hot sand and delivering dried grain. The principle of using a solid heat transfer medium for drying grain seemed to give definite promise of becoming a viable method of rapidly and efficiently drying grain. Results of drying experiments conducted with the equipment showed that initial sand temperature of 120^{o} C, residence time of 21.818 sec and high moisture content of grain selected (28%) were the optimum values for efficient drying of shelled maize.

An Evaluation of Seed Furrow Smearing

Seed furrow sidewall smearing describes compaction of soil in the seed zone that is caused, in some soil conditions, by the planter furrow opener and that may interfere with crop stand establishment. Soil smearing caused by planting with double disk furrow openers was investigated by measuring physical properties of soil in the seed furrow and by evaluating corn (Zea mays, L.) emergence and growth. Planter attachments for row preparation (no-coulter, single offset bubble coulter, and triple offset fluted coulter planter attachments) were evaluated for their influence on seed furrow sidewall smearing over a range of soil moisture contents. Planting tended to reduce soil bulk density in the 0 to 100 mm layer in the seed zone. In general, the soil was least dense when the triple coulter attachment was used. Air permeability of soil samples taken from the seed furrow sidewall, before the furrow was closed, tended to decrease with increasing soil moisture. The triple coulter treatment resulted in greater air permeability than did other coulter and least for the triple coulter. We observed that more roots grew parallel to the soil surface with no coulter and single coulter treatments than with the triple coulter treatment especially when soil property measurements indicated that more sidewall smearing had occurred. This research showed that row preparation by coulter planter attachments placed ahead of double disk openers can reduce seed furrow sidewall smearing and may improve stand establishment of corn.

Simple Technique for Determining the Moisture Diffusivity of Grains

The transfer of moisture from the grain during drying is a diffusion process. Keeping in view the importance of study of moisture movement mechanism for grain drying, this research was carried out to determine the moisture diffusivity of grain employing both graphical and constant diffusivity techniques.

Applications of Microwave Sensors in Agriculture

This paper aims at the measurement of non-electrical quantities in agriculture. The basic principle of operation of microwave sensors is presented along with some potential agricultural applications. Two major application like microwave dielectrometers for monitoring and control of the residual water content in agricultural products and doppler radar for monitoring and control of the flow of particulate solids. Description of laboratory models and some experimental results are given.

Soil Moisture Sensing and Signal Evaluation for Planters

This paper describes the capabilities and limitations of soil moisture electrical resistance relationship as a means of providing a usable signal for controlling seeding depth. Disk, J shape and knife electrodes were

employed in both configurations as two and four electrode probes. An A. C. regulated current of 1000 Hz was passed between the electrodes and the resulting potential drop was rectified and then displayed on a strip chart recorder. The voltage change with a change in moisture content was found quite substantial. The typical voltages measured across the two electrode knife probe were 13.4 and 0.60 volts for approximately 4 and 18 percent soil moisture content for sandy loam soil. The response time of this sensor to a step change in the moisture content was about 75 milliseconds.

A Standard Mathematical Technique for Determining Moisture Diffusivity of Bulk Paddy

Moisture diffusivity (drying rate) of bulk paddy was experimentally determined by constant diffusivity method and the moisture profile analysis for various drying time durations. This research was carried out in the Division of Agricultural and food Engineering Asian Institute of Technology, Bangkok, Thailand in 1978. The tests were conducted for different combinations of temperature and relative humidity. The diffusivity values were found to be affected by the temperature and the relative humidity of the surrounding air. The comparison of average diffusivity values, recorded by both methods, showed good agreement for the humidity and temperature ranges tested in this study.

Power Requirements of Tillage Implements at Different Depths of Operation

This study reports the comparison of the measured and theoretical power requirements for tillage implements viz. disk plow, sweep cultivator, harrow tine cultivator and disk harrow. The measured value of power was determined with the help of a dynamometer while the theoretical power was determined by using the equation. The difference of powers under different operating conditions, ranged from 3 to 142 percent. It was noted that at shallow depths, the power requirement was almost same for the cultivators and disk harrows. A substantial increase in power requirement was, however, observed in case of disk plows.

Implications and Prospects of Combine Harvesting Technology in Pakistan

This paper reports the present status of adoption of combine harvesting technology by the farming community, implications and future recommendations to adopt the efficient mechanical technology for timely harvesting of cereal crops and reduce grain losses. Combine population has the increasing trend due to non availability of sufficient labour and uncertain weather conditions during harvesting periods. Fragmentation of land into small pieces has been found a major constraint in the adoption of this technology. By the year 2000, the total number of combines has been estimated to be 43224 in order to harvest the crops in time. For adoption of this latest technology in its true sense, custom hiring system is recommended to be expanded to provide adequate and timely services to the small and medium farmers who cannot afford to won expensive machines.

Moisture Diffusivity of Bulk Paddy

Experiments were conducted to determine moisture diffusivity (drying rate) of bulk paddy variety, 'R.D.-11' employing constant diffusivity method and the moisture profile analysis of various time durations. The tests were conducted with different combinations of temperature and relative humidity ranging form 28-55^{o}C to 51.90^{o}C and 34.6% to 83.55%, respectively. It was found that with the increase in temperature from 28.55^{o}C to 51.9^{o}C and the relative humidity of 49.62%, almost 14.9% increase in the diffusivity values of paddy was recorded.

Agricultural Technology: Constraints and Future Prospects

This paper describes the present status, constraints and future prospects of agricultural technology in Pakistan. There is a reinforcing relationship that exists between hydrological, biological, chemical and

mechanical inputs for boosting up mechanical inputs along with improved seed, fertilizers, pesticides holding has been found a major constraint in the adoption of agricultural mechanization. Tractor and field labour population has the increasing trend whereas bullock power is decreasing with the passage of time. By the year 2005, the total number of farm tractors will be 5,25,000 so there will be one tractor for every 40 hectares of cropped area. The total available power per hectare will be 1.48 hp which will be quit enough to perform all kinds of farm operations. Custom hiring services have to be encouraged for providing adequate and timely services to the small and medium farmers who are unable to own costly agricultural machinery.

Accelerated Drying of Shelled Maize by Conduction Heating

The investigation was conducted employing sand as heat transfer medium for drying of shelled maize initially at 18.10% moisture content on dry basis (d.b.). A grain dryer was designed and fabricated using locally available material to find optimum operating conditions for drying of the grain. The process was found promising for providing a viable method of rapidly and efficiently drying of grain. For safe storage of maize grain for larger periods without deterioration of grain quality, the required moisture content (12.3%) was achieved with same temperature of 100^{o} C at 4.5 and 6.5 sand to grain mass ratios (SGMR) at 14 and 28 rpm of cylinder respectively. Conversely for drying at 100^{o} C, 4.5 SGMR and 28 rpm of cylinder were found suitable for short period storage of shelled maize.

Shattering Losses as Affected by Combine Indices

Interactions of combine indices (cutting and reel) with crop variety and grain moisture at harvest in relation to shattering loss of wheat and grain moisture were statistically significant at 5% level of probability. The results demonstrated that wheat recovered was 1.2 to 2.8% less as the grain moisture decreased from 24 to 15%. Crop variety also indicated a significant effect on the losses. Change in the reel as well as cutting indices had quadratic relationship with the shattering loss. Values of 1.25 and 2.00 were considered desirable for reel and cutting indices respectively with regard to minimization of harvesting losses.

Application of Fiber Optic Sensor for Evaluating Smeared Soil Surface

The effect of soil smearing on corn root penetration and crop stand establishment were studied in a laboratory experiment. Variables were soil moisture content, bulk density, and smearing surface preparation. Evaluation parameters were mean sensor output voltage, percentage of roots penetrated, and shoot height. Mean sensor output voltage measured by fiber optic sensor was found to be a good indicator of percentage penetrated roots. Root penetration measurements showed polynomially decreasing trend with the increase in mean sensor output. No significant differences were found among the means sensor output values for the three selected soil moisture levels but significantly higher percentage of roots penetrated at the highest moisture content. However, coulter pressure significantly affected the root penetration, shoot height, and sensor output voltage.

Description Isotherms for Popcorn (IOPOP-12)

Equilibrium moisture content (EMC) for popcorn variety lopop-12 was determined at 21.30 and 40^{o} C and relative humidifies of 11.2, 33 and 75.5 percent. A dynamic method to reach equilibrium was used by suspending 15 g samples in a wide mouth glass jar, with 250 ml of three different saturated salt solutions. Triplicate samples were used for all trails. The data obtained were plotted on the isotherms of popcorn variety purdue-410 and yellow dent corn. Equilibrium moisture contents were found to be different due to differences in physical and biological properties of the crops and their verities. These differences were comparatively more pronounced at higher relative humidities. No problems of mold growth were observed while desorption took place at high relative humidity, since a relatively short time was required to reach

equilibrium

Design and Development of a Force Transducer for Soil Pressure Measurements

A force transducer was designed and developed in the laboratories of Engineering Mechanics, Iowa Stat University, Ames Iowa, USA for measuring normal and shear forces. The calibration curves showed a linear relationship. Force transducer was designed for a normal pressure of 1100 kPa. The transducer was found to be very sensitive for measuring the desired parameters.

Pressure applied at the top of all the three soil columns under trials were measured by a force transducer installed at the bottom of each soil column. It was found that greater the length of soil column, lower the load transfer from top to bottom of the soil column.

Effect of Reynold's Number on Drain Time of a Tank

This paper describes the experimentally developed relationship between Reynold's Number (Re) and drain time for 90% drain for a set of three geometrically similar tanks. The drain times were taken for the progressive combinations of 75% water / 25% glycerin, 50% water / 50% glycerin, 25% water / 75% glycerin. The relationship behaved as a power law and the Statistical Package "SAS" provided the best fit line. The research was carried out in the Laboratories of Engineering Mechanics. It was found that for the cut off value of Re> 1120 the pi terms related to time behaved independently. Above this cut off value (Re > 1120) the RE effects were neglected and the length scale discrepancy was avoided in the model design. Moreover, for flows having RE > 1120 the techeotical solution appeared to closely predict the actual solution. The overall experiment results apply to the range of 1.5 < RE < 9300.

One Dimensional Solute Transfer in a Soil Profile

A numerical solution has been developed for predicting the amount of solute in different layers of a soil profile with time after the application of chemicals/fertilizers to the soil. It has been found that soil column having a greater bulk density checks the downward solute transport. Which can help in retaining the applied fertilizers/chemicals close to the top layer of soil in the seed zone. Therefore, solute going to the groundwater can be controlled and pollution be avoided. In conservation farming, the bulk density is greater than the conventional farming but the presence of worm holes and cracks left from rotten roots in conservation farming increase the saturated hydraulic conductivity and results in more solute concentration at deeper depth.

FIBRE TECHNOLOGY

1. COTTON FIBRE TECHNOLOGY

1.1. Raw cotton evaluation

This department has been carrying out a long series of experiments on regular basis to study the physico-chemical characteristics of various cotton strains and varieties evolved in different parts of Pakistan. The results of the varieties and strains studied for their staple length, fineness, bundle strength, moisture regain, maturity, etc. and chemical composition like cellulose, wax, ash, pectin, proteins, etc. have been presented in the Tables (1-2)

Consolidated results presented in the Table 1 reveal the over all dominance of Qallandri variety for various physico-chemical characteristics, followed by MS-84, MNH-93, AC-134 and B-557, whereas the results of yarn characteristics and spinning performance consolidated in Table 2 for different cotton varieties MS-84 showed superior performance, particularly for yarn strength, csp value, staple length and maturity.

1.2. Spinning performance of cotton

A number of research studies on cotton spinning performance have been carried out to evaluate our cottons for yarn number, tpi, yarn strength, CSP, neppiness and evenness. Some interesting results achieved are given below:

In an experiment designed to study the effects of different agronomical conditions on cotton quality and its yarn revealed that the strength of cotton fibres improved when planting time was delayed and the distance was kept as 2.5 ft X 1.5 ft. On the oilier hand, early sowing gave highest G.O.T. with better uniformity. The application of nitrogen as a fertilizer increased the strength and staple length, but fibres had become coarse when higher dose of such fertilizer was used. In a similar study it was found that both length and strength decreased at late picking, while fibre fineness improved with fall in maturity. Further, it was found that with late picking non-lint content and fineness increased.

The results of the various spun yarns from different cotton varieties are summarized in the Table 3.

Table-1 Consolidated results of physical characteristics of different cottons.

Name of variety	Non-lint content (%)	Ginning out turn (%)	Staple length (mm)	Fineness (micronaire)	Fibre strength (000 lbs. PSI)	Fibre maturity (%)
L.S.S	8.2	32.0	4.8	4.8	82.12	78
124 F	3.3	32.0	27.05	4.3	80.24	83
L-ll	8.1	35.0	28.0	4.2	83.09	73
AC-134	6.8	36.5	27.1	4.25	85.39	82
BS-1	6.5	37.0	24.8	4.6	92.96	78
MS-39	8.2	33.0	30.25	3.4	94.26	71
MS-40	7.7	34.0	31.30	3.7	96.46	75
Pak-22	2.7	33.0	26.95	4.3	88.33	81
B-557	6.6	34.9	28.2	3.6	80.36	76

Rachna	9.0	33.2	21.71	3.2	87.93	71
EXPRESS	6.3	34.1	27.7	3.4	80.41	77
MS-84	5.7	38.5	27.9	4.0	77.97	78
MNH-93	4.6	37.0	28.7	4.7	80.89	83
m-62	11.5	33.3	22.38	2.8	80.01	68
LH-72	9.2	34.5	22.84	3.9	89.25	78
AU-59	6.0	38.1	26.3	4.9	86.03	85
DELTAPINE	4.9	37.2	27.43	4.6	86.30	75
M-4	2.2	33.0	26.29	4.7	89.45	72
M-100	4.6	34.0	27.00	3.7	91.24	74
QALLANDRI	8.1	34.0	28.7	3.6	79.69	70

Table 2. Chemical constituents of different cotton varieties as related to fibre quality.

Cultivars	Cellulose (%)	Wax (%)	Ash (%)	Fibre length (mm)	Fibre strength th.lb/sq.	Fibre fineness (micro/in)	Maturity (%)	C.S.P values
B-557	91.64	0.46	1.47	28.25	88.41	3.77	82.52	1979
AC-134	89.17	0.43	1.45	28.12	96.67	3.87	81.71	2138
58/70	88.70	0.39	1.48	28.31	93.14	4.08	81.11	2053
SLH-14	90.87	0.40	1.45	28.06	82.10	4.20	79.97	1490
LH-62	89.79	0.41	1.39	22.38	80.01	2.82	67.89	1459
LH-72	93.13	0.55	1.40	22.91	89.25	3.91	78.33	1950
Rachna	91.62	0.69	1.44	21.72	87.93	3.15	71.05	1473
Express	90.98	0.43	1.44	22.71	92.86	3.08	72.75	1640
MS-84	93.15	0.69	1.53	29.82	86.72	3.99	82.16	2102
MNH-93	89.36	0.72	1.48	28.70	80.89	4.70	82.70	1758
Qallandri	93.65	0.33	1.38	28.70	79.69	3.63	69.75	15.11

Table 3. Consolidated results of yarn characters.

Varieties	Yarn count No.	Yarn strength (lbs)	C.S.P value (Hanks)	Twist per inch
L.S.S	19.86	112.2	2216	18.5
Rachna	21.06	70.0	1473	18.6
LH-62	20.87	70.0	1460	18.2
LH-72	19.51	100.0	1951	18.3
Qallandri	20.18	75.0	1511	16.9
124-F	29.42	60.0	1740	23.5
AC-134	26.64	75.8	2279	23.9
BS-I	30.33	71.7	2186	23.8
MS-39	30.06	61.8	1834	23.7
MS-40	29.89,	67.9	2031	23.9

B-557	29.81	76.0	2273	24.1
Express	29.72	81.8	2450	24.2
MS-84	30.40	55.9	1699	23.8
MNH-93	29.53	-75.6	2259	23.5
Deltapine	30.40	51.8	1577	23.7
M-4	29.51	59.0	1716	23.8
M-100	30.33	50.0	1516	23.5
AU-59	29.50	54.3	1601	23.5
L-ll	40.71	36.8	1499	27.4
Pak-22	38.46	51.5	1954	28.2

In a rotor-spinning study, it was concluded that for the host spinning performance, optimum twist factor was different for each count. For yarn of 10's twist multiplier 4.0 was found to be the most appropirate as it produced yarn of exact count with maximum leaf strength giving low U % value. Twist multiplier 5.0 produced the best yarn of 14's, whereas twist multiplier 5.5 produced fine yarns of 20's with excellent strength and CSP.

1.3. Strains evolved at the University

Technological studies on new varieties and strains evolved at this university revealed that AU-33 strain was the best in strength, fineness and its spinning performance, whereas AU-24, the second in quality was the highest yielder out of the present group. In another study, B-5 showed the most outstanding commercial worth and was-excellent in fibre quality characteristics.

1.4. Cotton finishing

(a) Mercerization

On mercerization, the physical characteristics and spinning performance of four cotton varieties viz,. L-ll, Pak-22, AC-134 and 124-F were studied by treating the yarn with sodium hydroxide. This treatment was carried out with 10 concentrations and time durations. The results of Lustre ratio, change in count, yarn strength and CSP were highly significant among varieties and concentrations.

(b) Crease-Recovery

The effect of three crease-recovery reagents, i.e. dimolhylol-ethylene-urea, dimethylol-ethylene urea formaldehyde and carbamate reactant, with two catlysts magnesium chloride and /,inc nitrate on yarn cloth fabricated with AC-134 cotton were studied. It was revealed that these crease-recovery reagents without catalyst have very little effect on the strength of cellulosic material. However, with catalysts reduction in strength was observed. Premercerization treatment plays an important role in the maintaining of strength, whereas softeners showed no effect.

2. WOOL FIBRE TECHNOLOGY

Table 4. Characteristics of Pakistani wools.

Sr.#	Wool	Fineness (µm)	Staple length (cm)	Fibre type (%)		
				True	Hetro typic	Medullated
1.	Lohi	41.96	8.25	44.33	35.83	18.33
2.	Kajli	33.09	5.58	36.17	35.16	27.00
3.	Kaghani	33.92	8.56	49.00	32.33	17.17
4.	Cholistani	40.66	9.55	30.00	38.66	30.00
5.	Awasi	41.38	9.80	37.67	50.66	9.33
6.	Balkhi	46.02	7.18	35.50	26.16	37.17
7.	Damani	44.57	6.10	51.00	37.53	7.53
8.	Hashtnagri	35.43	5.41	53.26	30.80	12.20
9.	Waziri	36.81	7.20	62.00	24.33	11.20
10.	Mixed yellow	37.65	7.93	41.50	43.75	14.75
11.	Mixed white	36.47	6.95	40.50	38.88	22.63
12.	Harnai	33.02	8.62	59.75	25.00	15.25

Table 5. Impurities and clean wool content (%).

Sr.#	Wool	Grease	Ash	Vegetable matter	Wool content
1.	Lohi	0.50	1.55	2.78	73.51
2.	Kajli	0.59	1.51	1.97	70.61
3.	Kaghani	0.94	1.75	2.36	73.29
4.	Cholistani	0.53	2.03	1.89	74.14
5.	Awasi	0.40	1.43	2.99	61.37
6.	Balkhi	0.36	1.64	2.31	81.19
7.	Damani	0.28	2.29	1.17	69.35
8.	Hashtnagri	0.30	3.71	2.01	65.37
9.	Waziri	0.19	1.89	0.60	75.84
10.	Mixed yellow	0.52	2.69	3.01	39.59
11.	Mixed white	0.51	2.10	3.91	40.18
12.	Harnai	0.92	1.84	1.92	57.47

Kapok were conducted for their chemical composition. The crops wore produced under different rate of nitrogen fertilizer and various spacings. Two years (i.e. 1965-66 and 1966-67) data were recorded and analyzed for ultimate fibre length and fineness; fibre bundle strength, and maturity; cellulose, lignin, ash and nitrogen contents. Hydrolysis, mercerization, carbonation and Acid Purification values were also compared. The results showed significant differences for the above parameters under different treatments of fertilizers and spacings for different fibre varieties. Non-significant difference was observed between both years crops. Maximum ultimate fibre length of 6.2 mm was observed in sunhemp, followed by Flax, Ramie, Kenaf, Jute and Patwa. The maximum dimeter of 43 microns was noted in Ramie followed by sunhemp, Kcnaf, Patwa and Jute. The minimum dia of 23 microns was observed in Flax. Ramie fibres were found the strongest with 124.26 x 10^3 lbs/sq. in bundle strength, while sunhemp fibres came out as the weakest ones with 90.6 x 10^3/sq. in. Flax fibres wore found to have maximum cellulose content of 81.37 per cent and the lowest of Lignin, i.e. 2.02 per cent. The mercerization and Hydrolysis values were highest for kenaf and Ramie with 16.6 and 35.8 per cent respectively.

In another study, Pakistani Jute, Bangia White B Jute, Bangia Tossa B jute, and kenaf were spun and the yarns were evaluated for their quality characteristics. Results showed the dominance of Bangia Tossa B, followed by Bangia White B, kenaf and Pakistani Jute with respect to grist, tpm, strength and quality ratio. It was concluded that although Pakistani jute has lowest strength as compared with other varieties yet its yarn can safely be used in hessian weft as well as sack warp as its breaking load is quite more than

minimum of the range. (b) Flax

Flax or linen (Linum usitatissimum) is one of the most important textile fibres. Flax yarn produces a fabric with an exceptionally clear surface and renders the fabric soil resistant property. Considering such merits of this fibre, its five varieties, viz., Russian, UK, Imperial, Rocket, and H-106 were grown to study their fibres for physico-chemical chracteristics. The specimens of each variety were collected at the different stages of maturity, i.e. green ripe, yellow ripe and brown ripe. The results showed that the increase in maturity, the ultimate fibre length and thickness increased, while moisture content decreased. Strength and cellulose content increased upto yellow stage but decreased in brown stage as maturity increased. The overall ranges of ultimate coll length were 15.7 mm in H-106 at green stage to 28.0 mm in Russian at yellow stage; and the range of cell thickness was 11.0 microns in Imperial at green stage to 24.0 microns in H-106 at brown stage. The ranges of fiore uundle strength were 108.2 x 10^3 lb/sq.in. Imperial at yellow stage to 84.6 x 10^3 Lbs/sq. in. H-106 at green stage. The mean values of cellulose, nitrogen, lignin, wax and ash contents were recorded as 72.0, 74.9, 73.4; 0.8, 0.7, 0.6; 1.6, 2.0, 2.6; 2.4, 2.5, 2.6; and 1.7, 1.6 percent respectively at green, yellow and brown stages. Prom overall results it was concluded that Imperial variety ranked top, followed by Russia, UK, Rocket and H-106. Yellow stage of maturity was found the best stage to harvest the fibre crops for quality characteristics. (c)Khip (Leptadenia pyrotechnica)

The Khip plant was reported to yield good fibre by the inhabitants of Bahawalpur. It was thus put under scientific research for the first time in this department in 1969-73. The Khip (Leptadenia pyrotechnica) a perennial and Xero-phytic plant belongs to the family Ascalepidacae). Its branches scatter on all sides and attain the height of 90 to 120 cm. The branches are thin, green, devoid of any thorns but have very small leaves which provide grazing material for sheep and goats of the region. Flowering starts in February and continues till March. The long thin pods bearing numerous small dark brown seeds with white lustrous seed hairs of about 13 mm length usually appear in April or May. Mature pods crack while drying and shed the seeds out, which are carried over to very long distances away by sand storms. Thus such natural distribution of these seeds becomes the source of new plants.

The extraction of Klhip fibre by retting method appeared to be a difficult problem because of scarcity of water in the Khip growing areas. So, the fibres were extracted by beating process. The fibrous material obtained in this method was silky white with excellent lustre, but contained some tiny particles of stem bark, etc. clinging with fibres in such a way that on mechanical removal with Shirley Analyser or by simple combing yielded out very high percentage of trash, i.e. about 75 per cent, leaving behind only 25 per cent usable fibre. The overall perusal of seed germination study results showed that khip seeds germinated better in sandy soil where adequate moisture is available.

The study on quality characteristics of khip fibres shows that fibre bundle strength was 88.50 x 10^3 lbs/sq. in. The values of fibre fineness ranged between 14.7 to 18.3 microns, whereas the range of ultimate fibre cell length was recorded as 0.84 to 1.37 mm. The chemical analysis of fibres yielded out the percentage of cellulose, protein, Wax, ash, lignin, acid purification and maturity were 79.0, 2.5, 2.2, 2.3, 5.7, 2.5, and 90.4 respectively. The spinning performance was not encouraging producing less than 10's yarn.

In another study on retting the isolates found in the retting water of khip stalks were cultivated on special glucose agar meldium containing glucose = 5 gin, yeast extract = 5 gm, Peptone = 5 gm, L-cystine =2 gm agar = 20 gm, litre of distilled water. After re-isolation and purification, four types' of cultures were found. The cultures were studied for their cultural, physiological and biochemical properties to identify them. The organisms were also tested for their retting ability. They retted the shoots in 5 days period. The micro-organisms found responsible for the retting of khip fibre were identified Bacillus polymyxa and Bacillus macerans.

4. PULP AND PAPER TECHNOLOGY

A pulp yield study on Maxi-Pak and Chenab-70 wheat straws (Triticum aestinum), Desi-9 and AC-134 Cotton stalks (Gossypium arborium); Kahi grass (Saccharum spontanium), Begassee (Saccharum officinarum); Soft woods of pine (Pinus sylvestric) and Poplar (Populus alba) was carried out and pulp characteristics wore studied. Sulphite process was used for wheat straws and grasses, while soda process was used for cotton stalks. For pine and poplar woods, sulphate process was found useful. Optimum crude, screened and unscreened pulp yield was obtained from wheat str.iws at 12 per cent concentration; from cotton stalks at 15 per cent concentration, while from soft woods at 18.75 per cent concentrations. The highest percentage of alpha-cellulose, lignin, and pentosan were noted in descending order from Desi-9 cotton stalks, pine wood and Maxi-Pak straws, respectively. Paper sheets were also made and tested for their strength at 45SR. The average tensile strength, tear factor, and burst factor for Maxi-Pak, .Chenab-70, Kahi, Begassee, AC-134, Desi-9, Pine and Poplar wore 18.26 kg/mm, 26 and 39.1; 15.6 kg/mm, 28 and 51.6; 15.2 kg/ mm, 24 and 39; 15kg/mm, 40, and 34; 17.4 kg/mm, 52 and 45; 19.1 kg/mm, 44 and 48; 12.2 kg/mm, 51, and 34; and 14.7 kg/mm, 50 and 44, respectively. These characteristics of Pulp and paper led to Lhc conclusion that the materials undertaken in this study can safely be used for the production of wrapping papers. However, the refined pulp of Begassee and Kahi grass can be utilized for quality paper.

In another similar study, Juntar (Sesbania aegyptiacae) and Dih (Typha angustata) were studied for their pulp yield and paper strength. Maximum percentage of crude and unscreened pulp yiold wore 48.51 and 25.84, respectively in sulphite process using 2.5 per cent chemical concentrations and screened pulp yield was 39.25 using 22 per cent soda in Juntar. The minimum percentage of crude pulp yield and unscreened pulp yield were recorded as 25.53 using 20 per cent NaOH and 0.25 using 17 per cent NaOH, respectively in Dib, while screened pulp yield was 22.67' in Juntar digested by sulphite process using 25 per cent chemical concentration. The breaking length, burst factor and tear factor of Juntar paper sheets at original beating degree were 10604.32 m, 63.86 and 46.08, respectively while for that of Dib these values were 5360.11 m, 66.72 and 42.53 respectively showing thereby that Juntar and Dib can feed the paper industry.

5. FIBRE BLENDING

The Department visualising the importance of blending in textile trade, carried out some blending work. The brief description of these studies is given as under:

(a) Blending of cotton with synthetic and regenerated fibres

The viscose rayon was belnded with 100/0, 80/20, 50/50, 35/65, 65/35, and 20/80 ratios of cotton/rayon in Pakistani medium-stapled cottons, viz. B-557, MNH-93, MNS-79, AC-134, BS-1, and AIJ-59 and were spun for various counts. The spinning performance of the blended and pure cotton yrns was evaluated for yarn number, twist, efficiency, strength, neppiness, and uniformity. The results showed that higher percentage of viscose in cotton/viscose blend decreased the strength parameters nut improved the uniformity, neppiness, lustre, and hygroscopic properties for both carded and combed yarns of various counts spun. On the other hand, the blending of viscose in small proportion did not necessarily improve the spinning running tests but only improved the strength to some extent. Further, too much end-breakage was observed to spin fin'e counts leading to the conclusion that spinning of such cotton varieties for finer count yarns, like 60's, would not be economical for commercial purposes. Analyzing all the results to pick up the blending ratio for optimum CSP value, it was found that 35X blend of rayon with 65% cotton seemed to be the limiting ratio beyond which uncertain strength would be expected. It was, therefore, suggested that rayon should not be blended less than 35% by weigh tage in cotton. The optimum results were achieved at 20/80 ratio of cotton/rayon. So far as spinning characteristics were concerned, B-557 yielded out the best results. Recent studies, however, showed somewhat its deterioration and dominance of M N11-93. Polyester has become exceedingly popular for minimum care

fabrics. Inevitably, B-557, MNH-93, LH-62, AC-134 BS-1, and Kxpress cotton were blended with polyester and yarns of various counts were spun with 20/80, 35/65, 50/50, 65/35, and 80/20 blending ratios of polyester/cotton. Both pure cotton and blended yarns were evaluated for tpro, yarn number strength, neps, and evenness. The studies indicated that yarn properties and spinning performance were affected by the weightage of the blended materials in the yarn. Higher percentage of polyester in cotton blend reduced the ends down but improved the uniformity of l.hc yarn. It was concluded that medium-stapled carded cottons can safely be processed for 30's yarn with best performance when blended with 65% polyester. Combed cottons, however, can be spun upto 60's yarn if blended with longer-stapled polyester. The optimum results were achieved at 35/65 blending ratio of MI-62/polyeKter. Despite showing coarser inclination towards Micronaire value, the new promising cotton variety MNH-93 produced the best results in respect of GOT, staple length maturity non-lint content, neps, and strength.

The results of blending rayon and polyester separately in cotton were so encouraging that it was felt desirable to study the possibility if a coarse short-stapled indigenous cotton might yield good results when blended with synthetic and regenerated fibres. Thus plolyester and rayon were blended in LH-72, B-557 and Ravi cotton with different ratios of cotton/polyester/rayon. Before processing all cottons were evaluated for their staple length, fineness, bundle strength, moisture, and non-lint content. Both pure and blended yarns were spun and tested for count value, tpm, skein-strength, csp value and uniformity, keeping all processing factors constant. The results indicated that cotton/polyester/rayon blends with 50/35/15 ratio not only produced stronger yarns, but also improved the yarn appearance and uniformity. Apart from the fact that the composition of various blends appear to be the controlling factor, the longer staple length plays the major role in spinning the yarn of quality. The spinning performances of desi cotton Ravi was poor, but when it was blended with longer staples of polyester and rayon, the problem was solved to a satisfactory level. Among various blends, LH-72/polyester/rayon, B-557/ polyester/ rayon, and polyester/Ravi/rayon, with 50/35/15 blending ratios were found to yield optimum results.

(b) Blending of wool with man-made fibres

In additon to several studies on various characteristics of fleeces produced by indigenous sheep breeds of Pakistan, acrylic fibres were blended in Pakistan indigenous Mixed white. Mixed yellow, Cholistani, and Harnai wools, and carpet yarns of one-and two-ply were spun. For the purpose of comparison Newzealand crossbred wool was also included in the study. Pure woollen and blended yarns were tested for their quality characteristics. The study revealed highly significant effects on quality characteristics of the blended yarns. The woollen yarns were improved in their twist, efficiency, count value, lea-strength, csp, elongation at break, and in uniformity when blended with acrylic. The optimum results were achieved at 57/43 ratio of wool/acrylic. The results also showed that the yarns spun from Mixed yellow clip lacked strength to be used in the products where serviceability and colour attraction are of prime importance. Out of five wool varieties examined for their yarn quality characteristics, Harnai wool blend emerged out to be the best, followed by Newzealand cirossbred. Mixed white, Cholistani, and Mixed yellow blends.

Similarly, polyester was also tried in Pakistani Mixed type wool tops with 60/40 ratio of wool/polyester, and carpet yarns were spun. Pure woollen and blended yarns were tested for tpm, yarn number, breaking strength efficiency, evenness, and irregularity index. Results showed significant improvement in those characteristics of blended yarns as compared with pure woollen one, but the improvement was not to that extent as was noticed earlier in wool/acrylic blends. On the other hand, wool blended yarns with polyester showed more uniformity and evenness than those yarns blended with acrylic.

(c) Blending of jute with kenaf

Pakistani, Bangia white B, Bangia Tossa B, jute varieties were blended with kenaf fibres in the rotating ratios of 20/80, 40/60 and 50/50, and coarse yarns were spun. On the basis of strength and quality ratio

parameters, optimum results were achieved with 20/80 ratio of Pakistani jute/kenaf, Bangla white B/kenaf, and Bangla white B/Bangla Tossa B.

6. TEXTILE TESTING AND QUALITY CONTROL

The results of different studies of fibres and yarns on their quality characteristics have been given under individual fibre. The results of some special studies on testing and quality control are given here:

6.1. Compressional characteristics of wool

An apparatus based on plunger and cylinder was developed to measure and compare the compressibility and residence of different fibres in loose bulk form. The compressibility was determined by taking applied load versus compressed thickness. The resilience was determined by taking the ratio of the work done in recovering by the specimen and the work consumed in total compression and decompression in one cycle.

It was shown that the behaviour of the mass of wool fibres in compression can adequately be described by an empirical equation of the exponential form:

$$(T-B) = (To-B)\, e^{-kwd}$$

where T is compressed thickness of fibrous mass, To is the initial thickness under zero load, B is the final compressed thickness, Wd is the additional applied load, and K is a constant called the "initial rate of compression" and defined as the ratio of the rate of change of thickness with additional applied load at zero load position to the total reduction in thickness under the maximum laod. The results showed that fine wool Merino comparatively resisted more in compression than carpet type wool, although it was compressed to a greater degree of effective density giving higher value of compressional force or weight. The rate of change of thickness with applied load indicated that among carpet type wools, lohi wool is softer in nature and more easily was compressed, while Newzealand wool resisted more, against compression. Welsh Mountain and Herdwick remained in between.

Resilience appeared to have a narrow range in the cycle of compression and relaxation. However, it varies within the wool types, and is highest in Welsh Mountain, followed by Lohi, Newzealand Crossbred and Herdwick wools. The resilience of wool fibres increased as the fibre length decreased. However, no relationship was established between diameter and resilience.

6.2. Load-extension characteristics of wool

It was shown that the study of constancy of the rate of loading or extension of the load-extension curve was possible with the help of derivative curves. The load-extension characteristics of eight types of wool fibres, viz. Lohi, Wellsh Mountain, PIerdwick, Newzealand Crossbred, Lincoln Swale Dale, Black Paced and Merino were studied with derivative technique. Considering the derivative curve of load-extension curve as summation of the various components evolved in molecular changes which occur in Leaching the fibre, the derivative mode is thus interpreted in terms of such component peaks of six regions into which the load-extension curve has been divided. Fibres were studied both in dry and wet states and seven component peaks were observed in Ilookean region and ten peaks in the post-yield region, leading to infer that fibre extension process is a summation of the changes occurred in molecular form. Extension in small discrete amounts observed in derivative curves can be ascribed to Alpha-Beta Transformation.

6.3. Pilling control

Pilling is a common teasing and unpleasant phenomenon both for the textile manufacturers and

consumers. Its intensity is further accentuated when natural fibres are used in combination with synthetic or regenerated fibres. It was thus thought desirable to investigate some techniques to control the pill formation on blended fabrics. The study was carried out in two phases. In first phase survey of cloth markets was made and samples of fabric were studied, and in second and final phase four anti-phillling techniques were tried. Heat setting in conjunction with singeing and shearing was found to have produced best results. This technique is more useful when applied on *grey* cloth.

6.4. Dye fastness

Effect of washing, sunlight perspiration, and rubbing were studied on the colour fastness of polyester/cotton and polyester/viscse blended fabrics which are commercially available in the market. The fabrics dyed with direct and disperse dyes on jigger pocess showed good performance to washing, perspiration, and rubbing, but dyeing these fbrics on jet process with same conditions produced excellent results. Similarly, samples of polyester/viscose blend dyed with disperse and reactive dyes on jot process showed excellent results for washing, perspiration, and rubbing. However, colour, fastness to sun-light was poor in both the processes.

6.5. Spinning performance

In processing fibres from raw materials to yarns of any count, twist factor, traveller size, and spindle speed of the spinning frame plays the major roles. To study the effects of these variables, B 557 cotton was spun for various count yarns. The studies revealed that for best yarn characteristics and optimum production, twist multipliers, traveller sizes and spindle speeds differed for each yarn number. For 10s yarns twist multiplier 4.0 produced the optimum results, for 14s yarn twist multiplier 5.0 yielded the best results, for 16s yarn twist multiplier 4.5 gave maximum csp with good single end-breakage and low u-percentage value. For 20s yarn, the maximum strength with highest uniformity and low end-breakage were observed with 5.5 twist multiplier. However, the best quality yarn for optimum production were achieved at 10,000 rpm spindle speed with 4.75 twist multiplier and *2/0* traveller size.

Studies on roving to yarn and sliver to yarn cotton spinning sequences for quality control fixation some approved cotton varieties were spun for various count yarns. The results of carded yarn showed that from first passage sliver yarn to second passage sliver yarn CSP progressively increased. Comparing direct spinning results with, those of ring spun it was found that the strength were much better in the latter case. The lea-strength of 10s, 20s, 30s, and 40s, yarns were 165, 91, 60 and 47 lb, respectively, showing that yarn loses its strength if spun for finer count. However, when CSP values were calculated it was observed that Pakistani medium-stapled cottons could safely be spun upto 40s yarn with satisfactory strength.

6.6. Development of testing equipment

(a) Fibre compressibility tester:

Research workers and engineers always have urge to replace such methods of measurement as based on tactual judgement. To meet this requirement an apparatus was developed to measure the compressibility and resiliency of loose fibres in bulk form.

The developed apparatus is principally based on "plunger and cylinder". The plunger of aluminium alloy is made floating freely in the perspex clylinder under controlled air-flow pressure. By taking applied load versus compressed thickness readings in a precise and simple manner, the resistance of the material in bulk form to compression can be determined. Also, the work done in recovering by the fibrous mass and the work consumed in the total compression and decompression cycle can be estimated. The apparatus gives not only a good starting point at zero-load, but also considerably reduces the frictional effect between the surfaces of plunger and cylinder. Moreover, on this apparatus the compressibility and

resiliency of fibrous material may be measured under extremely low pressure.

(b) Electronic differentiator

Taking the advantages of the recent growth of low-cost solid state operational amplifiers in modular form, and more recently in integrated circuit form, an electronic differentiator was developed by using Fair Child's operational amplifier micron A 741. The aim of the differentiator was to produce the successive differentiation of the classical load-extension curve. This differentiator when connected with the Helipot of the Instron, the output voltage of the Helipot is directly proportional to the signals traced by the chart recorder. Apart from the satisfactory differentiation, this differentiator facilitates a careful investigation of the effect of time in dynamometric studies of fibres. Moreover, the knowledge of the corresponding gradient provides with much bolter knowledge of the way in which the load is applied.

(c) Jute decorticator

Jute is very important bast fibre, and has long been utilized in the textile industry for various products. Extraction of this fibre by retting method has become a great problem for Pakistan as retting requires large amount of water in addition to laborious and time consuming work. To overcome this problem, a jute decorticator was developed with the collaboration of the Department of Farm Machinery and Power.

7. LATEST SPINNING TECHNOLOGIES

During the last decade a number of innovative spinning techniques (compact, vortex, air jet, hollow yarn etc.) have emerged into the textile world. The Department of Fibre Technology has initiated a series of research projects to evaluate the comparative performance of these spinning technologies at different processing variables for the optimization of the ultimate yarn quality by using Pakistani as well as imported cotton varieties.

7.1. Performance evaluation of Toyoda RY-5 Ring Frame modified to produce compact spun yarn

The purpose of the research project was to compare the performance of traditional ring spinning machine (modified to produce compact spun yarn) with Suessen Elite compact yarn spinning system. The results revealed that for yarn tensile parameters, the effect of compact spinning frames, spindle speed and yarn type was highly significant. The results for yarn evenness and hairiness revealed that the effect of compact spinning frames, spindle speed, yarn type were highly significant. The highest and lowest value of U% for compact spinning frames (C_1, C_2) were 10.67 and 10.11 percent, while that of hairiness is were 4.02 and 3.89. The effect of different spinning systems on most of the yarn parameters is highly significant except for yarn count. Original frame produces the best quality yarn as compare to modified frame. On the other hand the best quality yarn is obtained at lower spindle speed. In case of yarn type (noil extraction) the yarn of best quality is obtained at maximum noil extraction.

7.2. Effect of some processing variables on the quality of yarn spun at Vortex Spinner (MVS-8R2)

Automation and use of sophisticated electronically controlled machinery is now a days an integral part of all yarn manufacturing system. In 1980s air-jet spinning appeared to offer a real promise of commercial success because it is eminently suitable for the production of fine yarns. A major spinning technology, Murata Vortex spinning (MVS), was introduced in 1997. The major difference between Vortex spinning and air-jet spinning is that a pair of opposing air blasts from air nozzles is used in air-jet system, to impart structural integrity to the yarn mass. On the other hand in air-vortex system, a unique guide called a spindle, a needle holder and a single air nozzle is used for this purpose. In the air-vortex spinning, the fibre arrangements are much improved, defining closer spinning. Technically Vortex Spinning has a vast scope for research to be conducted by producing a variety of yarn samples at multiple adjustments on the

machine to evaluate yarn quality and to record the influence of these technical changes. This research project was carried out to estimate the effect of various variables viz. carded and combed sliver feeding, altering sliver hanks, drawing passages and spinning speed upon ultimate yarn quality parameters. The data regarding the yarn count showed non-significant effect due to the sliver type fed (C), drawing passage (P), sliver hank (S) and yarn spinning speed (D). The data pertaining to yarn tensile parameters (lea strength, CLSP, Single yarn strength, Yarn elongation and RKM) and yarn evenness showed highly significant, while yarn count showed non-significant effect due to sliver type fed (C), sliver hank (S) and drawing passage (P). While for yarn spinning speed the data represented non-significant results.

7.3. Effect of Some Mechanical Variables in Condense Spinning of Cotton Yarn.

The compact spinning is the development, which changed the technology of ring spinning through improved twisting process and minimizing the spinning triangle. The significantly better integration of fibres not only results in a reduction of hairiness but also improved dynamometric properties. In this concerned a study was planned to investigate the effect of different spindle speeds i, e. 17,000, 19,000, 21,000 rpm. Twist multipliers 3.7, 3.9, 4.9 and different traveler sizes 4/0, 5/0, 6/0 on spun yarn quality. It was concluded that lower spindle speed was found better for all quality parameters. Moderate traveler number was found better for all yarn quality parameters except yarn hairiness. But in the case of twist was maximum twist but not beyond optimum limit, produce the best quality yarn.

7.4. Effect of Air Guide Element, Twist Multiplier and Top Roll Pressure on the Quality of Compact Yarn

In-spite of having much quality edges on the competitor yarn techniques, major drawback of ring spinning is its hairiness. For its control many machine manufacturers in each area of Ring frames had adopted many techniques. Compact spinning is latest in this regard to minimize hairiness in yarn. The sum and substance of the research work is as follows. It was observed that perforated type air guide element produced excellent results for all yarn tensile, evenness and imperfection quality parameters viz. yarn lea strength, count lea strength product, Single Yarn strength, yarn elongation, RKM, yarn evenness, yarn thin and thick places, yarn neps and yarn hairiness. In the case of top roll pressure, moderate top roll pressure showed better performance for yarn quality characteristics like lea strength, CLSP, single yarn strength, elongation and RKM. As far as twist was concerned, it was concluded that maximum twist produce the best quality yarn, but it should not exceed beyond the optimal limit.

7.5. Effect of Different Rubber Cots Hardness, Twist Multiplier and Steel Ring Diameter upon the Quality of Yarn at Compact Ring Frame.

No doubt, compact-spinning process has a winning market acceptance. The perfect yarn structure provides for market cost saving in chain of textile production on one hand while on the other hand better production can be produced. In this concern this research study was planned and conclude that The sum and substance of the research work is that low rubber cots hardness produced excellent results for all yarn quality parameters, viz yarn count, yarn lea strength, count lea strength product, single yarn strength, yarn elongation, RKM, yarn evenness, yarn thin and thick places, yarn neps and yarn hairiness. In the case of twist it was found that the yarn quality improved at higher twist but not beyond optimum limit. While steel ring diameter showed non-significant results for most of the quality parameters.

7.6. Interaction effect of change in nozzles pressure and spinning speed on air-jet spun yarn.

Air jet spinning is a short but efficient open end spinning method for quality yarn production. The fibres assembling and twisting during this process mainly depends upon the air pressure in the jet/nozzles and the spinning speed. The two jets create vortices in opposite direction. The second nozzle inserts false twist to the fibres bundle while the air pressure of the first nozzle situated within the front roller and the second nozzle rotates the fibrous strand opposite direction to that of the first. In this research work the pressures of first nozzle and second nozzles was adjusted as n_1 = 2 Kg/cm^2, n_2 = 2.5 Kg/ cm^2, n_3 = 3 Kg/ cm^2, n_4 = 3.5 Kg/cm^2, and N_1 = 5 Kg/cm^2, N_2 = 5 Kg/cm^2, N_3 = 7 Kg/cm^2, respectively. The spinning speed were selected as S_1=240 m/min, S_2= 270 m/min and S_3= 300 m/min. the overall interaction study revealed that the imperfections of yarn samples of 30 (PC 52/48) have increasing trend with the increase of pressure of both the nozzles; it might be due to increase in fibrous strand tension, particularly associated with first nozzle high pressure. The overall results showed that the combination S1N1n1 was the best one. Increase of spinning speed also improved Uster imperfections.

1.7. Study of quality parameters of hollow yarn by using multiple fibres as a core in yarn structure

In this research study, the effect of different core fibres with different compositions on hollow yarn were investigated and suitable combinations were explored to achieve optimal results in hollow yarn formation both for ring and rotor yarn manufacturing. The results depicted that for hollow yarn quality all tensile properties of ring spun yarn are better than open-end spun yarn. While for Uster evenness parameters open-end spun yarn performed exceptionally better than ring spun yarn. The results for knitting fabric parameters depicted that when the share of PVA, polyester and other synthetics in the core increases, fabric strength, fabric density (GSM), courses and wales/inch also increases while shrinkage (length wise) percentage spirality, pill rating and abrasion value decreased. However under two different yarn spinning systems (ring and open-end), fabric strength, shrinkage percentage spirality and pill rating of ring spun yarn knitted fabrics is greater as compared to air-jet spun yarn. After fabric formation, during the finishing stage when core was dissolved, the PVA proved to be the best because of water solubility than other fibres dissolved in concentrated alkalis with a slight effect on cotton properties. After hollow tube formation, fabric of PVA behaved as pure cotton fabric in some parameters like shrinkage, abrasion and spirality more than the fabric of polyester, nylon and acrylic combinations successively.

7.8. Comparison of rotor v/s air-jet spinning systems with reference to some yarn quality parameters

The rotor and air jet spinning are two technologies in open-end yarn manufacturing. It was planned to produce two same counts of cotton and polyester blended yarns with three blend ratios a B_1 = 77:23, B_2 = 52:48, B_3 = 23:77 to analyze the effect of blend components and the spinning techniques. The factors of spinning techniques and blend ratio were found highly significant while the count changing showed non-significant effect. The air jet spun yarn samples shows better results; while the increase in polyester share in the blends revealed direct proportionality to the yarn strength in case of both of the counts 25^s PC and 30^s PC.

7.9. A study of yarn parameters through improved modification of G-33 to K-44 ring spinning frame.

The compact spinning process produces a new yarn structure through minimizing the spinning triangle, potential weak or problem spot which negatively affects spinning stability, and some yarn quality parameters. In this research project the effect of compact and conventional ring spun yarn prepared under multiple mechanical variables viz. break draft, spacer and twist multiplies, was investigated. The study concludes that various ring frame parameters selected for this study i.e., twist multiplies, break draft and spacers exerts a significant impact upon yarn quality. Modified ring frame (K-44), at twist multiplies

4.00 and moderate break draft (1.19) recorded optimal results for most of the yarn characteristics.

7.10. Interaction effect of change in nozzles' pressure and spinning speed on air jet spun yarn

In air-jet spinning system, the strand of fibres is twisted by two air-jet operated in contra rotation. This study envisaged the preparation of the optimal quality yarn at different pressure setting of air jet nozzles as well as spinning speed on the air-jet spinning machine. Card slivers of cotton and polyester were blended at draw frame by giving 3 passages treatment. In case of machine variables of different set of 1^{st} nozzle pressure and 2^{nd} nozzle pressure whereas 3 different spinning speeds were trailed systematically enhances the cohesion of the strand to give the final strength to yarn as higher 2^{nd} jet pressure leads to greater self axial rotation of fibres stand. The increased first nozzle pressure caused increase in yarn irregularity and imperfection where as, increase in the spinning speed showed an increase in yarn strength and production rate.

7.11. Comparison of knitted fabric from air-jet and ring spun yarn by selecting multiple blending ratios of cotton and polyester

Air-jet spinning is a pneumatic spinning method in which drafted strand of fibres is subjected to two successive opposing streams of air-jets between the delivery rollers of a conventional drafting system, and a take up device. In the research project the spinning performance of five different blends of polyester/cotton was studied at two different spinning systems i.e. ring and air-jet for the yarn of number 30^{s} count. The results revealed that for yarn quality all tensile properties (lea strength, count lea strength product, single yarn strength, rupture per kilometer and elongation) of ring spun yarn are better than air-jet spun yarn. While for Uster evenness parameters (yarn unevenness, thick, thin, neps and hairiness), air-jet spun yarn performed exceptionally better than ring spun yarn. For knit fabric parameters the results depict that when the share of polyester in the blend increases, fabric strength, fabric density (GSM), courses and wales/inch also increases while shrinkage (width and length wise) percentage and spirality decreased. However under two different yarn spinning systems (ring and air-jet), fabric strength, shrinkage percentage and spirality of ring spun yarn knitted fabrics is greater as compared to air-jet spun yarn.

7.12. Comparative study of simplex frame with and without inverter system for roving and ultimate yarn quality under different mechanical variables

The research project was performed at simplex frame for optimization of roving and yarn quality as well as quantity under variant mechanical changes such as break draft, twist multiplier and flyer speed. Following variables were selected to study their effects on the roving strand and ultimate yarn; roving frame M1 (without inverter system), M2 (with inverter system); break draft B1 (1.19), B2 (1.22), B3 (1.26); twist multiplier T1 (1.15), T2 (1.18), T3 (1.21) and flyer speed S1 (900 rpm), S2 (1000 rpm) and S3 (1100 rpm). The yarn of 20^{s} cotton carded warp was spun on Toyoda RY-5 ring frame at 16000 rpm spindle speed and 4.5 twist multiplier. It was concluded that various simplex frame parameters selected for this research project, exerts a significant impact upon most of the roving as well as ultimate yarn parameters. Modified simplex frame, at moderate break draft (1.22), lowest flyer speed (900 rpm) and twist multiplier (1.18) recorded optimal results for most of the roving and yarn characteristics and significantly reduces the roving breakage percentage as compared to the conventional simplex setup.

8. INTERACTION STUDY OF VARIOUS FIBRE CHARACTERISTICS

8.1. Study of maturity ratio with reference to fibre neps, using Advanced Fibre Information System (AFIS-N).

Introduction of Advanced Fibre Information System (AFIS) is a major break through in terms of rapid and

cost effective measurement of neps in cotton lint. From the existing stock of cotton, the bales with different levels of maturity ratio (M1=0.92, M2=0.93, M3=0.94, M4=0.95, M5=0.96, M7=0.98 and M8=0.99), fineness (F1=4.2F2=4.3, F3=4.4, F4=4.5 and F5=4.6) and fibre length (L1=1.10, L2=1.11, L3=1.12 and L4=1.13 inches), were sorted out and tested for neps and other fibre characteristics using AFIS and HVI. Length of cotton was found to be mot important from commercial point of view.

The over all interaction and regression analysis of staple length, fineness and maturity ratio of cotton variety MNH-93 achieved in this project reflect the following results:

- Regression analysis depicted that with one-unit increase in fibre length, length uniformity index is increased by 8.81unit, while an increase of 0.915 and 5.70 unit is recorded for fibre fineness and maturity ratio, respectively. The coefficient of determination R^2 explains that 67.8 % variability in length uniformity index is originated to its linear relationship with fibre length, fibre fineness and maturity ratio. The coefficient of multiple correlation ($R_{Y.123}$ = 0.8234) indicates a high degree of association between Y (length uniformity index) and its three regressors. Standardized multiple regression analysis depicts that maturity ratio is the factor having maximum influence on length uniformity index with highest value of standardized regression coefficient as 0.516. Length uniformity index gave best results at higher levels of length, fineness and maturity ratio.
- Multiple regression analysis also interpreted that with one unit increase in length an increase of 38.6 unit may occur in fibre bundle strength, while 0.553 and 7.87 units increase is for fineness and maturity ratio, respectively. The higher values of coefficient of determination (R^2 = 87.1 %) and coefficient of multiple correlation ($R_{Y.123}$ = 0.933) were recorded. Standardized multiple regression interprets that fibre length is the factor which has maximum influence upon fibre bundle strength with highest value of standardized regression coefficient as 0.849. Fibre bundle strength shows best results at higher levels of length, fineness and maturity ratio.
- With one unit increase in length an increase of 5.21 units may occur in trash percent, while an increase of 1.18 and 0.126 units is recorded with one unit increase in maturity ratio and fineness, respectively. The lower values of coefficient of determination (R^2 = 1.3 %) and coefficient of multiple correlation ($R_{Y.123}$ = 0.114) were recorded. Standardized multiple regression interprets that fibre length is the factor, which has maximum influence upon trash contents with highest value of standardized regression coefficient as 0.101. From the above discussion it can be concluded that fibre parameters have negligible effect upon trash content percentage.
- With one-unit increase in fibre length, short fibre contents are decreased by 93.2 unit, while a decrease of 3.38 and 54.4 units may occur for fibre fineness and maturity ratio, respectively. The high values of coefficient of determination (R^2 = 92.3%) and coefficient of multiple correlation ($R_{Y.123}$ = 0.961) were recorded. It is evident from the standardized regression coefficient that maturity ratio is the factor having maximum influence on short fibre content percentage with highest value of standardized regression coefficient (0.707).
- With one unit increase in length an increase of 423 units may occur in trash percent, while 37.4 and 27.9 units decrease is recorded for fineness and maturity ratio, respectively. The medium values of coefficient of determination (R^2 = 39.9 %) and coefficient of multiple correlation ($R_{Y.123}$ = 0.632) were recorded. Standardized multiple regression interprets that fibre fineness is the factor, which has maximum influence upon fibre neps with highest value of standardized regression coefficient as 0.469. Fibre neps showed increasing trend for higher levels of length, lower and higher levels of maturity ratio and lower levels of fineness.
- It was also inferred that length is the principal fibre parameter next to it is fineness and maturity comes later. These characters have a critical influence over other fibre parameters.

8.2. Correlation study of speculated break factor derived through coefficient of multiple fibre

characteristics with actual yarn test results of different spinning systems

This research project has correlated the speculated break factor value (measured with High Volume Instrument) with actual test results of yarn spun on different spinning systems both under carded and combed status adjusted to different twist levels. Twist factor being the controlling element. The speculated break factor was at par with ring spun carded yarn at twist factor between 4.0 to 4.5 and for combed yarns between 3.5 to 4.0. The actual CLSP value of open end yarn correlates with speculated CLSP value between 7 to 8 twist multiplier only for combed yarn. While the Air jet spinning system yarn has shown no correlation with speculated break factor value. Quadratic regression analysis shows that there exist 62.7% effect of twist multiplier on CLSP for ring carded yarn and 87.1% on combed yarn. Quadratic regression analysis further records that there exist 72.7% influence of twist multiplier on open end break factor carded yarn and 83.5% for combed yarn. Multiple quadratic regression analysis depict that there is 87.6% influence of nozzle pressure on break factor for air jet carded and 95.2% upon air jet combed yarn.

9. DYEING, PRINTING & BLEACHING PROCESSES

9.1. Performance evaluation of alkalis pH stabilizers in reactive dyeing and hydrogen peroxide bleaching of cotton knitted fabrics

Alkali is one of the main contributors to the cost of recipe in bleaching and dyeing process of cotton fabrics. The project was conducted to optimize the quality and cost of bleaching and dyeing process by using various alkalis at different pH levels. The results depict that bleaching loss percentage registered significant difference among treatment at all pH levels for different alkalis. The minimum bleaching loss was 1.07% at pH level P_1. The maximum bleaching loss 1.32 was recorded at pH level P2 (10.5). The maximum whiteness was achieved by Na_3PO_4 and at pH P_3.The minimum whiteness was achieved by Urea. It was also found that the dyeing darken when subsequent high amount were given after fixation process of inadequate durations. However an excessive pH fixation alkalis increases cost and does not allow maximum efficiency of the expensive machine there is also a danger of lower color yield due to sublimation of the dye.

9.2. Studies on Jet Dyeing of polyester by changing some processing parameters.

The dyeing time, rate of flow of the material, ph-value and dye concentration determine the mechanism of dyeing in jet dyeing. Pure (100%) polyester fabric samples were pretreated and dyes at three different concentrations of disperse dye i.e., dye forum blue SE-2R C1= 1%, C2=2%, C3= 3% at three dyeing time durations t1=30min., t2=60min., t3= 90min and pH values pH1= 5.5, pH2= 7.5 and pH3=9.5,. For each dye cone; the above time durations and the PH-values were trailed and the dyed samples were evaluated for their colors fastness under standard methods of ISO 105/C04. (For washing fastness), ISO AO3 for (Rubbing fastness ISO 105/x11 (for ironing) ISO 105/E04 (for perspiration fastness) and ISO 105/B01 (for light fastness). The overall results revealed as a conclusion that dye concentration C1, PH-value PH1 and duration t2 produced excellent results for all the fastness tests.

9.3. Studies on the effect of time temperature and dye concentration for thermo-fix alkali shock dyeing method.

The modern tendency is towards an insistence on colors, which are fast to light, washing, rubbing and bleaching; this movement makes great demand on the science of dyeing. In addition, considerable craftsmanship or art is required to produce level results and to produce shades of color matching the specified standards. Dyeing implies some affinity between the fibre and the dye and the dyestuff which possess this affinity are termed substantive. Some dyes have no affinity for some fibres and are removed completely by rinsing, other require the intervention of a second substance called a mordant, for which

both dye and fibre have an affinity, although not for one another. In all cases of thermo-fix dyeing, the important point is that there must be uniform temperature throughout the chamber, otherwise smooth dyeing is impossible. This research work was carried out to judge that how much variation occurs in the fastness properties of dyed fabric by changing time, temperature and dye concentration. Thermo-fix alkali shock method for dyeing PC blended fabric samples at different dyeing times t_1 = 60 second, t_2 = 90 second and t_3 = 120 second. Temperature T_1 = 170 C, T_2 = 190C, T_3 = 210 C and dye concentration C_1 = 1%, C_2 = 2%, C_3 = 3% were applied. The dyes used were Foron Blue SE-2R and drimirine Blue K-2RL. The results showed that the dye concentration C1 revealed very good to excellent fastness results at time t1 and temperature t3. The dye concentration C2 showed good to very good scale rating for rubbing fastness whereas washing fastness at the above variable showed very good to excellent for all shades at high time and temperature i.e. 120 sec. and 210 C.

9.4. Stone washing of denim under variant stone brands, their blends and weight composition

Stone washing is an important process in the denim finishing or garment wet processing of denim industry. Various brands of pumice stones viz. S1 (SEM Stone, Turkey), S2 (Local Balochistan, Pakistan), S3 (50% fresh SEM and 50% used SEM) and S3 (50% fresh local and 50% used local), were applies for three different time durations T1 (20 min), T2 (40 min) and T3 (60 min), and for three variant dose concentrations D1 (10 kg), D2 (20 kg) and D3 (30 kg). All of the above variables recorded significant effects upon physical properties of cotton denim cotton fabric. At minimum dose and time the fabric retained maximum strength and minimum weight loss, but the abrasion (ageing effect) at these levels was the least. Moderate dose (D2) and time (T2) is recommended for optimum quality. Local stones (S2) performed equally better when compared with imported stones. However, stone washing with blends of used stoned generated poor results.

9.5. Comparison of exotic and indigenous neutral cellulolytic enzymes as denim stone wash substitute

Four different cellulases enzymes viz. E1 (Denimax BT), E2 (Ultima LV100), E3 (cellulases U) and E4 (cellulases N) were applied at three different dose level D1 (200 g/lit), D2 (400 g/lit) and D3 (600 g/lit), for three time duration T1 (20 min), T2 (40 min) and T3 (60 min). All of these variables recorded significant effects upon physical properties of cotton denim fabric. At minimum dose and time, the fabric retained maximum strength and minimum weight loss, but abrasion at this level was the least. Cellulase N (E4) showed good performance at moderate and high dose levels. Whereas Denimax BT and Ultima LV100 performed better as compared to other at most of the treatment combinations.

9.6. Study of multi source direct dye application and important process variables to denim fabric quality.

In Pakistan reactive and direct dyes are widely used to dye the cellulosic textiles. The objective of the present research project was to analyze the effect of different brands of direct dyes on denim fabric properties under variable conditions of time, temperature and dye concentration. Different types of direct dyes, quantity of dose, dyeing temperature and treatment time, recorded non significant effects upon tensile properties of cotton denim fabric. Under all combinations fabric retained almost same strength. Regarding the fastness properties the overall results for fastness properties were found optimum for all shades at maximum time and temperature levels 60 min. and 120^{o}C. The imported dye Black NF 1200 and locally produced direct black 13 showed equally good performance under moderate temperature and time. Therefore more emphases should be given to consume locally synthesized dyes in order to save the foreign exchanged of the country.

10. KNITTING TECHNOLOGY

The knitwear industry of Pakistan is playing a pivotal role in value addition in the textile sector. Both domestic and foreign demand for knitwear (hosiery) is increasing rapidly. In the recent years knitted apparel have made impressive improvement in quality, volume growth and has the potential of leading Pakistan textile sector to the forefront of international textile trade. Visualizing the importance of this sub-sector, the Department of Fibre Technology initiated a series of research projects on various aspects of knitting technology.

10.1. Factors affecting the dimensional and geometric properties of cotton stretch knitted fabrics

Stretch and knitted fabrics have a secure place in the world of textile industry, and play an outstanding role in term of wear properties, comfort and functionality. In this study the effect of the elastane concentration (0%, 1%, 3%, 5% and 7%), tightness factor (12, 13.5, 5, 16.5), the take down tension (2, 3 and 5 kg) on quality of the single jersey and 1/1 rib were investigated. The results of the study showed that Fabric density (SM), width-wise shrinkage, courses per inch, wales per inch and stitch density increases with the increase in tightness factor whereas length wise shrinkage decreases. Tightness factor should be kept between 14.5 and 15.5 for optimum fabric quality. Fabric strength and widthwise elasticity increased with the increase of tightness factor whereas the spirality of the knitted fabric decreases as the tightness factor is increased. The results also revealed that the suitable combinations of take down tension, tightness factor and the elastane percentage could minimize shrinkage area. Rib fabric is more elastic, heavier and dimensionally stable as compared to the plain knit fabric.

10.2. Comparison of knitted fabric from air-jet and ring spun yarn by selecting multiple blending ratios of cotton and polyester

In this research project the spinning and knitting performance of five different blends of polyester/cotton was studied at two different spinning systems i.e. ring and air-jet for the yarn of number 30^s count. For knit fabric parameters the results depict that when the share of polyester in the blend increases, fabric strength, fabric density (GSM), courses and wales/inch also increases while shrinkage (width and length wise) percentage and spirality decreased. However under two different yarn spinning systems (ring and air-jet), fabric strength, shrinkage percentage and spirality of ring spun yarn knitted fabrics is greater as compared to air-jet spun yarn.

10.3. Effect of different blends of P/C with various twist factors on the quality of plain knitted fabrics.

Blend is an intimate mixture of staple fibres of different compositions, length, diameter or colour, spun together into a yarn. Blending enables the fabric to combine fibres so that good qualities of fibres are emphasized and poor qualitires are minimized. In this research study the effect of different blends of P/C with various twist factors on the quality of plain knitted fabrics was investigated. Spinning performance and all the yarn parameters were significantly affected by the percentage of individual fibres in the blends as well as changes in twist factor. Results derived for knit fabric characteristics showed that as with the increase in twist factor, the length and widthwise shrinkage, spirality, torquing percentage, fabric density (GSM), courses and wales per inch and stitch density value also increased. When the share of cotton in blend was increased, the shrinkage, spirality and torquing percentage increase while fabric density (GSM), courses and wales per inch and stitch density decrease.

11. JUTE TECHNOLOGY

11.1. Effect of jute cuttings percentage on the quality of jute yarn

Jute is one of the world's most important fibre crops, being exceeded in quantity only by cotton. The main

objective of this project was batch-cost reduction by large-scale utilization of cuttings, without any adverse effect either on jute yarn quality and appearance or on spinning performance. The samples of raw jute were spun at Apron Drafting system simultaneously by selecting different levels of cuttings percentage, flyer speeds and grists. The following variables were selected to study their effect. Cutting percentage C0 = 0%, C1 = 10%, C2 = 20 % and C3 = 30%; Flyer speed (rpm), S1 = 3400, S2 = 3600, S3 = 3800 and S4 = 4000; Grist G1 = 9, G2 = 12 and G3 = 16. The results revealed that the cutting percentage increase have no profound effect on yarn grist, end breakage rate and moisture regain, yet some minute effects upon single yarn strength, quality ratio and yarn elongation were noted. However, 10 percent cuttings recorded non-significant effect upon single yarn strength, elongation as well as jute yarn quality ratio. Hence 10 percent cutting can safely be added up without scarifying jute yarn quality, while 30 percent addition of cutting recorded no significant effect upon the strength of 16 pounds grist jute yarn which testifies that for coarser yarn spinning the cutting percentage can even be increased up to 30 percent.

11.2. Effect of different bleaching agents on Pakistani jute variables

Technological research on jute products, particularly in the field of chemical modification of jute is particularly non-existent in Pakistan. This research project was therefore conducted to study the effect of different bleaching agents on the quality characteristics of raw jute. Four different jute varieties (AARI White, Bangla White, AARI Tossa and Bangla Tossa) were selected and were given bleaching treatments with four bleaching agents (Hydrogen per oxide, sodium chlorite, sodium perborate and sodium hypochlorite). The results showed that the hydrogen per oxide bleach superseded over all bleaching treatments irrespective of the variety. Most excellent results for tenacity and fluorescent values were recorded under this treatment along with maximum weight loss. Hydrogen per oxide bleached jute showed its dominance over rest of the bleaching agents. Sodium perborate bleach increased the fluorescent value at par with peroxide but at the expense of strength loss. Sodium chlorite bleach also imparted improvement in the parameter of fibre strength.

12. AUTOCLAVE TREATMENT OF YARN CONES

12.1. Effect of ambient atmosphere on quality of ring, open-end and air-jet cotton yarn cones after conditioning in autoclave

Autoclave steamer is recently inducted in spinning industry for the treatment of yarn to stabilize required level of moisture in the yarn package. Moisture in atmosphere has a great impact on the physical properties of textile fibres and yarns. But on the other hand, a high degree of moisture improves the physical properties of yarn. Moreover it helps the yarn to attain the standard moisture regain value of the fibre. Yarn sold with lower moisture content than the standard value will result in monetary loss. Therefore the aim of “Conditioning” is to provide an economical device for supplying the necessary moisture in a short time, in order to achieve a lasting improvement in quality. The tensile parameters of yarn (Lea strength, CLSP, Single yarn strength, Elongation and RKM) showed highly significant difference in the mean values of treatments, among control, control versus other. Similarly the effect of yarn type, temperature, steaming duration and interaction YxT was also highly significant and the interactions between them produced non-significant effect. The results pertaining yarn evenness revealed highly significant differences in the mean values of treatment, control (untreated yarn) and control vs other. Similarly the effect of yarn type, temperature and duration is recorded also highly significant while the interaction YxT is only significant.

12.2. Response of ambient atmosphere on pre and post autoclaved P/C yarn cones

Moisture content in yarns has important implications in both technical and commercial terms. Many characteristics which contribute to the sales value of the yarn are dependent upon the correct degree of yarn moisture, which also influences the level of efficiency of subsequent operations. The new autoclave

yarn conditioning process is intended to provide a high tech alternative to the traditional steaming process. The study explores the effect of the auto-clave steaming on various yarn characteristics of 24^s and 30^s PC yarn. The results reveal that yarn count, lea strength and CLSP, single yarn strength and yarn elongation have highly significant differences in the mean values of treatments, among control and control vs. other treatments. Regarding to yarn evenness, the difference in the mean values of treatments, control vs treatment, was highly significant but among control was non-significant. Similarly the effect of blends and temperature upon yarn evenness was also highly significant Also the effect of blends, temperature, time duration interaction are also highly significant while among control (untreated yarn) and all other interactions remained non-significant under different counts. Regarding to yarn hairiness, differences in the values of treatments, among control and control vs treatments, and the effect of blends, temperature and steaming durations were highly significant under different counts, whereas interaction blending ration and time for 24's was significant but non-significant for 30's while other interaction showed non-significant response.

13. OPEN-END (ROTOR) SPINNING

13.1. Interaction study of draw frame sliver moisture and machine variables on open-end yarn quality

Since the rotor spinning has been experienced constantly increasing productivity, therefore this trend imposes greater demands on the control of environmental conditions during yarn manufacturing, particularly in case of cotton processing because of the hygroscopic nature of this fibre being very positive to moisture. The changes in fibre properties due to increases moisture contents are favourable for better rotor spinning performance. Therefore, the effect of feed sliver moisture was investigated upon rotor spinning performance and physical properties of rotor spun at different sliver weight, opening roller and rotor speed. There moisture levels were selected i-e M1=6% , M2=8% and M3=10%, with opening roller speeds O1=6500 rpm, O2= 7500 and O3=8500 rpm, sliver weights as G1=50 gr/yard, G2=60 gr/yard and G3=70 gr/yard, where as the rotor speeds as S1=55000 rpm, S2=65000 rpm, S3=75000 rpm. The overall results were found highly significant. Yarn tensile properties improved significantly. With the increase in moisture level while yarn irregularity and imperfections increased. Excellent results were obtained at minimum moisture level M1, higher sliver weight G1, higher opening roller speed O3 and lowest rotor speed S1.

13.2. Interaction study of some rotor spinning machine variables by feeding combed sliver for optimum yarn quality

New field of application for rotor yarns have been established using combed slivers as the feeding material. With combed sliver the rotor groove does not accumulate as much trash and consequently the spinning twist can be reduced without an increase in ends down level. This also results in a clear increase in machine productivity. Fewer customer complaints and claims because of reduced yarn faults (less trash, better spinning conditions, fewer piecing) also the dyeing and finishing is more consistent because the immature short fibres have been removed in the combing process. The objective of the present research project is to evaluate the yarn characteristics by using combed sliver in open-end spinning machine, at multiple processing variables. All the yarn properties were improved by extracting higher percentage of noils at combing machine. By decreasing the level of noil extraction the yarn characteristics deteriorate. The best value of all yarn characteristics were recorded at N_3 (15% noil extraction). The optimum yarn characteristics are obtained at minimum rotor diameter, when rotor diameter increase the spun yarn characteristics were degraded. Different rotor speed exerted highly significant effect upon all yarn properties. Yarn lea strength, single yarn strength, elongation, breaking length, decreases with increase in rotor speed while imperfection and hairiness increases. The best results were recorded at S_1 (30,000 rpm) for all yarn properties. Under both yarn counts, yarn properties, viz; lea strength, count lea strength product, single yarn strength, breaking length, yarn elongation, thin, thick places, yarn neps and

evenness recorded best results under coarser count (16^{s}). Whereas, yarn hairiness was found excellent for 30^{s} rotor spun yarn.

14. DETERMINATION OF ENDOTOXIN LEVEL IN VARIOUS COTTON

Cotton dust is removed from the fibres at various stages of processing from harvesting, ginning, carding till spinning but micro dust particles could not be eliminated through mechanical cleaning. Inhalation of these micro dust particles is the cause of the development of the respiratory disease known as "Brown lung" in textile workers. The causative agent of byssionsis in dust has not yet been identified but endotoxins found in raw cotton are suspected to play a role in the development of the disease. The large numbers of textile workers are facing the problem of respiratory disease caused due to the presence of byssinogenic agents in cotton, which becomes air borne during the processing of fibres into textiles. Actually endotoxins (Lipopolysaccarides LPS) are produced by gram-negative bacteria that colonize cotton plants in the field. When ginned cotton fibre is opened and processed in textile mills, these endotoxins are release in the air contributing to the pulmonary disease. A series of research projects was conducted to investigate effect of various methods of eliminating endotoxin contents from raw cotton on fibre and yarn properties.

Endotoxin content of cotton fibre could be reduced up to 84 percent by water washing, 76 percent under autoclave and 62 percent by flash heat. Washing, heating and autoclave treatments affect length, fineness, and strength, as well as yarn characteristics viz. count, yarn strength, count lea-strength product value (CLSP), and endotoxin level. Although water wash treatment reduced maximum amount of endotoxin level but it had more severe effect on fibre physico-chemical characteristics and yam properties as compared to autoclave and heat treatments, whereas, autoclave treatment was also better from heat treatment. Under four cultivated species, two groups of cotton long staple and short staple were used. *G. barbadense.* From long staple group and *G. herbaceum* from short staple cotton species presented better performance under endotoxin eradication treatments.

15. INDUSTRIAL COLLABORATION

The department has strong linkages with the textile and fibre industries including Spinning, Knitting, Denim Jeans, Dyeing/Finishing, Polyester fibre, Jute, Pulp/Paper and Woolen industries and is in regular contact with the research & development sections of almost every major textile/fibre processing industry. The findings of the research work conducted by the teachers and post-graduate students of the department are shared with the industry as well as testing services are also being provided to the various fibrous industries.

The collaboration exists in the following areas;

15.1. Jute Industry

Test house facilities in the department are commercially utilized for the standard specification evaluation of jute bags for the procurement of wheat for the following Jute Mills

- Crescent Jute Products, Jaranwala, Faisalabad.
- Thal Jute Mills, Muzzafargarh
- Amin Fabrics, Kotri
- Madina Jute Mills, Muzzafargarh
- White Pearl Jute Hafizabad
- United Jute Mills Ltd. Sheikhupura
- Suhail Jute Mills, Noshehra

15.2. Cotton Textile Industry

Testing services are being provided for the testing of raw cotton characteristics at the most sophisticated latest version of High Volume Instrument (HVI) for the below mentioned cotton textile industry.

- Hassan Spinning Mills, Faisalabad
- Quality Cotton Corporation, Faisalabad
- Shafi Spinning Ltd., Faisalabad.
- Anjum Textile Mills Ltd., Faisalabad
- Crescent Bahuman Ltd., Hafizabad
- Pak-Kuwait Textile Mills Joharabad
- Nishat Textile Mills Ltd., Faisalabad.

15.3. Federal and Provincial Research Organizations

Evaluation of the fibre characteristics is accomplished for newly evolved cotton strains/varieties as well as paraphernial research samples for the following research organizations.

- Ayub Agricultural Research Institute (AARI), Faisalabad.
- National Institute for Biotechnology & Genetic Engineering (NIBGE), Faisalabad
- Center for Agricultural Biology & Biotechnology (CABB).
- Department of PBG, University of Agriculture, Faisalabad.
- Department of Agronomy, University of Agriculture, Faisalabad

15.4. Government Sector

Services are being provided to the Punjab Food Department for bulk evaluation of gunny bags for the procurement of Wheat

15.5. Student internship

The post-graduate students are sent to the following organizations for internship/research activities

- Crescent Textile Mills Ltd., Faisalabad
- Nishat Textile Mills Ltd., Faisalabad.
- Sargodha Textile Mills Ltd., Faisalabad
- Reliance Textile Mills Ltd., Sheikhupura.
- Ibrahim Fibres Ltd., Faisalabad.
- Masood Textile Mills Ltd., Faisalabad
- Azgard-9, Muzzafargarh
- Crescent Bahuman Ltd., Hafizabad
- Gulshan Spinning Mills Ltd., Sheikhupura.
- Rupali Polyesters, Sheikhupura
- Khawaja Woollen Mills, Gujranwala
- Crescent Jute Mills Ltd., Jaranwala

IRRIGATION AND DRAINAGE

1. Optimal Design of a Subsurface Pipe Drainage System

There can be several combinations of design variables such as drain depth, spacing and diameter that satisfy the design and operational requirements of a subsurface pipe drainage system but each one with different cost. The combination with minimum cost is desirable from economical viewpoint. An optimization model consisting of minimization of total cost as an objective function with constraints was developed to determine the optimal values of the design variables.

The results showed that shallow drains of the smallest available pipe size (4") with closer spacing are cheaper than the deeper drains with wider spacing. The collector consisted of the largest available pipe size (15") as determined by the amount of discharge that had to be drained from the area at an available slope of 0.002. Testing the feasibility of shallow drains with closer spacing in the field was recommended.

2. Impact Assessment of a Subsurface Drainage System in the Fourth Drainage Project of Faisalabad

This project funded by NRAP/IWASRI was conducted in collaboration with the Department of Rural Sociology to study the social impact assessment of a subsurface drainage system. The results showed that water shortage, waterlogging and salinity are the major factors affecting land and crops in the Fourth Drainage Project area. Regarding the impact of drainage system on land, 28% of the respondents said that the system has lowered water table and thereby made the land cultivable.

More than half of the respondents mentioned improved land quality, waterlogging & salinity control and economic conditions of tenants and landless as positive impact of drainage system. The negative impact responded by 10.5% of the respondents was that land has become dry and unable to cultivate due to shortage of irrigation water. Increase in crop production due to drainage system was reported by more than three quarters of the respondents. Positive impact of drainage system was also observed on income level, health, property/house and number of animals in Fourth Drainage Project area.

3. Development and Performance Evaluation of Orchard Water Spraying System (Rain Gun) to Modify Aerial Environment

Among various reasons for low yield of citrus, dropping of immature citrus fruits due to abrupt rise of temperature during May and June is the most significant reason. It was reported that application of water upon citrus trees in the form of spray during hot season could improve its flavor and size. This study included development of nozzles of circular, rectangular, double rectangular and triangular shaped outlets manufactured locally and their performance evaluation to select the most appropriate nozzle to spray water aerially on citrus trees. The study concluded that circular nozzle is better than the rest of the three nozzles in respect of discharge, effective area, application rate, coefficient of uniformity and distribution uniformity. Guidelines were provided to the farmers regarding the amount of water they should spray to bring the temperature down to the desired level.

4. Comparative Performance of Sealing Materials to Reduce the Infiltration in Farm Earthen Storage Reservoir

The construction of lined reservoirs at farm is an expensive option. On the other hand, earthen reservoirs face problems of excessive seepage. In order to overcome seepage problems and to prolong the utility of

stored water, a number of surface sealing materials and techniques were tested and evaluated for infiltration against the unlined water reservoirs.

Mixture of lime with brick dust, mixture of bentonite with base soil, mixture of wheat straw with base Soil, puddling of bottom of unlined reservoir, sealing the bottom with polyethylene sheet were tested. The minimum infiltration rate was found in case of materials 1 and 2 as compared to all other options tested. However, bentonite showed poor stability against standing water. Mixture of lime with brick dust and the mixture of wheat straw with soil had higher stability characteristics. Therefore, mixture of lime with brick dust was recommended as the most appropriate lining material for economical earthen water storage reservoirs.

5. Evaluation of Alternate Furrow Irrigation for Cotton

The study was conducted on a cotton crop sown on furrows. Cultural practices except irrigation techniques were kept the same for different treatments. Irrigation water was applied to each furrow, every other furrow alternately and every other furrow continuously through out the irrigation season. Total quantity of water applied, water use efficiency, requirement efficiency and application efficiency were determined and cost analysis was carried out

The results showed that alternate furrow irrigation required 41 to 46% less water as compared to every furrow irrigation. Yield obtained under alternate furrow irrigation was more than that obtained under every furrow irrigation by 44.4 kg/ha. Water use, water application and water requirement efficiencies were improved under alternate furrow irrigation. Cost analysis indicated a profit/saving of Rs. 2040/ha for alternate furrow irrigation as compared to every furrow irrigation.

6. Evaluation of Irrigation and Planting Practices for Continuous Use of Sub-surface Drainage Water

Various water management practices were developed to use poor quality water for irrigation. Three such practices are irrigation at 50% depletion of available water, irrigation with 25% leaching fraction of 0.2 combined with bed and plain planting. Sub-surface drainage water was applied continuously for three years to grow wheat in rotation with maize in the area of Fourth Drainage project with the collaboration of IWASRI & UAF.

Crop parameters such as grain yield, straw yield, number of tillers and plant height at harvesting were measured. Wheat crop was more sensitive to drainage water at the grain formation stage and the maize crop was more sensitive to drainage water at its germination stage. Comparing the planting practices, the reduction in average grain yield of wheat was higher under bed planting (12%) as compared to planting on flat (10.5%). Frequent irrigation (25%) with drainage water performed better to suppress salinity effects than other two management practices.

7. Feasibility Study of using Raingun Sprinkler System under Irrigated Areas

A study was conducted on wheat crop at Postgraduate Agricultural Research Station (PARS) to compare the performance of raingun sprinkler and conventional border irrigation system under farmers field conditions. Water saving and crop yield were used as parameters for making comparison of two systems. The raingun sprinkler system was found superior to border irrigation in respect of water saving.

The crop yields under raingun sprinkler was found to be 27% higher as compared to that obtained under border irrigation method. Water saving to the tune of 41 % was achieved under the raingun sprinkler system. An economic analysis of raingun sprinkler system gave the benefit cost ratio of 1.74: 1, thus confirming the feasibility of the sprinkler system under irrigated area.

8. Impact of Management Practices in Reuse of Subsurface Drainage Water

A study on the reuse of drainage water for crop production was conducted in Faisalabad Fourth Drainage Project (FDP) with the collaboration of International Waterlogging and Salinity Research Institute (IWASRI) and this. Three irrigation practices (irrigations at 50% and 25% depletion levels and irrigation with leaching fraction of 0.2 combined with two planting practices (bed and plain) were tested for irrigating wheat crop with sub surface drainage water. Irrigation with canal water at 50% depletion was used as control practice.

Crop parameters such as grain yield, straw yield, number of tillers and plant height at harvesting were measured. Before and after growing season, composite soil samples taken from 0-15, 15-30, 30-60, 60-90 and 90-120 cm depths were analyzed for pH, TSS, soluble Cation, Soluble Anoin, SAR and ESP.

In case of using drainage water, a reduction of 11 to 12.5% was observed in grain yield. The soluble Na, SAR and ESP values of the soil after wheat harvesting increased significantly. Planting practices, however, did not show any significant effect on the various soil chemical properties except TSS, which was relatively less under bed planting than plain planting.

9. Simulation of Irrigation Scheduling for Improving Wheat Yields in Canal Command Areas

Based upon field experimental data, a simulation model was developed that relates water use and crop yield. To represent plant water uptake, a sink term was used in the model. Considering crop parameters, soil physical properties and climatic conditions, the model predicted daily moisture contents of five layers in the soil profile of 120 cm depth. The model also predicted grain yield at the end of crop growing season. After calibration, the model was used to predict the irrigation schedule for obtaining maximum yield in cana1 command areas.

10. Comparative Performance of Precisely Leveled Basin and Border Systems of Irrigation

Performance of basin irrigation system was compared with that of level border irrigation system using the time required to irrigate, crop yield and volume of earth movement for land leveling as performance parameters. The study was carried out on farmer's field with a sandy loam soil in Shahkot Project area for 3 Years. With the given flow rate ranging from 2 to 3 cfs (53-85 lps), the level border irrigation used about 8 to 22 minutes per plot more time to irrigate than that needed under basin irrigation system. The average increase of time to irrigate border was observed to be about 42 %, which was mainly associated with the greater advance distance encountered in the borders. The yield of wheat crop from both the systems remained comparable. The study concluded that with the given criteria of irrigation, flow rate and soil texture, the basin irrigation performance was appreciably better than the border irrigation.

11. Evaluation of Parameters Constraining Irrigation Warabandi System in Pakistan

Diagnostic investigations of problems faced by the Warabandi system and its implications on irrigation practices in Pakistan were made. Two watercourses of Shahkot Distributary Command were studied. The inequity in water distribution at tertiary level was found up to 33 %. About 58 to 83% share holders of both the watercourses accomplished irrigation with trading practices. On an average; only 1/5th portion of the land holding could be irrigated in a given turn indicating inadequacy of irrigation turn time. The study suggested a turn cycle of 14 days instead of 10.5 or 7 days to reduce the problems of water trading practices and inadequacy of turn time.

12. Equitable Water Distribution Allocation Model for Watercourse Command

To overcome the inequity problem, a water allocation model based on volume of water per unit area is proposed. The model considers the conveyance losses and actual filling & draining allowances observed in the watercourses (WC). The model allocated a uniform volume of 3113 ft3/ac to all the farms of WC 120620-R against the existing allocation of 3553 ft/ac at the head to 2374 ft^3/ac at the tail. At WC 1301l8-L command, the model allocated 3410 ft^3/ac uniformly to all the farms against existing allocation of 3839 ft3/ac at the head to 2730 ft^3/ac at the tail.

Accordingly with the time-based allocation, the model provided 22.4 min/ac at the head to 31.6 min/ac at the tail against a uniform sanctioned time of 25.5 min/ac on WC 120620-R. At WC 1301 18-L, the model allocated time varying from 24.5 min/ac at the head to 34.4 min/ac at the tail against uniform sanctioned time of 27.6 min/ac. This study concluded that the proposed model can successfully predict equitable water allocation at a given watercourse command provided insitu quantitative assessment of water losses and, filling and draining time is available.

13. Post Lining Performance Assessment of Irrigation System at Canal Command Level

Five irrigation channels lined under command water management project were selected for performance assessment in terms of adequacy, equity and seepage losses. The discharge observations were made at key points along the distributaries/ minors as well as in the watercourses off shooting from these distributaries/minors. Modified Inter-Quartile Ratio (MIQR), Delivery Performance Ratio (DPR) and seepage losses were used as performance parameters.

The results indicated that the system management was unable to maintain the adequate flow at key monitoring points along the Niazbeg distributary. The comparison of observed and designed flow rates along the Sialkot distributary, 2L/3R and IR/3R minors depicted that the observed flow rates were very close to the designed ones with the shortage of 14-17 % at tail reaches.

The computed MIQR showed that inequity did exist to varying degree in the distributaries/minors studied. However, about 80 to 100% of the command area received equal or greater than the designed supply except the Niazbeg distributary where MIQR was 35%. The study of DPR of outlets depicted that there were variations in discharge among various watercourses. A substantial amount of water (0.11-7.34 cusecs per million square feet of wetted area) had been saved by canal lining. However, the saved water was not equitably distributed among the watercourses.

14. Impact of Precision Land Leveling on Irrigation Efficiencies and Crop Production

Precision land leveling is the process of smoothing the land surface within ±2cm of its average elevation. It creates a favorable environment by having a uniform moisture distribution in the seed bed. A study was conducted to develop strategies to increase water use efficiency through precision leveling. Two adjoining irrigation bunded units of 0.18 hectare each 30m x 60 m were selected. One of the fields was left as such to represent a traditionally leveled field while the other was precisely leveled within ±2 cm of its average elevation. Average application and distribution efficiencies of TL field were less by 3 and 9.7% as compared with PL field.

15. Performance Assessment and Comparison Of Synthetic and Granular Envelops Using One Dimensional Permeameter

Considering the important role of envelops for the efficient performance of sub-surface drainage system about 6 synthetic and 3 granular envelope materials were tested in the laboratory using base soil from the 4th Drainage Project, Faisalabad. The performance parameters included hydraulic conductivity and discharge through the envelopes. The hydraulic conductivity of geo-textile generally decreased with the increase in total gradient. For gravel, it remained almost unchanged and only slightly increased with the

increase of total gradient. This synthetic envelope material satisfied the filter criteria but showed a relatively poor performance in hydraulic conductivity as compared to granular materials.

16. Evaluation of Irrigation System Performance and Abiana Assessment and Collection Procedures

This study was conducted on Sialwala minor, which off-takes from Dijkot distributary. This selected minor was found to operate at about 30% efficiency. The distribution pattern along the length of minor was also studied. The head moghas were drawing relatively more water than their due share. The tail watercourses were also drawing more water than their due share, but the increase over and above the authorized discharge in case of tail outlets were less as compared to the head outlets. Evaluation of abiana assessment and collection procedure indicated that the abiana assessed was usually collected at the end of the year, however, under booking was a common source of leakage. High delta crops were also looked as low delta crops.

Based on this data it was recommended that flat rate of abiana based on acreage owned could help in reducing the leakage in the abiana assessment and collection procedure. It will also promote effective use of water by the farmers.

17. Evaluation of Irrigation System Rehabilitation Project

The irrigation system rehabilitation project-II (ISRP-II) was carried out on three-canal subsystem (Killian wala, Venoi and 11-L Pakpattan) in Punjab. Under this project the main distributaries were completely desilted and rehabilitated minors lined and banks strengthened. It was done to ensure equitable distribution of water along the entire length of the distributaries. Evaluation of this project indicated that situation of water equity improved but not to the anticipated targets. The head reach mogha were still found to be drawing 2 to 3 time more water than the due share while the tail reach moghas were drawing less water than their authorized share. Tampering of moghas to get more water was found to be the main problem contributing to inequity of water distribution. Cropping intensity and crop yield did increase as anticipated with the improvement of water supply through this project. Initiation of improved water management extension program was recommended. This could help providing the efficient use of increased water supplies which was imperative to get the anticipated increase in the crop yields and cropping intensities in command areas of the selected canal sub systems.

18. Development of Single Gun Sprinkler Irrigation System

Water scarcity particularly at the tail reaches of the watercourse commands can be partially overcome by using the available canal water supplies more efficiently. The Single Gun Sprinkler System which is operated through a portable pumping system and storage tank is capable of improving water application efficiency to 85 percent as compared to 60 percent achieved in the gravity irrigation system. This system has the potential to improve crop production by about 25 percent.

19. Development of a Double throated Flume (DTF)

It is a versatile addition to the family of water measuring devices used in open channel. The DTF is particularly adopted to the lined rectangular channels where other devices face the problems of remodeling of watercourse cross section, undesirable borrowing of soil to install the flume and subsequent addition of sediments to water when flume is removed. In fact, DTF can be installed & used much more efficiently in lined rectangular channels as compared to other flumes.

20. Diagnostic Analysis of Warabandi System

The existing irrigation Warabandi system that was developed about a century ago has a number of design and operational problems that constrain the efficient use of irrigation water for improving crop production. These problems include inequity of distribution, trading practices, inadequacy of water supply and sufficient turn time. An equitable distribution model developed in the study enabled the farmers of a watercourse command to benefit equally from irrigation water and minimize trading practices. Implementation of updated rules of Warabandi can improve irrigation practices leading to increasing crop production.

21. Performance Evaluation of Imported and Locally Manufactured Emitters

The performance of locally manufactured emitters was compared with the imported emitters at 63, 84, 105, 126 and 147 Kpa. The discharge of the two local and one imported emitters was found to be 2.7, 6.5 and 3.84 lph respectively at standard pressure of 105 kpa fulfilling the required criteria. The results revealed that the locally manufactured emitters fulfilled the standard criteria of fitness and were considered good for use in drip irrigation system. The advantage of locally manufactured emitters was that they were 10 % cheaper than the imported ones.

22. Determination of Optimal Dimensions for Level Borders under Different Flow Rate and Soil Type Conditions

The layout and size of the fields are an important part of efficient water management. This study was conducted at the Postgraduate Agricultural Research Station (PARS), Faisalabad to determine the optimal dimensions of level border under different flow rates and soil types. It was found that for sandy clay loam, the optimum length of level border is 60 meter for a flow rate of 3lps/meter width. Under clayey soils, the optimum length should be 90 meter for the same discharge.

23. Development of Nomographs for the Cost Calculation of Tubewell Components and Their Economical Selection

Groundwater is a major source of supplemental irrigation in Pakistan. It has to be lifted at a certain cost. The analytical methods employed for cost estimation are very complex while estimating cost alternatives available, cannot be evaluated due to the lack of proper mathematical tools. In view of this deficiency, this study was undertaken to develop nomographs, which could facilitate cost estimation of tubewell components and to test various combinations of tubewell components and the optimal one. The most economical combination of tubewell components consisted of PVC strainer, PVC suction and blind pipe, M.S delivery pipe, locally manufactured pump and electric motors as a prime movers.

24. Optimizing the Water Resources of an Agricultural Farm- A case study

Efficient and timely application of irrigation water ensures higher yield of crops per unit area whereas inefficient application of water reduces the yield and also creates the problem of waterlogging. This research work was done to study the water availability and requirements at PARS, Faisalabad to suggest an optimal cropping pattern for making effective use of available irrigation supplies. It was found that the irrigation supplies were more than the actual consumptive use requirements both in Kharif & Rabi seasons. Furthermore, the cropping intensity at the farms of different departments could be increased by adopting optimal cropping pattern.

25. Design, Development and Calibration of Double Throated Flume (DTF) for Rectangular Lined Channels

At present, a number of flow measuring devices such as Parshall Flume, Cut-Throat Flume and Broadcasoted Weir flume are available for flow measurement in the watercourses. These flumes, when

used in lined watercourses impose problems of leakage, watercourse cross-section alteration and dumping of soil into watercourse for blocking around the flume. The Double Throated Flume overcomes these problems when used in the lined watercourses. The DTF has been tested and calibrated for flow range of 31 to 127 lps approximately and throat width of 4 to 20 cm. The flume has shown a satisfactory performance with correlation coefficient of 0.97, which is reasonably good to measure flow rate accurately.

26. Diagnostic Analysis of Lower Pumping Efficiencies in SCARP Tubewells

In view of poor performance of SCARP tubewells, a limited number of tubewells were tested and their performance was studied by measuring their specific capacity and discharge. Tubewell discharge was measured by plate orifice method and static and pumping water level at the tubewells was also measured to get the drawdown for calculating specific capacity. The specific capacity and percentage discharge, reduction was regressed as a function of tubewells lifts. It was found that the tubewell life has significant, effect on the percentage discharge reduction and specific capacity.

27. Optimal Field Design and Watercourse Layout for a Watercourse Command Area

An optimization linear model was developed for a selected farm in watercourse command area of Sargodha district to demonstrate methodology for developing optimal border design and watercourse layout system. Low conveyance and application efficiencies observed in the field suggested that the field design and watercourse layout must be improved to utilize the available water resources most efficiently. The developed model considered profit maximization with constraints related to available water resources, farm power, area under watercourses, area under bunds, and water losses. The optimum size of border was found to be 10m wide and 200 meters long with a significant reduction in length of watercourses. The optimal design improved the profit by 13 percent over the existing field size and watercourse layout system.

28. Impact of Watercourse Improvement on the Operational Analysis of Watercourse

Operational analysis of the watercourse losses were studied on a watercourse No. 52810-L located at Shahkot distributory. The conveyance losses were found 41% comprising 19.5% on main watercourse and 21.5% on farmer’s branches. On improvement of only main watercourse, the loss in the main watercourse was found reduced from 19.5% to 9.75% but in the unimproved farmers' branches, the loss was increased from 21.5% to 24.5%. After improvement of total system a saving of 50% was found. The component of deep percolation was not affected much, which was 10% before any improvement and 7.26% after improvement of complete watercourse system. The study suggested the renovation of complete watercourse system including main as well as farmer’s branches to have the anticipated benefits of the program.

29. Use of Polyethylene Film for Lining Watercourses

The concrete and bricks, when used for watercourse lining were not completely impervious and some seepage losses occurred. Provision of some impermeable layer like polyethylene sheet beneath some protective cover can guarantee complete check to the seepage losses for many years at a relatively very low initial investment. Trapezoidal watercourse with 7.6 cm thick layer of bricks as a protective cover laid over the plastic film was 54 percent cheaper and gave complete seepage control as compared to the conventional lining (Double brick lining in rectangular design). The polyethylene film when used for lining with tiles as a protective cover was found cheaper, durable and highly impermeable fulfilling all the requirements of good lining.

30. Development of Sliding Slab Nakka for Watercourses

'Pakka Nakkas' help reducing seepage losses on the bifurcations as well as facilitate water diversion into the branch watercourses. Round pannel 'Nakka' usually installed on the improved watercourses under the OFWM projects have been found to exhibit certain problems with the passage of time reducing the effectiveness of these structure. Sliding slab "Nakka" developed at the University of Agriculture, Faisalabad has shown great potential to over come the problems associated with the Round Pannel 'Nakkas'.

31. Brick Masonry Watercourse Lining in Trapezoidal Design - A Low Cost Alternative for Pakistan

Watercourse lining technique in trapezoidal design using 11.5 cm thick brick masonry walls, 7.6 cm thick bed and plastered from inside was developed which was found to be about 38% less costly as compared to conventional lining technique. A technique was also developed for bank compaction and section preparation in trapezoidal design using metallic template. Water savings in case of single brick lining technique was found to be 80% as compared to the conventional lining technique where water savings was 96%. However, this low cost lining technique enjoys an equal effective life of 20 years as compared to conventional lining technique. This durability with 80% water saving of the original loss made this low cost lining most economical, feasible and effective technique for Pakistan.

32. Scheduling Irrigation in Cotton Through Simulation Modeling

Field experiments were used to develop optimum irrigation schedules for cotton crop, which result in maximum transpiration and minimum percolation losses. A physical based model, SWAP was used to evaluate the impact *of* different timings and amounts *of* irrigation on the Water Management Response Indicators (WMRIs) such as relative transpiration (Tr), scheduling efficiency (Seff), evapotranspiration efficiency (ETeff) and percolation index (PI). The model was first calibrated to optimize soil hydraulic parameters *of* experimental site. For this purpose, soil moisture contents were measured with the help of Time Domain Reflectometry (TDR) at different depths from soil surface and compared with simulated soil moisture contents. The calibrated model was used to simulate the effect of eighteen different combinations of timings and amounts of irrigation on the WMRIs. The simulations revealed that after pre-sowing irrigation of 8 cm, three subsequent irrigations (5cm each) and then two irrigations (7cm each) with an interval of four weeks are enough. For this irrigation schedule, Tr, Seff and percolation losses were 96%,98% and 2.75cm respectively with total irrigation depth of 29cm.

33. Regional Estimation of Evaporation using Remote Sensing Data

The evaporation of water from soil and plant surfaces is an important parameter of the hydrological cycle. Evaporation can be calculated indirectly from the surface temperature by means of energy balance approach. The energy balance approach involves the partition of available energy into sensible and latent heat. The remote sensing data in the thermal infrared spectrum can be used to determine surface temperature and this information by incorporating in various models can be used to estimate regional level evapotranspiration. In this study, a simple methodology was developed to estimate the sensible and latent heat fluxes using remotely sensed data from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). The various components of surface energy balance were computed during satellite overpass and 24h integrated fluxes were derived for the full ASTER scene acquired over the lower Rechna Doab region of the Indus Basin on 04-10-2000. The surface brightness temperatures were derived from the thermal band 13 and the Normalized Difference Vegetation Index (NDVI) from two VNIR bands of the ASTER. The aerodynamic resistance (ra) required to estimate sensible heath flux is computed using a semi-empirical expression. The evaporation in the region covered by the scene was found to be varied from 0 to 4.25 mm/day with highest from the river water surface and lowest from the bare soil.

34. Modeling Soil Water and Chemical Transport Processes to Improve Water Use Efficiency Using GLEAMS Model

The availability of irrigation water and rainfall both determine the timely use of the soil water to fulfill the crop water requirements. The non-productive evaporation and drainage losses, however, need to be minimized for better crop productivity. Water deficits spans may synchronize the least sensitive growth stages of the crops to water stress. For this purpose, the temporal details of the soil water status in the root zone and water requirements of the crops need to be studied. The calibrated and validated computer model such as GLEAM provided such data to improve the, irrigation and fertilizer management techniques. Therefore, this study was designed to calibrate and validate the GLEAMS model to improve water use efficiency with the following specific objectives: (a) Calibrate and validate the GLFAMS model using lysimeter data on soil water, soil nitrate concentrations and crop yield from 1993 to 1995. (b) Simulate daily values of the soil water and nitrate-nitrogen concentration in the soil profile, and crop water requirements during the growing season (c) Identify the soil water deficit spans in relation to least sensitive vegetative growth stages during the growing season to improve the water use efficiency.

35. Sustaining Crop and Water Productivity in the Irrigated R ice-Wheat System of the Pakistan's Punjab

This is an ADB funded research project led by IWMI and is coordinated by national organizations of PARC, OFWM and UAF in addition to international organizations of IRRI, Cymmet and IWMI. The following field studies were carried out on 4 selected watercourse commands in Rechna Doab.

Testing of Resource Conservation Technology (RCT) including zero tillage, bed planting and laser leveling for rice and wheat crop.

Water balance assessment of surface water and rainfall contribution to irrigated crops under rice-wheat system as supported by field experiments and socio-economic surveys. The study has concluded that there was a net recharge during rice crop and net withdrawal/pumping during wheat season indicating over irrigation of rice crop. The groundwater was found to contribute 70-75 percent of water requirements, canal water as 16 percent and rainfall less than 10 percent.

36. Contribution of Irrigation Conveyance System Components to the Recharge Potential in Rechna Doab under Lined and Unlined Options

Groundwater data had been collected through observation wells installed across main canal, distributary and watercourse to assess recharge from various components of irrigation system by using modeling approach. The focal idea of the study was to assess the effect of lining of watercourses and distributaries on the recharge to the groundwater. Two models - MODFLOW and GLEAMS, were used to predict recharge from the irrigation system components and irrigation return flow from applied irrigations to crops, respectively. The effects of lining of watercourses on recharge contribution have also been evaluated. One Ph.D student of the department was engaged to carry out the study with funding from NDP.

37. Water Table Response to the Operation of Pipe Drainage System

To protect against failure of the pipe drainage systems, successful operation and maintenance of pumping facilities along with other operational components must be guaranteed. The water table response to the pumping operation becomes one of the indicators of performance evaluation of the pipe drainage system. The drain discharge data collected by M&E organization WAPDA were compared to the data collected by the Fourth Drainage Project. The comparison showed a great discrepancy among the observed discharge values. The water table response in the drainage activities in various sump areas observed through piezometers were plotted against the drain discharge data. It was observed that inspite

of lowest operational time of pumps (49%) the sump area of S1A maintained its water table below design depth. The sump system at SIB areas did not operate to its potential during observation period and water table was mostly remained above design depth of 1.22m. At SID area the drainage system operated more effectively (81 % operational period) maintaining water table below desired level.

38. Remodeling of On-Farm Surface Irrigation System at Watercourse Command for Improving Irrigation Efficiency

The results of this study showed that the pipe-lining technology of lining watercourses is very efficient in terms of water conveyance and silt transport in the water course system. The reach time of water from canal outlet to the farm gate was found to reduce from 35 minutes to 9 minutes over a distance of 640 meters. The cost per linear meter has been found to be 602 Rupees as compare to 613 Rupees in case of brick lining.

The conveyance efficiency was increased from 64% before lining to 98% after lining. Laying of pre-cast concrete pipes was quite faster than brick construction at the site. Therefore, the technology has been found to be useful and efficient in terms of reduced time of construction and therefore it was recommended for watercourse commands where topographic slope of more then 0.05% is available.

39. Use of Industrial Sludge for Crop Production and its Impact on Drainage Water Quality

Lysimeter study was conducted to investigate mineral property of sludge material in soil matrix for drainage water quality and ground water contamination. The experiments were conducted in a "Physical Drainage Model" available on the experimental area of Department of Irrigation and Drainage. Experiment conducted for potato indicated the FYM gave higher yield than Sludge, whereas combination of sludge, FYM and NPK gave considerably higher yield than the control and sludge treatments. The result revealed that sludge application suppressed the potato yield. The suppressing effect was less when it was applied in combination with FYM and NPK.

Regarding drainage water quality and groundwater quality, results showed that in subsoil water samples the rate of release of sludge elements in soil matrix had similar trend as of FYM, whereas, a little higher concentration of Na necessitates to be more careful in the use of sludge material.

WATER MANAGEMENT RESEARCH CENTRE

1. CROP PRODUCTION AS AFFECTED BY IRRIGATION METHODS, RACTICES AND DEPTH OP GROUND WATER

1.1. Effect of bed width and fertilizer level on yield of wheat crop.

In this regard, a furrow-bed sowing technique in combination with appropriate level of fertilizer was adopted. A comparison of flat sowing technique was made with furrow-bed sowing technique with different bed widths of 60, 80 and 100 cm and furrow width of 23 cm between each pair of beds. The results of this study indicated that the combination of 80 cm bed-width with 112.5 kg nitrogen/ha gave the highest wheat yield of all other combinations. The interactions also showed that flat sowing with control fertilizer gave the lowest yield of all. Higher soil bulk density (1.4 g/cm^3) and lower root/shoot weight were observed with flat sowing as compared with furrow-bed sowing method. It has been observed that soil bulk density level of 1.27 g/cm^3 and above is detrimental to crop root. A low Oxygen Diffusion Rate has been observed in an area of high soil bulk density and a flat sowing technique can provide an environment of temporary suffocation in flood irrigation method. It was further observed that average saving of water with 60, 80 and 100 cm bed width was 37, 45 and 50 percent respectively compared with flat sowing. Less growth of weeds was observed in furrow-bed sowing method than flat sowing technique.

1.2. Effect of water management on yield of rice

The water management and cultural practices for sowing of rice appear to be very important to get more yield with lower application of irrigation water. For this purpose, an experiment to examine the, effect of irrigation water application after 4^days and 8 days time intervals with varying depth of irrigation water (10, 7<5 and 5 cm) instead of growing paddy in a continuous standing water was conducted. It was found that on overall basis, application of water after 4 days gave significantly higher yield (3335 kg/ha) compared with 8 days irrigation interval (2167 kg/ha). The interactions between the interval and depth of irrigation gave the lowest yield of all. It was also observed that 4 days time interval with 7.5 cm depth of irrigation proved-to *be* the best combination in time interval and irrigation depth combinations. The lower yield with 10 cm irrigation depth may be due to depletion of soil nutrients while 5 cm depth of irrigation water after 4 days may not meet the crop requirements. Some studies have shown not much difference between yield of rice if grown in continuous standing water or irrigation water applied at field capacity. It has also been observed that in growing of rice in a continuous standing water. The suspension of irrigation water 14-17 days prior to paddy harvesting does not diminish crop yield.

1.3. Economic combination of irrigation and fertilizer levels to obtain maximum yield of sugarcane

An experiment was conducted to find a suitable combination of irrigation water and fertilizer level to obtain a high yield of Sugarcane in Shahkot area. In this study 10, 12 and 14 irrigations (100 mm each) levels were combined with 0, 125, 1H8 and 250 kg/ha nitrogen level. The interactions between irrigation and fertilizer levels indicated that the application of 188 kg N/ha with 12 irrigations (1200 mm) was the best combination for getting maximum cane yield under existing conditions in the project area. It has been generally observed that in a clayey loam soil, 12-16 irrigations gave average to maximum cane yield. Thus 12 irrigations in combination with 188 kg N/ha in a high water table **area** like Shahkot can meet the crop requirements. Further, the higher irrigation level may cause the depletion of soil nutrients which may adversely affect the crop yield.

2. UTILIZING SALINE WATER FOR THE PRODUCTION OF SALT TOLERANT CROPS.

2.1. Low cost reclamation technology for salt affected soils

The results from the series of farm-level experiments revealed that soil application of gypsum alone or in combination with sub soiling proved statistically better than the other treatments (sub soiling and the control) for soil and crop yield improvements on the Gandhra series which is a member of the fine loamy mixed hyperthermic family of Malic Comborthids. The same was true for the physico-chemical amelioration of the Khurrianwala series which is a member of coarse loamy, mixed hyperthermic family of Typic Halorthids-but that for crop production, all the treatments fared well by the end of the fifth wheat crop. Rice proved to be a better crop for reclamation due to its drainable surplus water and soils like Khurrianwala soil series can be made productive within 2-3 cropping seasons with moderate soil water and crop management, while sub soiling + gypsum or gypsum alone with rice-wheat rotation can make soil like Gandhra soil series fit for growing a variety of crops within 4-6 cropping seasons.

2.2. Potential for using brackish groundwater for crop production

In this study, saline-sodic groundwater (TSS = 16.3 me/I, SAR 9.3; RSC = 7.1 me/I) was made to pass through 183 m long water course lined with gypsum stones of various sizes (10-20 kg). This amended water was applied on control (Gandhra saline-sodic loamy clay to sandy clay soil ECe = 12.1 DS-m-1, ESP = 71.4), sub-soiled, gypsum treated (75% GR) and sub-soiled gypsum treated plots in a field trial of permanent layout to see its effect on rice-wheat rotated crops over a period of five years. Water quality of saline-sodic groundwater was monitored by analyzing samples of unamended and amended tubewell water taken during the growth period of crops and it was noted that TSS were decreased from 16.5 to 12.0 me-I-1, SAR from 9.3 to 6.0 (m.moles-I-1)1/2 and gypsum in wheat gave higher yield than sub-soiling and amended water. Gypsum and gypsum + sub-soiling was equally effective in lowering the ESP value near 15 with 1 rice + 2 wheat crops, while in case of amended water the ESP was reduced from 71.4 to 15.8 with 8 crops (4 wheat + 4 rice) indicating that gypsum stone method was a relatively slow process for reclaiming a highly saline-sodic soil like the Gandhra.

2.3. Quick reclamation technology for salt

In reclamation trial using gypsum (100% GR) and HC1, H2SO< and CaCia all added at 75% GR, it was found that gypsum at 100% GR gave best results, both for crop yield and soil reclamation.

2.4. Reclamation through fertilizer action

In this soil reclamation experiment Ca- containing nitrogenous (Ca (N03)2, Ca = 43%) and phosphatic fertilizer (SPP) (Ca = 46%) were applied to the soil with the idea, that poor farmers could benefit from fertilizers instead of using costly chemical amendments. The data for 9 crops (5 wheat + 4 rice) showed that $Ca(N0_3)_2$ and SSP gave the highest yield .during reclamation trial on Gandhra saline sodic soil. The ESP of the soil was decreased from 70.8 to 30.8 with SSP + Urea and from 77.6 to 31.1 with $Ca(NO_3)_2$ + TSP indicating and additional help for reclaiming the soil. There was also a considerable effect of Ca ion coming from the ground water, applied in the reclamation of saline sodic soil. It was concluded that farmers who could not afford costly amendments to reclaim saline-sodic soils could use Ca-containing N and P fertilizer.

3. IMPROVED METHODS FOR REHABILITATING WATERCOURSES

3.1. Water control structures

The most important achievement has been the development of "The Sliding Slab Nakka" for the water courses. This newly designed 'Nakka' is simple in construction, convenient in operation, and cheaper in

cost by about 30% as compared to the 'Nakka' of the round Pannel Type currently installed on the improved watercourses. Furthermore, there is leas chance of chipping and breakage occurring in the structure of the new type, ensuring effective life for it.

3.2. Watercourse lining techniques

The research results of studies in respect of low cost techniques for watercourse lining revealed that watercourse lining in trapezoidal design using a single brick masonry layer (7.5 cm thick), underlain by a polyethylene film, is 50 percent less costly as compared to the traditional lining technique in rectangular design with 22.5 cm thick walls. Secondly, this design of the watercourse has been found to have about 12 percent higher hydraulic efficiency (accommodating more discharge for a given wetted perimeter). Thirdly, since the sides of this trapezoidal section are subjected to relatively less earth pressure, it provides added stability to the design. Lastly, it is found to be more labour intensive than capital intensive. However, apart from this, the technique needs to limit the top width of the watercourse to 68 cm using a side slope of 1:3, otherwise the cattle are likely to damage it.

A low cost technique for lining the watercourse in rectangular design has also been developed. In this case, 11.5 cm thick brick masonry walls are built provided with 22.5 cm x 22.5 cm thick brick masonry column^ after every three meters and plastered from inside. The bed is also lined with a single brick (7.5 cm). Watercourses lined by this technique have been found equally effective in reducing seepage loss, quite durable and about 40 percent less costly as compared to the traditional lining technique. The applicability of this type of lining technique, is however, limited to the wall height up to 45 cm only.

4. OPTIMIZING THE EFFECTIVENESS OF THE ON FARM WATER APPLICATION TECHNIQUES UNDER TRADITIONAL AND IMPROVED WATER MANAGEMENT CONDITIONS

4.1. Precision land levelling

In order to determine the extent of grade that can be safely provided to the irrigated fields without affecting the water intake uniformity and yield of crops, fields with different grades, ranging from zero to 0.3%, were evaluated under different types of soils. It was found that fields planed on grades up to 0.1% on heavy soils and up to 0.2% slope on light soils yielded as good results as fields with zero grade .without reducing the water intake uniformity. This reduced the cost of levelling by 50 to 60% depending upon the slope.

4.2. Irrigation techniques

Different irrigation techniques were also optimized for getting good crop yields at maximum irrigation efficiency. The border, furrow-ridge and furrows-bed irrigation methods were compared for maize crop. Furrow-bed method gave very encouraging results for water saving and higher crop yields. A saving of 20 to 25% water was found through the use of this method. In addition, it also eliminated the chances of crop submergence during early monsoon rains by providing adequate drainage at field level and reduced the effect of high salinity on germination by pushing the salts out of the rootzone to the centre of the bed. This practice has ultimately resulted in 12 percent increase in the crop yield at an additional expenditure of Rs. 220 per acre at the prices of 1983-84. However, it has been observed that despite the immense usefulness of this method it is not being adopted by the farmers probably on account of the non-availability of the needed improved implements.

5. IMPACT OP IMPROVED WATER MANAGEMENT TECHNOLOGIES ON SURFACE AND SUB-SURFACE HYDROLOGY AND SALT BALANCES OF WATERCOURSE COMMAND AREAS

5.1. Water budget

Water budget studies were initiated to examine the impact of various improved water management techniques on the surface and sub-surface hydrology of the two watercourse command areas. The data collected so far have indicated that contributed to the ground water was only 8-105, while the remaining portion was either- evaporated or evapotranspired back to the atmosphere through wanted and unwanted vegetation. It was further observed that inspite of the general stabilization of depth of subsoil water by the SCARP tubewells, .the ground water table rose by 30-60 cm on account of infiltration from monsoon rainfall every year. Thus, precipitation was found to be the major contributing factor for raising water table due to lack of surface drainage facilities. This caused great damage to the 'Kharif' crops (maize ad cotton) resulting in the accentuation of the already imbalanced 'Kharif': 'Rabi' cropping intensity ratio of 1:1.38. The provision of network of field drainage system to take care of monsoon surface run off and the drainable surplus would help considerably in maintaining the ground water table at a safe depth. The situation can further be improved through encouraging installation of fractional tubewells at the farm level to draw water tables down to lower levels.

5.2. Operational irrigation evaluations

Operational irrigation evaluations were also carried out before and after applying improved water management technologies. It was found that the main water-course on an average lost almost the same quantity of water as the farmer's branches. Improvement of the .main watercourse alone, resulted in a saving of 8 to 12 percent water which subsequently increased losses in the unimproved farmers' branches by about two to three percent. Thus the overall increase in water supply affected through the improvement of main watercourse has been found to be only six to nine percent. However, the improvement of the entire watercourse system (main watercourse and farmers' branches) has shown a reduction of conveyance losses to the extent of 50%, increasing thereby the conveyance efficiency from 60% to 80%. This clearly indicates the necessity of improving the entire watercourse system including the main as well as the farmers* branches for capturing the potential benefits of the improved technology.

5.3. Watercourse cleaning and maintenance

A study was conducted to determine the effect of poor cleaning and maintenance on the rate of deterioration of improved watercourses so as to document the benefits of improvement over time. The data revealed that after two years, the improved watercourse, sections which were not periodically cleaned and maintained were found losing almost the same quantity of water as prior to their improvement.

5.4. Salt balance

The salt balance studies carried out in the command area of the tow watercourses (375.20 hectares) revealed that on an average about 162 tonnes of salts through canal irrigation supplies and 1213 tons through SCARP tubewell water were found added annually in the crop root zone. In addition, about 122 tons were estimated to be accumulated in the root zone due to capillary rise during dry period. The removal of salts from the root zone was estimated as 88 tons by the crops, 398 tons by leaching through precipitation, 483 tons by flushing due to over irrigation and 215 tons by deep percolation through watercourse system. The net addition of salts per annum has been worked out to be 313 tons (0.83 tons/hectare). The salt load was found to contain higher percentage of sodium contents, which has caused a general hardening of the surface soil thereby affecting the agricultural productivity of the area. This situation is suggestive of the need for gypsum application for maintaining the productivity level of such areas.

6. TRAINING WATER MANAGEMENT SPECIALISTS IN DEVELOPING FARM MANAGEMENT PLANS AND FARM CONSULTANCY SERVICE

6.1. Development of farm plane

Development and execution of appropriate farm plans ensuring the judicious use of irrigation water have been found to enhance the gross margin (Gross income minus variable cost) by 51 percent with an additional cost of 20 percent. Judicious combination of available farm resources resulted in 8 percent higher income without any extra cost. These findings clearly show that there is a knowledge gap ad the shortage of capital on these farms. Moreover the farmers especially the commercial ones were handicapped by the inadequacy of labour at the transplanting time of paddy rice, harvesting and threshing of wheat.

The knowledge gap can be narrowed down by improving the management skills of the farmers through extension service. The existing procedural formalities stand in the lifting and use of credit by the small farmers. Simplifying the loaning procedure can enhance the capital supplies at the farm level. As regards the labour shortage at peak load periods it can be overcome by developing transplanters and harvesters suited to our local condition.

6.2. Dietary status of rural people

The dietary assessment survey spotlighted the serious portion deficiency particularly of animal origin among the rural masses. The non-farm households were found more deficient than the land owing households.

The Government policies aiming at enhancing the mass education alongwith the development of livestock, poultry, and fish farms and be of great help in improving the prevailing situation. Provision of income generating opportunities by accelerating the pace of industrial development in the rural areas is probably a proper solution.

6.3. Impact of modern technology

The study attempted the estimation of the impact of modern technology on wheat yield by comparing the contact fields output with those of the control ones. A package of modern technology comprising improved seed, method of sowing, balanced fertilizers, 1 irrigation and weed control was tried on the farmers' fields (contact field) and the neighbouring fields sown by the same farmer under traditional practices was taken as control. The modern technology packages have been found increased the yield of wheat significantly (40% ever the control field per acre). The major contribution was made by improved seed, N & P fertilizers, weed eradication, irrigation and proper sowing time. The contribution of cultivation intensity was of the lower order indicating that the existing level of this operation is higher than required. The old myth of "More cultivation the higher yield" seems no longer true. The extension material in this regard needs to be re-examined in order to find out economically feasible level under the prevailing conditions. The extension message thus formulated will indicate the felt needs of the project farmers.

7. ORGANIZING AND TESTING WATER USERS' ASSOCIATIONS AND THEIR FEDERATION AS SELF-SUSTAINING ENTERPRISES

Studies were conducted, how to make the water users associations viable and effective. The data show that as a result of the improvement of watercourse system, the conveyance efficiency increased by about 20 percent, but the benefits of watercourse improvement started diminishing with the passage of time due to lack of cleaning and maintenance. The improved watercourses, where water users' associations remained no longer effective, got soon deteriorated, increasing thereby the conveyance losses to their original level. However, the situation in the project area was quite satisfactory as the associations organized for purpose kept functioning effectively. Data regarding the rate of reduction in conveyance

efficiency of the improved watercourses were collected by interviewing the farmers. According to the farmers' perception, in case of single purpose societies, the rate of reduction in conveyance efficiency averaged 19 percent per annum, in the double purpose societies it was 14.8 percent but in case of multi-purpose societies the reduction rate was quite nominal, i.e., 5 percent per annum. The results suggested that the multi-purpose water users associations should be organized on each and every watercourse so that useful life of the water channel is prolonged. Multi-purpose WUs cooperatives also attracted large membership averaging 95 to 100 percent as compared to double and single purpose associations.

8. DEVELOPING OP EFFECTIVE EXTENSION METHODS .FOR MOTIVATING FARMERS TO ADOPT IMPROVE ON FARM WATER MANAGEMENT PRACTICES

8.1. Extension methods

This component was involved in developing effective methods for the rapid dissemination of the knowledge and technologies developed by other sister components among the farmers of the protect area. For this purpose, different extension techniques like field demonstrations, lectures and flannelgraph stories were applied to transfer the new technology to the farmers. Demonstration, as compared to the lecture meetings and flannelgraph stories, was found to be the most effective extension method. Adoption of new technology, such as improvement of watercourses, their cleaning and maintenance, improved irrigation, and better agronomic practices have been considerably accelerated through the method of demonstration.

8.2. Operational research

Operational research study for the reclamation of salt affected soils through the use of gypsum was carried out in the three villages of the project area. The required quantity of gypsum for this study was provided by the Punjab Agricultural Development and Supplies Corporation free of cost. The gypsum was applied according to 100 percent gypsum requirements following sub-soiling. After leaching, the wheat crop was sown deepening all other inputs equivalent to those as applied on the normal fields. It resulted in bringing about an average yield of 2 tons per hectare. The rate of return was 1.32. Having been convinced of the usefulness of this technology, the farmers were prepared to adopt it provided the required quantity of gypsum could be arranged on credit.

ACHIEVEMNETS FROM 1991 ONWARD

The University of Agriculture, Faisalabad through its water management research and training programme for rural development phase-I (1979-86) and phase-II 1987-1991 carried out research in the related fields of water management at national level for the personnel of water management and Agri. Extension Services of the provinces. Since research and training are continuous processes, after completion of the Phase-I and II, it was considered imperative to shift this programme from Development to Non-Development under the name of Water Management Research Centre (1991-92). The Water Management Research Centre, University of Agriculture, Faisalabad was in fact a continuation of the already functioning Water Management Research and Training Programme with a new name to perform the same functions of research and training in Water Management. Keeping in view the budget constraints imposed by the UGC/GOP, four sections were created by merging the previous nine components. These were Farm Irrigation Management Section, Irrigation Agronomy and Soil Management Section, Socio-Economic Section and Training and Extension Section. This programme has been successful in developing technologies on various aspects of water management creating an environment among the farming community to adopt the improved water management practices for productive agriculture and training a number of personnel of relevant disciplines. In additions, the Centre has developed infrastructure facilities for carrying out the research activities in water management.

WATER MANAGEMENT RESEARCH CENTRE

OBJECTIVES

The Water Management Research Center aims at developing solutions to the problems of poor performance of irrigation system. It means, a) developing a conceptual and theoretical basis for better understanding of irrigation system, b) production practices, methods, and organizational reforms which can be used by irrigation agencies to improve system performance and c) providing specific answers to problems relevant to specific contexts. The major objectives of this center are as follows.

- To provide research results which will prove useful to policy makers in the future planning and implementation of the On Farm Water Management Programme.
- To strengthen research and training facilities at the University of Agriculture, Faisalabad in the field of water management through interdisciplinary approach and to increase faculty involvement in the solution of farmer's Problems
- To conduct diagnostic and field oriented research studies in water management to find solutions of the problems faced in the field.
- To develop appropriate water management technologies for improved irrigated agriculture through research verification and demonstration on farmer's fields for increasing crop production.
- To provide technology and guidelines to be used by watercourse and irrigation engineers to facilitate their doing a better job of motivating the farmers and introducing technological changes.
- To directly support training courses for personnel of the Water Management and Agricultural Extension Department by providing planned educational and field training in all aspects of water management and increase essential interaction with the farmer to motivate him to adopt new technologies.
- To organize seminars/symposia pertinent to research in the fields of water management.

The Major studies successfully conducted are summarized as under.

- Use of recycled drain water for crop production in normal and salt-affected soils.
- Scheduling of irrigation for wheat and maize gown at different depths of groundwater table for effective use of water resources.
- Use of different irrigation methods like border, furrow-ridge, furrow-bed, etc., for getting good crop yield at maximum irrigation efficiency.
- Determination of the economic depth of irrigation water applied to rice at each irrigation.
- Determination of the effect of water stress and adequate time of transplanting in rice.
- Comparison of different sowing methods (transplanting vs direct sowing in lines or broadcast) in rice.
- Determination of the effect of irrigation interval in rice.
- Studies in wheat for determination of the effect of water stress at critical growth stages, to quantify the water requirements based on Cumulative Pan Evaporation (CPE), irrigation scheduling using different ratios of Irrigation Water (IW): CPE.
- Production economics of growing different wheat-lentil associations.
- Use of zero tillage, its constraints, and its adoption under farmers' conditions for rice-wheat rotation system.

- Prediction of irrigation schedules with or without rainfall for wheat, sugarcane, barseem, and tobacco crops using climatic data the observatory of the Centre.
- Screening of cotton varieties based on CPE and comparison of different irrigation methods (flat, furrow-bed and furrow-ridge) for water use efficiency.
- Determination of appropriate number of irrigations for gram. Lentil and mug beans.
- One of recent contribution of the Centre is the development of "**Four-row Wheat Bed Planter"**.
- Determination of water requirements and response of wheat to different soil moisture depletion levels
- Genetic response of wheat (*Triticum aestivum* L.) to irrigation at different levels of crop evapotranspiration (ETo)
- Impact of split fertilizer application on wheat
- Genetic response of cotton (*G. hirsutum* L.) to irrigation at different levels of crop evapotranspiration

DESIGN AND DEVELOPMENT OF "FOUR-ROW WHEAT BED PLANTER" FOR IRRIGATION WATER SAVING

There is a growing need for our irrigated agriculture to produce more when availability of irrigation water is decreasing and sources of capitals for agriculture are drying up. Irrigation water available on the farm is very precious and therefore it is essential to save each drop of water. Under this situation, there is dire need to make innovative efforts for developing irrigation water saving techniques, which are cost friendly and easy to incorporate in our conventional agricultural practices. Hence, this study was conducted to control losses of irrigation water on the farm during its application by comparing furrow-bed with border and traditional basin irrigation methods especially for wheat. The main objective of this study was to introduce "Raised Bed Technology" in the country.

Water Management Research Centre has designed and developed a machine called **Four Row Wheat Bed Planter** to accomplish the desired goal (Ahmad, 2004). The machine is designed to plant four rows on one bed. A furrow for irrigation separates each bed. There is a buffer zone in the center of four rows on the bed. The machine develops two lines of crop on both sides of the furrow. Each furrow has to irrigate only (20 cm) of the adjacent beds. The center to center distance of two beds is (90 cm) with a bed of (60 cm). Thus, the machine has provision to plant 4 lines in (90 cm) width while maintaining the traditional plant population (Fig. 1). The machine has a provision of adjusting planting depth.

This newly designed wheat bed planter has been tested for planting wheat at the experimental area of Water Management Research Centre, Post Graduate Agriculture Research Station (PARS), University of Agriculture, Faisalabad. The machine was compared with traditional flat sowing on borders.

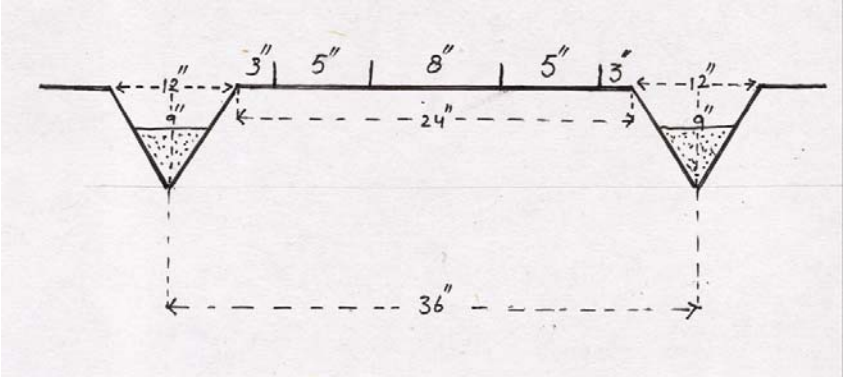


Fig.1. Planting pattern of wheat on (60 cm) wide beds with (30 cm) wide furrows

The results indicated that growing of wheat crop on 60 cm wide beds with 30 cm wide furrows by using wheat bed planter saved significant amount of irrigation water (about 50%) as compared to flat sowing with border irrigation, yielding a non significant effect on grain yield and harvest index while effecting significantly water productivity. Keeping the marvelous results of the machine in view, the use of machine at farmer's field has been started by the research team of Water Management Research Centre under the Technology Transfer Programme of University of Agriculture, Faisalabad around Faisalabad and Toba Tek Singh. About 200 acres of Wheat has been sown at different farmers' conditions. In addition, machine performance has been demonstrated in the experimental areas of different organizations like, Ayub Agricultural Research Institute Faisalabad, OFWM, and AMRI-Multan. Moreover, efforts are underway to improve the machine for the sowing other crops i.e. maize, cotton and even rice on the beds. Experiments conducted for maize and cotton with the same machine in the experimental area of WMRC has also shown promising results for not only water saving but also increase in yield.

Results of irrigation water applied to wheat during Rabi 2003-2004 are presented below.

Depth of water applied in each treatment (cm) and water saving

No. of Irrigation	**Depth of irrigation in Borders (cm)**	**Depth of irrigation in bed planter**	**Water saving in wheat bed planting**
1st	7.50	3.83	49 %
2nd	7.44	3.53	52 %
3rd	7.25	3.45	52 %
4th	7.10	3.55	50 %
Subtotal	29.29	14.36	51%
Rauni Irrigation	7.5	7.5	-
Total	**36.79**	**21.86**	**40 %**

Technology Transfer Programme of University

Under the Technology Transfer Programme of the University WMRC has expanded its activities at farmers' fields in various parts of Faisalabad and all three tehsils of district Toba Tek Singh i.e., Gojra, Toba Tek Singh and Kamalia. Bed planting of wheat has first time been introduced in these areas with highly appreciable results and demanding response from the farming community. Furthermore bed planting of maize and cotton has also been done with successful results. This is a continuous activity under the guidance of the Director, WMRC.

Some photographs at farmers' locations are presented below.

Wheat on beds

Sugarcane intercropping in bed planted wheat

Maize on beds

TRAINING

Training of in-service professionals and semi-professionals especially newly recruited staff of OFWM is another major activity of the Centre.

In this regard, 396 personnel of OFWM and Department of Extension from all four provinces were trained through Water Management Training Programme, University of Agriculture, Faisalabad.

Training of 320 staff members (Assistant Agriculture Engineers, Water Management Officers, and Supervisors) is under way from December 06, 2004 under the "***National Programme for Improvement of Watercourses in Pakistan – The Punjab Component".***

FOOD TECHNOLOGY

1. PROCESSING OF FRUITS AND VEGETABLES

1.1. Dehydration of fruits

Pears of different varieties namely Leconte, Batang and Kieffer were preserved by dehydration and their storage stability observed. Dehydration ratio was from 3: 1 to 4: 1. Leconte showed higher values for colour, taste and texture than Kieffer while Kieffer was superior in organoleptic value than Batang. The SO_2 content of dehydrated products decreased with storage.

Dehydrated guava fruit did not absorb- moisture during storage. Retention of ascorbic acid in the dried products after 360 days storage was 22.6 % in white and 29.9 % in red varieties. Jam when prepared from fresh fruit, was superior than that obtained on cooking dehydrated guavas that had been stored for six months.

Apricots were sundried after giving different S02 treatments as well as blanching in different concentrations of syrups for 1 minue. The dried product contained 15.9 to 18.3% moisture. During 6 months storage a loss in S02, an increase in reducing –sugars and water soluble pectin were evident.

Bettor colour and taste was noted for the sulphur treated products but apricots blanched in syrup and then dried were more acceptable as far as texture was concerned. Bananas were sundried in the form of chips after giving antibrowning treatments with 1% citric acid, 0.5% potassium metabisulphite and 0.5% sodium thiosulphate. Least browning and maximum ascorbic acid retention were noted in products that were sulphited prior to drying. Milk shake prepared from the dried bananas showed that organoleptically, potassium metabisulphite and sodium thiosulphate treated were ranked high.

Spray drying, a recent technique was employed to get dried lemon and mango juice powders. Ascorbic acid losses were noticed during processing and storage. The caroenoids present in mango juice declined, during processing and storage. The reconstitution value decreased during storage. The colour, flavour and taste of reconstituted drinks were acceptable.

1.2. Dehydration of vegetables

Effects of dehydration were studied on carrots, garlic and potatoes. A study was undertaken to observe the effect of pretretments such as blanching, precooking and sulphiting on the quality of dehydrated carrots. A slight decrease in carotene and substantial losses of ascorbic acid, proteins and non-reducing sugars were observed. The maximum coefficient of rehydration and good texture were obtained in crrots precooked at 212°F for 10 minutes. Pre-cooking yielded carrots on dehydration that were suitable for meat dishes and "halva".

Garlic was dehydrated and packed in polyethylene bags, plain tin cans and ball jars after size-reduction into powder form. Dehydration had significant effects on the moisture and other volatile substances while constituents like fat, protein, ash, crude fibre, N.F.E. and carbohydrates were not appreciably affected. As packaging materials, ball jars and plain tin cans under vacuum were most suitable for enhanced storage stability. Garlic powder in polyethylene bags was inferior in quality. Organoleptic assessment indicated highest scores for fresh garlic followed by those in tin can and glass jars.

Dehydration, reconstitution and cooking experiments were conducted on different potato varieties i.e. Pactoi, Ultimus, Urgents, Kabuli, Eigenheimer and Erdgold. Dehydrated potato varieties when analyzed

for various constituents showed that starch, protein and SO_2 are comparatively higher in the crop grown at Sialkot than Faisalabad. On dehydration of different varieties, it was observed that the least losses occurred in protein (X) and highest in reducing sugars. Erdgold and Factor when soaked for 2 hrs and boiled for 30 minutes yielded maximum coefficient of rehydration. Factor variety possessed best taste, odour, colour, flavour, texture and palatability.

1.3. Canning of fruit and fruit juices

Canning was carried out to observe different factors affecting the quality of canned guavas. Differences in syrup concentrains and levels of calcium were the main characteristics under study. Syrups of different sugar concentrations had a marked effect on the product quality with respect to flavour, taste and texture. Drained weight was also affected by sugar concentration and storage duration. With increase in length of storage, T.S.S.i acidity and reducing- sugars showed rise whereas ascorbic acid level declined. About 50% on the average loss in reduced ascorbic acid was observed during canning. Different sugar concentrations and addition of $CaCl_2$ did not check the oxidation of ascorbic acid. Water-soluble pectin increased during canning and storage. The product containing 30% sugar syrup plus 0.8% $CaCl_2$ was superior in colour and texture. Better flavour was reported in the product containing 30% sugar syrup plus 0.2 % $CaCl_2$.

Guava bases when tested for suitability in beverages revealed that 15 and 20 Brix bases retained maximum flavour. Taste and overall acceptability was best for 15 Brix and 2% acidity in guava-base.

Kinnow juice was given two treatments prior to canning i.e. (1) exhausting and water bath heating for 5, 10 and 20 minutes at 212°F and (2) deaeration and flash pasteurization. The products were stored for 270 days. Reduced ascorbic-acid (ASA) decreased during canning and dehydro ascorbic acid (DHA) increased. During storage both decreased. During 60 days storage, the water-soluble pectin fraction decreased in the products processed for different periods while in deaerated and flash pasteurized juices an increase was observed. Fresh and the deaerated and flash pasteurized juices were ranked higher than the others from the sensory stand point.

Research was conducted to determine the effect of different levels of calcium chloride and calcium lactate in cover syrup on the quality of canned orange slices and the characteristics of pectic substances in these slices. Storage period was 120 days. In cases where different quantities of calcium salts had been added to the cover syrup, percent esterification and anhydrogalacturonic acid showed less decrease. The products containing 30% sugar syrup plus 0.5X calcium chloride or calcium lactate possessed better colour, flavour and texture.

In another experiment on canning different levels of sucrose, calcium chloride and calcium lactate were tried on langra mango slices. Storage changes were noted for 120 days. An increase was observed in the drained weight, acidity, relative viscosity of cover syrup and water and ammonium oxalate soluble pectin. Flavour of the products canned in 40% syrup, differed significantly from the rest. The products containing 30% sugar solution plus 0.5 or 0.8% calcium chloride and calcium lactate differed significantly in texture from the products canned in 30% syrup alone.

When two varieties namely langra and Chaunsa were canned as slices in lacquered and plain tin cans with 0.5 g and 1 g calcium chloride added to the cover syrup and stored for 225 days. Results obtained were as follows. Beta-carotene remained stable during canning and upto 75 days and then decrease started. Total pectin as percent andydrogalacturonic acid (AGA) was 40% in Chunsa and 62.5% in langra. Drained weight equilibrium was reached in 75 days. Organoleptic evaluation after 9 months storage showed non-significant effect of types of containers and calcium chloride concentration on the products.

In study undertaken to standardize the conditions for the production of canned tomato Juice two

extraction methods i.e. cold pulping and hot pulping were employed. At the same time two canning procedures i.e. conventional and canning after deaeration and flash pasteurization at 205°F were used. The products were packed in plain and lacquered tin cans.

Higher extraction and more viscous pulp was obtained on steaming the tomatoes. Carotene proved fairly stable during processing and storage of canned tomato juice. A significant increase in water-soluble pectin was recorded during hot pulping as well as when processed and stored as canned juice. The acidity of canned juices after 210 days was 26 to 43% higher than that of fresh pulp. Minimum increase in acidity was found in hot pulp samples packed after deaeration and flash pasteurization. Similar effect was observed on total soluble solids and optical density. Organoleptic evaluation showed that all samples of canned tomato juice were equally liked by the judges.

1.4. Blending

Blends were prepared by mixing fruit juices in different proportions to meet consumer demand for a variety of fruit juice drinks and to study the complementary effect of one juice on the properties of another with respect to such parameters as clouci stability, bitterness and acceptability. Bitterness development in stored orange juice could be masked by enriching with mango juice, the best blend being 66 and 75% mango juice concentration. High mango juice level in orange; mango juice blends tended to stabilize the cloud in the drinks. Mango juice when blended with orange juice and converted into squashes resulted in squashes with better taste, colour and flavour. When orange juice was blended with guava pulp and processed into squashes, it was observed that guava rich blends were loaded with ascorbic acid and possessed superior cloud, better taste and innovated flavours. Further, this technique yielded more glasses of drink per bottle on dilution with water than from squashes available in the market.

In another study, stability of pulp from mango varieties namely Langra, Chaunsa and Anwar Ratol on storing for 150 days was assessed. In addition, the pulp from different varieties was blended and converted into drinks. Anwar Ratol and Chaunsa were most suitable for canning. Canned pulp from sucking type mangoes retained freshness fairly well whereas that from Langra showed decolorization and flavour loss on storing. Sensory evaluation of different drinks showed best results for pure Anwar Ratol and its blends. For a touch of variety, Chaunsa and Langra blends too could be marketed.

To preserve orange juice and to make grapefruit more acceptable to consumers blends were prepared as orange; grapefruit juice (1:1/4, 1:1/2, 1:3/4 and 1:1). Blends were deaerated, flash pasteurized, packed in No.2 plain tin cans and stored for 300 days. The volatile reducing substances in juices increased during canning.

On the basis of organoleptic evaluation conducted after 270 days, it was observed that the best colour was retained in the canned single strength orange and grapefruit juices as well as orange juice mixed with l/4th part grape-fruit juice. Canned 1:1 orange: grape-fruit juice blend and single juice possessed high flavour but were less acceptable taste-wise.

1.5. Effects of additives

Effects of different additives on bottled mango and orange juices were studied. During 240 days storage, it was observed that the orange juice to which calcium chloride had been added showed more browning and cloud separation. In the case of bottled mango juice, better colour stability was noted in case of the product to which calcium chloride had been added. The comparison of the values for maximum increase in water- soluble pectin fractions showed highest values in case of added pectin, followed by ascorbic acid, calcium chloride and borax treated samples. The mango juice to which 0.2 X pectin was added ranked boat on the basis of colour, flavour and taste followed by the one fortified with 300 mg ascorbic acid and 0.2 X calcium chloride. When different levels of pectin and Tyioze SL 600 (Hoeschst) were

added in the squashes prepared from pasteurized and unpaatcurized juices, these additives tended to reduce the rate of settling.

In a research on substitution of sucrose by liquid glucose as a sweetener in orange squash, it was observed that sucrose could be replaced by liquid glucose upto 20% without affecting the physio-chemical characteristics to a marked extent.

In case of mango juice, pure sugar containing product was found to be more acceptable than one in which liquid glucose had been added.

Cloud destabilization of orange juices and squashes depends on the activity of pectin enzymes during processing and storage. It was observed that pectin esterase activity decreased during the first 30 days and then increased upto 60. Poly galaclturonase activity decreased in the chemically preserved squashes too. Highest pulp settling occurred in chemically preserved juice and squash. The orange squash prepared by comminution of steamed oranges was adjudged as a acceptable from colour, odour and taste stand points. Carbonation of orange juice resulted in a product of good colour, taste and flavour. Organoleptic tests regarding effect of heat on the quality of pectin in mango juice showed that the product hot packed at 212°F ranked highest in attributes such as colour, odour and flavour followed by 200 °F and 180°F heat treated.

In a project on the factors affecting the extraction and clarification of grape juice, an effort was made to produce clear grape juice by splitting up the colloidal system using chemicals and 'mechanical means. Pressure filteration after mixing with 25% hyflosupercel yielded best clarified juice in 5 days. Heat treating the grape juice at 180 °F for 1 min clarified the juice in 6 days whereas filteration-cum-casein (20g/l) treatment resulted in clear juice in 2 days. The clarified juice could be successfully carbonated.

Sweet limes could be used to prepare squashes, syrups and pickles both in oil and vinegar.

During processing and storage of tomato paste, several chemical changes occur resulting in deterioration of natural colour and nutritive value' of the product. In full ripe tomatoes the three most important pigments are cotenoids, anthocyanins and floavounes. A study was designed to know the relative changes in water-soluble (anthocyanins and flavanones) and fat-soluble (carotenoids) pigments of tomato paste during processing and storage., Besides this, the effects of different anti-oxidants i.e. butylated hydroxyanisole (BHA) and butylated hydrosytoluene (BUT) and chelating agents ethylenediaminetyetracetic acid (EDTA) on the stability of these pigments was also investigated. These studies showed no significant difference in the visible spectra of water and methanol extracts with passage of time in different samples of tomato paste suggesting relative stability of anthocyanins and flavanones. When the fat soluble pigments were partitioned by T.L.C. method, the UV spetctra indicated the occurrence of oxidative changes. The EDTA containing tomato paste underwent rather constant deterioration with passage of time as revealed by both visible and UV spectra. As no detectable change was observed in BHA and BHT containing tomato paste hence only these two might be used to supress the oxidative changes in carotenoids during processing and storage of tomato pulp.

A research was conducted concerning qualitative and quantitative characteristics of different apple varieties grown in Pakistan as well as substitution of corn syrup in jam making. The water-soluble pectin in different varieties varied between 0.538 to 0.750 % (A.G.A.). Kulu variety contained the highest followed by Amri and Mashadi. Ca-pectinate was from 0.375 to 0.501 %, highest being in Kulu followed by Amri and Mashadi. Substitution of corn syrup for sucrose in jam making reduced the cooking time. It was observed that with the increase in corn syrup content of jam, all pectin fractions tended to be higher than in jam prepared with 100 X sucrose. Corn syrup could be substituted upto the level of 20 to 50 X without affecting the sensory quality of jam.

Suitability of high fructose syrup made from inedible broken rice as replacement of sucrose at different concentrations in pomegranate and almond syrups was assessed. Sucrose could be replaced by high fructose syrup upto 25% without adverse effect on physico-chemical characteristics of these products. Different preservatives were tried to find their effect on the stability of whole almond syrup and almond seed cake syrup. Whole almond syrup showed greater cloud separation on keeping. When stored for 2 months, no rancidity developed. Almond seed cake syrup was preferred over whole almond syrup by the judges. Sodium methyl paraben and sodium propyl paraben when added at 0.025 and 0.05 X levels tended to increase the shelf-life of the syrup.

Orange peels were blanched and dried and then treated with hydrochloric acid and citric acid respectively prior to spray drying. Pectin yield obtained varied between 12 and 25 % in case *of* hydrochloric acid extraction and 11 to 23 % in citric acid treatment. Jelly grade of the pectin was 82 to 151 for HCl and 76 to 121 for citric acid extraction.

Good grade pectin was obtained from orange peels at 2.5 pH and 20 minutes extraction time with hydrochloric acid.

In the first phase called "development phase", enlargement of fruit was accompanied by rapid formation of pectin material particularly in soluble fractions. In about 6th week ripening sets in which colour changed from green to yellow. Sodium soluble and ammonium oxalate soluble pectin fractions started decreasing and water soluble and total pectin continued to increase. Firmness of the fruit decreased rapidly. A rise in pectinesterase and polygalacturonase activity were noticed. In the last phase an abrupt decrease in the firmness occurred and the fruit became pulpy. The decline in total pectin became evident.

In another project, mode of ripening of different mango varieties was observed along with their suitability for canning. For ripening studies mangoes were wrapped in news paper sheets and stored in perforated wooden trays for 8 days at 82-99 °F and 78-91 X relative humidity. During the ripening process, loss in weight was 17.5-20.6 %, 130-160 % and 13 to 15 % for Langra, Dusehri and Fajri respectively. The water, acidity, ascorbic acid, and protein contents decreased while total soluble solids, carotenoids and sugars increased.

For canning mangoes were peeled, sliced and processed in 30 % syrup for 20 minutes at 212 °F and stored at 82-90°P for 45 days. Organoleptic evaluation showed that canned Dusehri possessed better quality than Langra and Fajri.

2. DAIRY TECHNOLOGY

2.1 Milk processing and its quality:

The studies were carried out on the factors which are responsible for the quality of milk. One of these factors i.e. fat was determined by the method of babcock. The method was found to be accurate and reliable. Solid not fat and total solids were estimated by the bead test method which was found, to be simple, low cost, of high speed and accuracy.

Studies on ultra high temperature processing of milk showed that there was an increase in the acidity but there was no effect of processing on free faty acids, fats and protein. Microbiological test revealed that 83 % samples were completely sterile after processing. The effect of light and its intensity was investigated on-the quality of milk at room temperature and at refrigeration temperature. The ascorbic acid content were greatly affected by packaging and storage temperatures. The retention of Vit. C was more in amber coloured bottles as compared to other packaging materials. The milk packed in amber colour bottles had the highest organoleptic properties. The effect of stabilizers on the keeping quality of milk was investigated. It was found out that milk stabilized by the use of pectin and mango pulp had the greatest

keeping and organoleptic properties. Brix and refractive index of all blends fairly increased during the storage.

2.2. Utilization of by-products of milk

The studies were carried out on butter whey for its possible utilization in various food products, because it is an important and valuable waste of butter manufacturing plant. The whey was dried and used in different foods. It was observed that dried material contained 6% fat, 37% protein and 39% lactose. The products with this composition is rich and nutritious. It was found that replacement of 20% MSNP in ice cream increase the melting point and taste of the product. It also reduced the addition of sugar in ice-cream to a considerable extent. The use of whey in bread at the rate of 5% has a positive significant effect on this product.

Huge amount of cheese whey is produced during the manufacturing of cheese. The whey is a total waste and cause pollution problems. It was possible to dry the whey and change it into a valuable product for use in various foods. Dried cheese whey contained 13 % protein and 71 X lactose. It was found feasible to enrich orange juice using 3% dried whey. Replacement of 20 X of MSNF in ice cream by the use of dried whey gave encouraging results. Addition of dried whey to wheat flour at the rate of 5X for making bread, improved the organoleptic characteristics of this product.

2.3. Storage stability of butter and cream

Many chemical changes take place in the butter during storage. The changes are affected by the storage temperature and relative humidity. It was observed that acidity increase at 40°F and room temperature storage at 0,20,40,60,80 and 100 X relative humidity. There was a decrease in iodine value and moisture contents at above mentioned conditions. The moisture loss was higher in case of cow's butter as compared to buffalo's butter. The acid value increased considerably during storage especially at higher temperature and at high humidities. pH values decreased after 15 days of storage. Peroxides were developed after 30 days. After 60 days of storage at 85°F and 40°F, the peroxide values wore 0.86 and 0.35 in butter from pasteurized cream, 1.0 and 0.4 in butter from unpasteurized cream.

2.4. Microbiology of ice cream

Studies were conducted to evaluate the quality of ice cream prepared on commercial and semi commercial scale. It was found that psychrophilic count was more in semi-industrial stored ice-cream (107/ml) than the industrial ice cream (104/ml). In fresh semi-industrial samples, the psychrophilic count varied between 1.8 x 106/ml to 107/ml. Coliform were higher number in semi industrial than in industrial. The conform count varied between 6 to 22/ml in industrial ice cream and 110 to 2100/ml in semi-industrial fresh ice-cream. The research showed that ice-cream manufactured at small scale was definitely heavily contaminated and posed health hazard problems for the consumers.

2.5. Fermented milk products

a) Yoghurt:- Studies wore carried out on the microflora of yoghurt to determine the shelf life of this products. It was found that coliform ranged between 30-50/ml during storage. The count was 80/ml in case of dahi. There was an increase in the viable count of mold and yeast during storage. An increase was noted in titratable acidity and total solids but lactose contents decreased due to the conversion of lactose into lactic acid. Addition of flavour and pulp exerted a highly significant influence on the organoleptic properties of the products. The mango and apple pulp added yoghurt were more liked than plain yoghurt. It was also concluded that the products prepared by the addition of 30 percent and 40 percent sweetened fruits maintained the highest quality during storage. In another

investigation it was found that products containing 12, 16 and 20 percent orange syrup maintained the highest quality during storage.

b) Cheese:- The studies were conducted on the causes of spoilage of choddcr cheese to enhance the keeping quality of this product. Choose was liable to be spoiled by mold during ripening and .storage. It was possible to check the spoilage by the use of various antifungal chemicals. It was observed that use of potassium sorbate at the rate of 0.2 % was most effective.

c) Domiati Cheese:- The studies were carried out to evaluate the quality of Domiati cheese as a result of the addition, of various nail concentration. It was concluded that the cheese prepared with the addition of lactic starter from milk containing 10 percent SNF, with 4 percent, 8 percent and 12 percent salt was scored better than the cheese prepared without the addition of lactic starter with the same SNF and salt contents in the milk. The moisture contents decreased during storage in both the cases.

3. CEREAL TECHNOLOGY

3.1. Wheat

3.1.1. Baking quality

The studies were undertaken to observe the effects of different factors on the baking qualities of wheat. It was observed that 1000 kernel weight, bushel weight, grain density and flour yield decreased in rusted and pest attacked grain. The damaged by posts exhibited higher fat acidity and diastatic activity. The baking qualities were also affected by rust as the ash content in rusted grains was higher than sound grains.

The concentration of vitamins in flour increases as the degree of extraction rises to 100 percent. The averages of thiamine in wheat, atta, nan and roti were 0.467, 0.412, 0.306 and 0.299 mg/100 grams respectively. The retention of this vitamin in products made from flour of Chenab was found to be high during milling and baking.

The effect of milling and baking on the retention of lysine was also studied and found that wheat flour and nan of Maxi Pak had higher lysine contents than others. The data also indicated that removal of bran resulted in lowering the total phosphorus, phytic acid, calcium and iron content of flour.

3.1.2. Effect of ionizing radiations

The studies were carried out to investigate the effect of ionizing radiations on chappati making qualities of wheat flour. The results indicated that the samples of atta of C-591 exposed to 25,000 r and of C-273 at 20,000 r were found to be suitable for chappati making. The dough development time decreased with an increase in irradiation treatments.

3.1.3. Protein fractionation

The studies were explicited to determine the protein fractions in some important wheat varieties in Pakistan. It was observed that amount of protein recovered through fractionation was slightly higher than the crude protein determined by Kjeldahl's procedure. The albumin content of Pari-73, Pothwar, Sandal and Chenab-70 was higher than globulin. The relative proportions of albumins, globulins, gliadins and glutenins also varied significantly in patent flour, bran and short from different varieties. It was also found that lactic acid at 0.05 molarity was more effective than other acids in protein fractionation scheme. The results indicated that loaf volume of bread was directly related to gluten content and its protein (gliadih, glutenin and total protein).

3.1.4. Shelf life of products

The studies were conducted to determine the effect of preservatives to extend the shelf life of products. The life of tanoori roti when packed in polyethylene bags having 4% sodium chloride and 4% non-fat dry milk when stored at room temperature was 2 days and 16 days when stored at refrigeration temperature. Tho roti containing sorbic acid 0.2% and glycerol mono stearate could be stored for 3 days at room temperature and 30 days at refrigeration temperature packed in polyethylene bags. The nans treated with hydrogenated fat packed in cellophane bags and frozen had a shelf life upto 3 months.

3.1.5. Diastatic activities of wheat

The studies were carried out to determine the diastatic activities of wheat varieties and influence of supplementation of malted barley flour and fungal alfa amylase on baking qualities. It was found that wheat varieties namely C-273, Ch-70, SA-42 and Mnxi-Pak were low in diastatic activity and supplementation of malted barley flour would result in substantial improvement in their baking quality. Variety C-273 received higher baking scores at 0.3% addition of malted barley flour while variety Mexi-Pak and chenab-70 gained nearly equal baking results at 0.4% level. Two dosage of alpha amylase were also given and the baking characteristics of roti were studied. The level of fungal alfa amylase required to reduce the peak viscosity within the range of 350 to 650 BU was determined. At this level of supplementation the optimum shelf life of roti was found to be 17 hours after baking.

3.1.6. Dough improving agents/oxidizing agents

The intent of these investigations, was to explore the action of dough improvers upon the physical properties of the dough with the use of farinograph and also by comparing their effects on the finished product. Farinographic studies revealed that the addition of 25 ppm potassium bromate had no effect on water absorption but it had slight effect on arrival time, development time, tolerance index, stability time to breakdown and valorimefcer value. The organoleptic evaluation exhibited that external and internal characteristics of bread made with potassium bromato had more score that the bread made without bromate. It was also concluded that addition of calcium peroxide and non-fat dry milk increased water absorption capacity of 60 & 75% extractions flour except the use of potassium bromate. The addition of calcium peroxide with non-fat dry milk in 75% extraction flour of variety Pak-81 gave the best results for bread baking.

3.1.7. Grading of wheat

The studies were carried out on the quality and grade of wheat produced by the farmers. 224 wheat samples of crop years 1977-78 and 1978-79 were collected from the farmers of district Faisalabad. The test weight of samples of year 1977-78 ranged form 52.2 to 68.2 lb/bu, the moisture content ranged from 10.3 to 12.4% protein contents from 7.79 to 13.88% and 1000 kernel weight from 26.6 to 51.8 gms. The test weight of samples ranged from 9.3% to 11.3%, protein 8.67 to 13.26% and 1000 kernels weight from 30.2 to 51.76 gms. The results have completely proved the inadequacy of the F.A.O system for the procurement of wheat.

3.1.8. Preparation of flat bread by sour dough method

The studies were conducted to evaluate the quality of flat bread prepared by sour dough method. It was concluded that rotis prepared with hop's extract were significantly better in respect of foldingability and taste than rotis made with sponges prepared with yeast.

3.1.9. Microbiological studies of commercial starter

Starter cultures from twenty bakeries of Faisalabad district were tried for their performance in baked bread. It was found that the starter cultures of indigenous sources released less carbon dioxide gas resulting in less volume. The result obtained revealed that total viable dcount ranges from 2.88 x 106 to 2.77 x 1010, lactic acid bacteria from 4.8 x 104 to 4.85 x 109, acetic acid bacl-oria from 4.15 x 104 to 3.8 x 108 and yeast were 4.3 x 102 to 3.65 x 107per gram of starter.

3.1.10. Supplementation/enrichment

The studies were carried out to investigate the effects of ingredients added for enrichment purposes on the quality of bakery products.

a) Fish Flour; It was stated that nans, rotis, bread, cookies and cakes containing 10% fish flour is regarded to be the best and acceptable organoleptically and nutritionally.

b) Lysine, Thiamine, Kiboflavin, Niacin, Vit A and Iron: It was concluded that relatively little loss of synthetic nutrients used for supplementation was taken place and significant improvement in weight gain and protein efficiency ratio was recorded when nans were supplemented with a combination of vitamin-mineral mixture and lysine. It appears that lysine could be added at 0.1 to 0.2 % level in case of nans.

c) Groundnut Flour: It was observed that groundnut flour upto the extent of 20 % could be satisfactorily incorporated in nans without any perceptible change in organoleptic qualities. However it is recommended that due to better net protein utilization value of groundnut flour upto 10 % of the weight of nan may be employed by the public for supplementation purposes.

d) Guava and pea powder: Nans & biscuits could be satisfactorily supplemented at 5% level guava powder & pea powder.

e) Gram Flour: The rotis and nans prepared with 15 % and 20 % gram flour were preferred over 10 X. The protein efficiency ratio of roti supplemented with 15 and 20 X gram flour was significantly better than unsupplemented & with 10 % gram flour.

f) Soyblend and Milk: When flour was replaced wit wheat soy blond at 40 % level there was an increase of 1.53% protein and 0.34 % ash content. The cookies prepared with this blend were organoleptically acceptable.

g) Sesame seed Flour: Enrichment with sesame seed flour increased the protein level of nan significantly without altering its organoleptic characteristics.

h) Detoxified cotton seed flour: Organoleptic studies in case of roti exhibited that upto 10 X level of supplementation, taste, flavour and eatability were not markedly affected but change in colour was noted even at 5X level. Protein level in the rotis was increased. It was also observed that lunch nans and breakfast nans prepared from a blend of 15% CSF and bread from 10 X CSF could be accepted.

i) Coconut Flour: It was found that coconut flour upto 10 X could be satisfactorily incorporated in simple and fancy nans without any perceptible change in organoleptic qualities. However it is recommended that due to better utilization value obtained, in nans supplementation upto 10 X may be employed for public and industrial purposes.

3.2. Rice

The studies were conducted in order to find out physiochemical characteristics of promising varieties of rice.

The grain weight and length of Basmati-370 and Irri-6 were highest followed by Irri-6 Parboiled), Johona 349 and Irri-6 (Kala Shah Kaku). Width of grain was maximum in case of Irri-6 while Basmati-370 has the lowest value. On cooking the grain length increased by about 52.7 to 10.3 percent with 25.9 to 5X width and 14.;9 to 49.4 X depth. The iron content increased in parboiled rice. Palman-246 and Irri-6 showed high amylose contents. Basmati-370 had very strong aroma, Kashmir Basmati was observed to be inferior to PK-177. Irri-6 possessed weak aroma.

4. FATS AND OILS

Fats and Oils are good sources of energy and provide fat soluble vitamins (ADE&K) and essential fatty acids. Pakistan is in short supply of edible oils. One third of the total required is produced in the country and the rest is imported. Cottonseed is the major source (88 %) of the nationally produced oil. Rest is rape/mustard seed oil followed by peanut, sesame, soybean, sunflower etc.

4.1. Rape/mustard seed oil

Rape/mustard seed oil were characterized by G.L.C. It was found that Pakistani grown R.S.O. contained higher levels erucic acid (Ca 50%) which is nutritionally undesirable. Rape seed oil also contains minor quantities of sulphur compounds. The effect of processing operation on the total sulphur contents of rape seed oil was studied. Degumming (Phosphoric acid treatment) had an insignificant effect on the sulphur contents while deacidification (Alkali-refining) removed about thirty % and bleaching with fuller's earth removed about 50 % of the total sulphur in commercial crude oil. Deodorization affected nearly, the complete removal of residual sulphur left after the application of treatments mentioned above. The so refined oil was subjected to hydrogenation. The studies revealed that the hydrogenation was more effective, as determined by rate of decrease in iodine value (Wijs) and increase in the melting point at 25 Psig than at 30 Psig. The rate of effectiveness was, however, not significant. The rate of hydrogenation was compared to cottonseed oil subjected to hydrogenation under identical conditions. Cottonseed oil showed a better, though insignificant, rate of increase in melting point per unit increase in time. Oils of different varieties of Brassica Kpecios grown in Pakistan are also characterized and evaluated for quality and usefulness.

4.2. Cottonseed oil

Bulk of total supply of edible oil produced in Pakistan is from cottonseed. Cottonseed is grown mainly for fibre. The physico-chemical characteristics of oils derived from improved varieties of cotton were found comparable with those generally accepted in international trade. The fatly acid composition of oils showrd less of saturated (32 %) and more of unsaturated. The maximum linoleic acid (18.2) content was found in B-557 (49.6 %) followed by MNS-79(47.22). Other varieties (NIAB-78 and MNI1-93) contained this dietary essential fatty acid in amounts less than 40%. Bleaching of cottonseed oil was carried out using activated carbon and Fuller's earth. It was found that colour removal was better with activated carbon as compared to Fuller's earth. bleaching losses were dependent of the quantity and type, of absorbent used. Activated carbon retains more oil than Fuller's earth. The effect of processing operation on quality of characteristics of cottonseed oils was also studied. Refining with weak alkali decreased the acid value, Polenski value, unsaponifiable matter, RM value whereas bleaching caused an increase in these characterstics. Bleaching with mixture of Fuller's earth and activated carbon was more effective when used singly.

4.3. Sunflower seed oil

Sunflower seed Oil is one of the oilseed crops grown here to narrow the deficiency-gap in the supply of edible oil in Pakistan. 11 is u short duration crop and contains higher contents of good quality oil. The seeds of promising varieties (shams. Moor, Sptc, Arma-Virsky, Mayak and H.O.I.) were studied. It was

found that Sptc contained about 44 % oil whereas Arma vivsky about 33%. The falty acid analysis of oils derived from these varieties showed that Sptc contained highest amount of saturated fatty acids (21.6 %) whereas Noor had the highest amount of unsaturated fatty adics (89.5 %). Noor also has maximum of linoleic acid (75.4%). It was also found that refined, bleached and deodorized sunflower oil w;ik found as good as common hydrogenated vegetable oil for culinary purposes. The storage stability of commercially available sunflower seed oil was affected by storage conditions and type of antioxidant. Ft was found that NOGA and PG showed greatest effectiveness at 0.15% concentration. The effect of light and high temperature was quite peroxygenic and the samples developed organoleptically detectable odor when peroxide level was about 4U.O Moq/Kg or more.

4.4. Other oil seeds

Ground nut oil, corn oil, and soybean oil were also characterized and evaluated for edible purposes. Ground nut oil in refined form was found good for frying fish, potato chips, biscuits, cakes etc. Similarly corn oil was equally good culinary purposes when compared with commercially available vegetable ghee. The storage stability of soybean was found better when stored in crude form as compared to storage of refined oil. High temperature, exposure to light and access to oxygen accelerated the oxidative deterioration of oil in all forms.

4.5. Animal fats

Butter is best form of edible fat obtained from animal milk. The shelf life of butter is of different nature. It was found that butter during storage showed a rapid rise in acid value than in peroxide value. No detectable changes were noticed upto 30 days of storage. Meat muscles contain fat which requires special care for quantitative determination. Dry and wet methods of fat extraction were used for fat determination in a animal tissues. It was found that fat percentage by dry methods was higher than that obtained by wet method. However, the physico-chemical characteristics of the extracted fats were not found different from each other.

5. SUGAR TECHNOLOGY

It has been established on the basis of technological results i.e. purity of juice and recoverable sugar (sucrose) that early varieties of cane do not come upto the required standard while mid-season and late-varieties grown in the Punjab fulfill these conditions.

A study carried on the effect of variety staleness and maturity of sugar cane on sugar recovery under Faisalabad conditions showed that some varieties suffer with the prolonged storage i.e. more than 24 hours than the others but the imporper maturity of cane adversely affect the recovery of sucrose under all the conditions.

A study carried out to see the effect of mill sanitation on the quality of cane juice revealed that there was no effect of mill sanitation and milling aid on the brix percentage of the samples of cane use analysed immediately after crushing. But that of the samples stored at 77°F and 90°F for four hours were significantly affected by the use of mill sanitation and milling aid when compared with the pol of the samples without sanitation and millig aid.

Effect of clarification on the percentage recovery of sugar from Punjab canes revealed that due to higher mineral content in the Punjab soil adversely affect their recovery value. Out of the raw juice, the crusher juice had the maximum purity, last mill juice, the minimum and the mixed juice in between the two values. The lowest purity of last mill juice was due to more addition of nonsugars on account of subsequent increased mill extraction.

The mixed juice had higher brix values than that of the clarified juice and the first carbonation juice usually had slightly higher brix values than the clarified juice. It was observed that the decrease in brix value was mainly dependent upon the quality of juice, density and dose of milk of lime and the methods of liming. The pol values of carbonated juices were slightly lower than that of the mixed juice. This decrease in pol value was due to the loss of sugar in press-cake. It was further observed that the highest purity rise was obtained in case of clarified juice while the greatest per cent removal of nonsugars was found in the first carbonation juice. Clarification efficiency and the production of molasses was affected to a large extent by the quantity of mixed juice, density and level of liming and by the extent of nonsugar removal. It was also established that there was a highly negative correlation between the clarification efficiency and production of molasses. Quality and recovery of sugar did not depend upon the clarification process alone but also on the quality of cane and factory efficiency.

An experiment was conducted to determine and evaluate starch in sugar cane juice and its products such as, primary, mixed and clarified juice, syrup, raw sugar and final molasses. It was observed that there was a significant difference in all samples except between mixed juice and raw sugar. Dilution of primary juice as a result of imbibition water resulted decrease in strach content in mixed juice. Further decrease in starch during processing took place at the clarification station where the major amount of starch alongwith other impurities is precipitated and removed during filtration process. However, the concentration of clarified juice into syrup gave rise to increased content of starch due to the concentration effects. But the highest amount of starch was found in case of syrup followed by raw sugar and the least amount of it was found in the final molasses.

The above observations indicate that starch has the tendency to crystallize with sucrose thereby not only increasing the impurity of raw sugar but also decrease the rate of crystallization. Hence minimum amount of starch should be present in raw juice to avoid processing problems at the filtration and crystallization and to provide pure sucrose to the food industries ns impure sucrose also create certain problems particularly with the beverage industry.

Besides varietal effect the starch content of cane juice be reduced by harvesting the cane at proper stage of maturity as well as by proper topping the cane, but if present in significant amount creates several problems and proper precautions may be taken to reduce the strach content to the minimum by proper harvesting, topping and processing of cane with an object to remove the maximum amount of strach during the clarification process.

Investigation was carried to study the effect of coagulants *on* the settling rate of defecated cane juice. Different doses of coagulants namely Sedipur T-l, Sedipur TF-2 and Separan AP-30 were added to the boiled juice to find out their effect on the rate if settling of mud and the supernatant juice was analysed for various quality characteristics such as total soluble solids, pol, purity P205, ash, reducing sugars and colour.

A definite improvement in the settling rate of impurities present in the defecated cane juice was shown by the cougualnts used for the study. The degree of efficiency of these coagulants was found in the order of Sedipur T-l, Sedipur TF-2 and Separan AP-30; concluding that 0.7 ppm of Sedipur T-l was the most economical and efficient dose amongst the several doses in the study. The purity of juice, clarified with the help of coagulant was found to be higher than that of the mixed juice and also brought about immense improvement in the colour of clarified juice.

In order to remove scales from the evaporators caustic soda and soda ash were used. As regards the effectiveness of sodium hydroxide, 35 per cent solution gave the best results for fifth body but poorest results were obtained in the first body of the evaporators; whereas 15 % solution of sodium carbonate dissolved the maximum scale i.e. 0.247g/0.5g in the 5th body while 20% solution yielded the poorest result. Hence it was concluded that 35% solution of sodium hydroxide and or 15% solution of sodium

carbonate can be successfully used for the removal of scales in various bodies of the evaporators.

Efforts were made to extract wax from the filter cake of cane sugar factories and the study of its physicochemical characteristic was carried out. Each sample was extracted by using different solvents such as benzene, ethyl alcohol, isopropyi alcohol, n-butyl alcohol and petroleum ether. Analysis of variance revealed that all the solvents differ significantly from each other and among the solvents benzene gave the highest yield of wax i.e. 13.27% from filiter cake of Cooperative Sugar Mills Ltd. Rahwali.

Physic-chemical characteristics of extracted wax were determined following the usual methods and compared with the values of cannauba and bees wax. The various constants studied were melting point, specific gravity, acid value, iodine value, saponification value & unsaponifiable matter.

6. MEAT, POULTRY AND FISH TECHNOLOGY

6.1 Effect of ionizing radiation on the nutritional quality of beef

Effect of ionizing radiations, produced form Co60 source in different levels of irradiation treatment in nutritional quality characteristics of beef meat was investigated. There were no systematic rise or fall in moisture content of meat irradiated for different doses. There was no regular increase or decrease of % ash in various parts of irradiated meat. A little decrease in nitrogen, protein, and fat was observed during irradiation. The bacterial load decreased in all the different beef parts.

6.2 Quality inspection of fresh stale and spoiled fish during Frozen Storage.

Fish was stored for 0,15,30,60 days. Percent total nitrogen of muscle increased slightly from 0-30 days whereas it remains constant there after. A similar trend has been followed by the changes in soluble protein of fish samples. Hydrogen ion in terms of pH values decreased all the way through the storage period. All the samples grew tough in texture hut the sample stored for lesser period of time. No abnormalities were pointed out as regards to consumer's acceptibility of all the fish samples whether treated by slow or quick freezing methods and stored for any of the four storage periods.

6.3. Some studies on drip loss and water holding capacity of fish Muscle.

Fish was treated with the solution of following chemicals, i.e. sodium chloride (5,7.5 and 10 %) and sodium hexametaphosphate (5%, 7.5% and 10%). The minimum drip loss was in case of 10 % sodium hexametaphosphate. The maximum solution uptake was in case of sodium hexametaphosphate at 10 % level. The pH remained more or less neutral (6.2-7.0), at which maximum water holding of protein was observed. Water holding capacity of fish muscle increased with increasing concentration of chemicals. This was highest in case of sodium hexametaphosphate and lowest in case of 5% sodium chloride stored for 80 days. Protein concentration of the drip decreased with increasing salt concentration, minimum in sodium hexametaphosphate treated samples.

6.4. Preservation of fish by dry salting and brine salting

Total protein in dry salted fish increased with storage time, due to loss of moisture from fish muscle. In brine salted fish total protein decreased due to some brine absorption by muscle tissue. Change in moisture contents showed just the reverse results. Dry .and brine salted fish treated with 30 and 35% salt did not show any spoilage and discoloration.

6.5. Meat curing and preservation.

The cure was applied as dry curing and brine curing using sodium chloride, sodium nitrate, sodium nitrite, sugar and ascorbic acid as curing ingredients. Comparison of data regarding colour, shrinkage, taste, flavour, chewability and consumer's acceptibility of the cured and cooked meat revealed that brine cured meat was better. However samples from both the curing methods did not differ significantly.

6.6. To Study the comparative effects of antibiotics on colour

Flavour, Taste and Bactercial lead present on cured Beef Packed and stored under refrigeration temperature.

Comparative effects of chlorotetracyclino and chloromycetin was studied on meat to control the bacterial spoilage. It wan concluded that chlorotctracycline remained effective after 45 days than did chloromycotin. Chlorotetracycline-treated meat was liked better as regards colour, flavour and taste. Samples from both treatments differed significantly. Both the antibiotics served to prolong the storage life of treated meat as compared to untreated meat samples.

6.7. Development and evaluation of dehydrated sausages from beef

Four formulations, with different additives were compared to single out the most appropriate one. Parmula A beef (6 Ib.), tallow(2 lb.), sodium chloride (3%) soya flour, (3.6) spices (1%) B:

All ingredients of A+Sugar (3.6%) vitamin C (3/4 mg per 100 Ib.) and B.H.A. (0.01%); D : all ingredients of C+sodium nitrite (1/4 mg/100 lb.) and sodium nitrate (2 oz/100 lb.) Sample D scored high rank for colour, flavour, tenderness and chewabihty, Fading of colour after 30 days storage in all the samples posed a problem

6.8. Study on the effect of freezing and irradiation on protein solubility, lipid oxidation and visible spectrum of pigment of meat.

Analyses were carried for the effect of irradiation and freezing on protein solubility, lipid oxidation and visible spectrum. The effect of freezing and storage on peroxide value showed slight increase upto 8 weeks storage. The protein solubility of frozen samples continuously decreased throughout the storage period 2 weeks. Peroxidation of the samples increased as result of irradiation indicating that gamma irradiation enhances the development of peroxides. The effect of gamma irridation on protein solubility showed a decreasing pattern. The effect of different irridation doses and storage period on the absorption spectrum of beef extracts, showed that in all irradiated samples the absorption was more in shorter wavelength (400-550 mm). The influence of freezing on the absorption spectrum also showed more absorption in lower end of spectrum (400-500 mm).

INSTITUTE OF FOOD SCIENCE & TECHNOLOGY

Effect of degree of grain sprouting on quality of white flour and biscuits

Studies were conducted on wheat cultivate PAK-18. The wheat was sprouted for 24, 48, 72 and 96 hours. Flours were produced from these samples and tested fro different quality parameters. The moisture remained constant in all the samples, crude protein, gluten and total ash decreased in sprouted as compared to unsupported sample. Alpha amylase activity was much higher in the sprouted as compared unsupported wheat Various physical characteristics like test weight, thousand kernel weight and particle size index milling yield, reduction four, shouts and flour recovery decreased while break flour, bran percentage increased in sprouted sample. Various theological characteristics like water absorption, arrival time, dough development time, dough stability and resistance of the dough decreased in sprouted wheat while the tolerance index and softening of the dough increased the score of sensory analysis of biscuits for color, taste, flavor, texture and overall acceptability increased in the blends of sprouted wheat samples. The variation in chemical composition and archeological properties among different flour mill streams exist which ultimately influence the quality of baked products. The information may be useful for millers and bakers to prepare flour for bread and biscuits.

Physico-Chemical and biological evaluation of protein-enriched biscuits using wheat soy blends

In this research project, soybean was subjected to different treatments to get untreated full, fat untreated partially defatted, treated full fat and treated partially defatted soyflours. Composite flour were prepared by blending wheat four with 20 percent of all the 4 types of soyflours. Then the biscuits prepared form various flours were subjected to chemical, physical, sensory and biological evaluation. Biscuits were subjected to sensory evolution by a panel of 5 judges, it was observed that quality score (with respecte to colour, taste, flavour texture and overall acceptability) was decreased with increasing protein content as compared to standard biscuits (white flour). Soy blended biscuit remained good even after 90 days of storage. The results of sensory evaluation on zero day showed that people had more liking for full fat soy flour (untreated and treated) containing biscuits after white biscuits. Biological studies revealed the highest value for digestibility in case of diet C (casein) followed by diet B and A (treated full fat and untreated full fat soy flour containing diets) respectively.

Iron fortification of wheat flour

Nutritional iron deficiency is a major health problem in developing countries. Iron deficiency results in anemia which is particularly prevent in growing children and pregnant and lactating women. This research project was designed to enrich the wheat flour with an iron source and to check its stability during storage and processing. From these studies it was concluded that the iron content in the enriched flour differed significantly with the variation in iron levels, storage intervals and storage temperature, and found significantly lower in the bread as compared to respective parent flour.

In Pakistan wheat is mainly used for the preparation of unleavened fat bread locally known as chapatie which is prepared from whole wheat flour which contains a substantial amount of bran. This fraction of wheat grain is rich in phytate content. Phytate I san ant nutritional compound which makes Ca, Mg, Fe and Zn unavailable to the body by forming insoluble compounds in the intestine. The present studies revealed that bran contained the highest amount of phytate followed by whole flour and straight grade flour. The phytate was reduced during baking of bread and chapatti.

Recent Trends in Quality Control in Commercial Beverages

The study was launched at the Coca Cola plant, Faisalabad. The first and foremost requirement is to

provide the beverage in crystal clear sterile bottles. Under this study the control limits for each of the parameters have been provided that may serve as a guideline for the future work in quality control operations in beverages.

Removal of Neurotoxin from Matri (Lathysus sativus)

Matri (grass pea, chilling pea khesari dal) belongs to family Leguminosae and botanically known as Lathyrus sativus. In Pakistan, matri is the second most important cool-season legume crop.

Preparation and evaluation of preserved fermented black carrot beverage (Kanji)

Carrots are the most important root vegetable among other vegetables. It contains many nutrients, vitamin, minerals and other inorganic materials. The most important ingredient in carrot is carotene (alpha and beta carotene). The black carrot contains Bet-carotene, which is precursor of vit. A in human body.

Studies on shelf life of bread by using acidulates and their salts

Acetic acid andlactic acid were used in bread in combination with calcium propionate to enhance the shelf life of bread during storage up to 94 h. it was found that the lactic acid in combination with calcium propionate was proved to be most effective against growth of fungi. The moulds, isolated from these studies belong to Aspergillus flavus. Followed by A. fumigatus, pencillium spp, Rhizopus and Mucor.

The weight volume ratio were found to be higher in breads with lactic acid in combination with calcium propionate.

Suitability of durum wheat varieties for the production of doughnuts

Durum wheat is mainly used for the production of pasta products. It fetches higher price de to its attractive and bold grains. It is also resistant against one of the important diseases, kernel blunt. The durm wheat in Pakistan is not grown on a major area but it occupies some aress in the Gujranwala Division.

Preparation of burger bun for multi chain restaurants

Common wheat (Triticum aestivum) is a number on food grain crop consumed directly by the population and its production leads to all other food grain crops. Its main use is in the from of unleavened flat bread locally known as “Chappati” while the rest of the wheat is used for the preparation of bakery products such as bread cakes cookies and buns. It is recommended that optimum quality burger buns should be prepared using 50ppm was used singly and in combination with malt flour @ 0.5% to improve the quality of burger buns.

Rheological and Technological Characterization of New Spring Wheat’s Grown in Pakistan for the Production of Pizza.

Seven newly evolved Pakistani wheat varieties Inqlab 91, Chenab 2000, Iqbal 2000 Auqab 2000, T95713, ?V 7002 and V 7003 were collected and analyzed for physico chemical analysis, rheological studies and pizza baking qualities. The moisture, ash, and crude protein content ranged from respectively. The wet and dry gluten varied significantly among the wheat varieties. The highest SDS sedimentation value was observed in Auqab 2000 followed by Iqbal.

Development of Indigenous Yoghurt Culture

In Pakistan yoghurt is prepared by using starter cultures, which are normally imported from other countries. To overcome this need, the studies were done under local conditions to prepare and preserve native isolate of lactobacillus spp. As yoghurt culture. The main objectives of this study were to isolate *lactobacillus bulgarius*, to preserve it and to use it as starter culture in the manufacture of plain yoghurt.

Quality and grading of wheat produced in district Faisalabad.

Wheat grain samples collected from various locations were tested for physico-chemical characteristics. It was observed that wheat grains contained extraneous matter which significantly varied from location to location within the district. The test weight and 1000 kernel eight were not affected due to the verities.

Effect of parboiling on chemical composition and cooking quality of some rice cultivars

Four Pakistani rice cultivars namely Irri-6 Super Basmati and Basmati-2000 grown during 2001 crop year were included in the present study in order to asses the effect of parboiling on chemical composition and cooking quality characteristics. Each rice cultivars evaluated after parboiling treatment for a proximate composition and mineral elements. Water uptake ratio equilibrium moisture content, sedimentation volume, thermal canning stability and volume expansion ration test were also conducted to check the cooking quality of rice cultivars as influenced by parboiling.

Influence of lentil and guar gum composite flour on plasma biochemical profiles of rats

Guar Gum, a water soluble dietary fiber has been explored as a possible hypocholesterolemic and hypoglycemic agen and consequently contributes to the reduction of the risk of Diabetes and Cardiovascular diseases,. Dietary patterns emphasizing foods high iin complex carbohydrates and fiber are associated with reduced risk of coronary heart disease (CHD) and diabetes mellitus (DM) lower blood glucose (BG) and blood cholesterol (BC) levels. The present research with the main objectives.

Extraction and utilization of rice bran oil in baked products

Rice Bran oil was extracted from stabilized rice bran and after refining was applied into baked products such as cookies at various levels i.e. and by gradually replacing normal shortening to check its effectiveness as bakery shortening and its ultimate role in extending the shelf life of product due to its natural antioxidants by using thiobarbituric acid number test with the help of spectrophotometer.

Characterization and preservation of streptococcus spp. As yoghurt culture

Yoghurt starter culture (*Streptococcus thermophillus*) isolated from indigenous source and yoghurt was prepared from this isolated culture. Now this culture is indigenous to Pakistan and Billion of foreign exchange earning will be made through it.

Acid-Page Gliadin Composition and Cluster Analysis for Quality Traits of Different Wheat Varieties

Forty six different wheat varieties grown in Pakistan grown under identical conditions during the crop years 1996-97 and 1997-98 were tested for various physico-chemical, biochemical and baking (layer cake and bun) properties. The cluster analysis was carried out and wheat varieties were bifurcated in different six groups. The grouping based on the cluster analyses will help the wheat breeders to have choice in wheat varieties for selection in further quality improvement work.

Nutritional and technological evaluation of rice bran for the production of bakery products

Freshly obtained raw rice bran was thoroughly mixed with 20% simple water or 20% solution of 1% acetic

acid or calcium hydroxide to inactivate the anti nutritional factors present in rice bran. Then the treated rice brans were cooked by passing through an extruder cooker maintained at a temperature of 130±2°C for 10-15 seconds. The treated and extruded (processed) rice bran was dried to less than 10% moisture. The nutritive value of processed rice brans was compared with the raw rice bran through chemical, biological and statistical methods. It can be concluded from the findings of the present study that non-significant differences existed in various constitutes like protein, fat, carbohydrate and minerals in between raw and processed rice brans. This will help to combat malnutrition existing among various groups in Pakistan. It can be recommended that anti nutritional factors like lipase, lipo-oxigenase, trypsin inhibitors, haemagglutinin-lectin and phytates can be inactivated through moist, acidic or alkaline processing of rice bran to utilize their nutrient potential. The processed rice bran can be supplemented up to 15% in wheat flour for the preparation of bread, biscuits and chapaties. The processed rice bran can be used in the feeds of broiler chicks replacing 20% (w/w) maize or 15% (w/w) wheat.

Effect of iron and zinc fortification on the stability, acceptability and efficacy of whole wheat flour

The opportunities for fortification of whole-wheat flour with iron and zinc were explored in present research project. The whole wheat flour was fortified with iron (NaFeEDTA, elemental iron) and zinc ($ZnSO_4$, ZnO) fortificants in different concentrations and stored in polypropylene bags and tin boxes for sixty days under ambient and controlled storage conditions. The efficacy and nutritional assay was conducted on albino rats to assess the effects of fortification on hematological parameters, interaction and retention of minerals in some body organs and their percent absorption in the body of rats. The concentration of micronutrients like zinc, iron, manganese, copper and cobalt varied significantly due to fortification. It may be concluded that elemental iron and zinc sulfate at a dose level of 40 ppm and 30 ppm, respectively, when added to whole wheat flours, packaged in polypropylene bags, stored under either condition for a period of sixty days exhibited better results. The treatment combination containing elemental iron with $ZnSO_4$ gave the best results for fortification of these minerals in whole-wheat flour and the objectives of fortification of whole-wheat flour can be achieved without any risk of higher cost and any health hazards. Use of NaFeEDTA as source of iron in whole-wheat flour can be a second choice for whole-wheat flour fortification.

Studies on physico-chemical characteristics and preservation of cultivated mushrooms

Commercially cultivated Button (*Agaricus bisporus*, *A. bitorquis*) and Oyster (*Pleurotus ostreatus*) mushrooms were collected from commercial farms and evaluated for their Physico-chemical characteristics and preservation in brine solution. The study period was 90 days. During this period the preserved mushrooms were steeped in brine solution containing various combinations of fixed (Citric acid, Acetic acid, table salt, Ascorbic acid and potassium sorbate) and variable chemical preservatives (Potassium metabisulfite and sodium benzoate) It was concluded that a high temperature tolerant mushroom *Agaricus bitorquis* was found to be the best when evaluated through sensory evaluation methods. Statistical analyses were carried out using response surface methodology.

Physicochemical and Efficacy Studies of $FeSO_4$ Fortified Whole Wheat Flour through Small Scale Grinders.

The present research was carried out to ascertain the physicochemical and efficacy studies of iron fortified whole-wheat flour through small scale grinders (stone grinder and china grinder) also known as chakkis in local language. For this purpose wheat was milled at stone and china grinders and was fortified with $FeSO_4$ premix @ 20g/100kg of whole wheat flour which gave 30ppm $FeSO_4$ and 1.5ppm of folic acid by micro feeders installed on the grinders.

It was concluded that iron fortification did not affect proximate composition, chemical composition except total iron level and rheology of whole wheat flour from small scale grinders. It was found that fortification

was very effective against anemia and iron deficiency. It should be done to improve nutritional status of the population.

Effect of Type of Fortificants on the Quality of Whole Wheat Flour

The present research was carried out to ascertain the effect of fortificatns (local and imported ferrous sulphate) on the quality of whole wheat flour milled through small-scale grinders like china and stone chakkis. Fortification was done at levels of 10, 20 and 30 ppm respectively for both fortificants. Samples were stored in tin containers for 7 weeks. Chapattis were prepared to determine the effect of storage and fortificants and their different levels on the sensory characteristics at 0.28 and 49 days of storage interval. Iron retention was highest in flour containing 30 ppm of iron. It was also seen that the judges preferred chapattis prepared from whole wheat flour contain 30 ppm of imported

Ferrous sulphate. Imported ferrous sulphate was more suitable and performed better than the local ferrous sulphate.

Citrus Waste Utilization for the Production of Pectin

Citrus peels after oil extraction were sun dried and stored in polypropylene bags after grinding. These grinded peels were then used for pectin extraction and lactic acid fermentation. Pectin was extracted by acid hydrolysis and was purified by isopropanol and ethanol. Mussambi variety was found to be the most suitable for pectin extraction and pectin recovery was 16 percent on dry weight basis at 95ºC with 1:40 peel: water ratio. This extracted pectin was then used in yogurt as thickening agent and results were quite comparable with those of commercially available pectin.

Varietal Studies for the Production of Glucose through Acid Hydrolysis of Citrus Peels

Dried and grinded citrus peels were subjected to dilute acid hydrolysis prior to lactic acid fermentation. Maximum recovery of glucose by dilute acid hydrolysis was obtained at 110ºC for 90 minute time and with 10 percent acid concentration. The recovery percentage was 68.67% on dry weight basis. Average glucose recovery was 55.19% from musammbi variety at 120ºC for 120 minutes when time, variety and temperature were compared. On the basis of these results it was recommended that best variety for glucose recovery was musammbi and temperature range was 110ºC to 120ºC. While acid concentration and time for hydrolysis were inversely proportional to each other (with increase in acid concentration, time for reaction decreases).

The conversion of agro-industrial wastes into useful products is not only an attractive option for energy production but also a remedy to air pollution and other environmental concerns. In present studies the efforts were made for utilization of food industrial wastes for useful products. Along with other conversions attempts were made for the production of cellulose enzyme from citrus peel so that this enzyme could be used in alternative techniques employed for waste management through hydrolysis

Chemical preservation on composition of commercial mushroom varieties in Pakistan.

Pleurotus ostreatus, *Agaricus bitorquis* and *A. bisporus* varieties of mushroom grown on wheat straw were investigated for their proximate composition, pH, and absorbance of steeping solution at 30 days intervals up to three months. These mushrooms were also subjected to sensory evaluation. The pH of mushrooms significantly decreased during storage. While an increase in absorbance of brine filterate at 30 days was observed. Treatment number 5 had little effect on protein content; T1 had very little effect on crude ash content of preserved mushrooms. This method of chemical preservation of mushrooms proved best to keep mushrooms up to 90 days storage period.

AGRICULTURAL EDUCATION

1. AGRICULTURAL EDUCATION IN SECONDARY SCHOOLS

1.1. Conditions required for the introduction of agricultural education

Five studies were conducted to identify the conditions necessary for the teaching of agriculture in the high schools, The respondents were the teachers of high schools. These studies led to the following conclusions:-

1. Limited number of students took agriculture group.
2. Physical facilities were not adequately available.
3. The schools having some budget for the teaching of agriculture did not utilize it for real purpose.
4. Public leaders like MPA'S strongly favoured the introduction of agricultural education at large scale.

1.2. Agricultural education for young farmers:

Some studies were conducted regarding the need for the training of young farmers in agricultural education. Following were some of the important conclusions:-

1. No proper guidance was provided to the young farmers about the latest agricultural developments.
2. Majority of the respondents favoured arrangement for the training of young farmers.
3. Proper physical facilities and trained staff were not made available.

1.3. Syllabus in agriculture for secondary school class:

Following were some of the most important conclusions of the studies dealing with agriculture curriculum;

1. Curriculum in agriculture should be based on the needs of the community
2. Text books needed revision keeping in view the latest technology
3. More emphasis should be laid on practical when teaching agriculture to the students
4. Project method was found to be the best of all other methods for agriculture teaching
5. Internal system of examination was considered to be the most comprehensive

1.4. Agricultural education and the diffusion of agricultural practices:

More than ten studies were undertaken to determine the role of agricultural education in the diffusion of agricultural information through the students of high school studying the subject of agriculture. Following are some of the salient conclusions:-

1. At present rural schools were not playing any role in the diffusion of agri. practices.
2. It was, however, concluded that the agricultural education programme envisaged through rural

schools could be of much help in the diffusion of modern agricultural technology.

3. Majority of the schools were lacking the needed physical facilities like literature, buildings, land, equipment etc.
4. Agri. teachers were not equipped with sufficient knowledge and the students were never taken to the fields for agricultural campaigns.

1.5. Teachers' Competencies and other aspects of Education:

A number of studies were conducted on the determination of teachers' competencies and other aspects of Education. Following were the salient outcomes and conclusions of these studies.

1. Most of the students were not satisfied with the possession of needed competencies by the teachers particularly at University level.
2. The Socio-economics Status of parents was directly proportional with the achievements of their children.
3. Significant relationship was found between achievements and good study habits like schedule of study and writing back.
4. Electronic media was found to have negative impact on children's personality development.
5. Over crowdedness in the class had negative effect upon students' achievement.

2. ADULT EDUCAT10N

The process of development can be accelerated if the population is literate. There is a lot of feeling in the developing countries to increase the literacy rate. Some research studies were; conducted on different aspects of adult education. Their main findings are produced as under:-

1. At present adult education programme has not made any impact, on the improvement of the community socioeconomic conditions.
2. All the respondents were interested in adult education programme and desired to include all the related disciplines of agriculture in this programme.
3. The relationship between educational level and good Occupations was highly significant.

AGRICULTURAL EXTENSION

1. ADOPTION OF AGRONOMIC PRACTICES

Some studies were conducted on the adoption of farm innovations of different field crops. Their main conclusions are presented here.

1.1. Wheat

Improved wheat varieties were adopted by fairly large majority of the respondents but recommended sowing time of different varieties, recommended dose and time of application of chemical fertilizers were not fully adopted by majority of the farmer respondents. The seed treatment was generally not done and recommended seed rate was not considered important. Overwhelming majority wheat of the respondents was not aware of the exact timing and number of irrigations applied to the heat crop. In addition adoption of intercultural operations were also not a encouraging factor. Sowing of wheat with Rabi Drill and other improved implements was practised only by farmers having large holdings. Farmers having small and medium size of land holdings did not use the implements because of high cost, lack of loan facility and sometimes their non-availability.

1.2. Maize

Majority of the respondents adopted all the recommended practices including varieties, seed rate, sowing method, quantity of fertilizer, irrigation practices, interculture and thinning operations. The reasons for non-adoption as reported by non-adopters, were shortage of labour, lack of capital, lack of irrigation water, and lack of technical know-how.

1.3. Cotton

Studies relating to cotton crop were conducted in cotton growing areas and the sample of respondents for each study varied from 150-225. Recommended cotton varieties were generally sown by a very majority of the farmer respondents, but they used below recommended seed rate, because they considered the recommended one as too high to be needed to get optimum yield. Thinning of crop was practised very rarely. The crop was generally sown in lines but row to row and plant to plant distance was not fully maintained by about 50 percent of the respondents. The recommended plant population was not maintained by majority of the respondents. Similarly recommended number of irrigations was applied by almost 50 percent of the farmer respondents. While recommended dose of N.P.K. was applied by majority of the farmers.

1.4. Sugarcane

A fairly large majority of the respondents adopted the recommended varieties and proper sowing time. However, adoption of recommended seed rate, seed treatment and sowing method was not encouraging. The reason for non-adoption was lack of information. Adoption of recommended dose of fertilizer was also not encouraging because of lack of finance to purchase the required quantity of fertilizers. Hoeing and earthing up were not followed due to lack of labour. Similarly plant protection measures were not practised by majority of the respondents due to lack of finance and lack of knowledge.

115. Potato

The studies revealed that practices including recommended number of ploughings, green manuring, dose

of NPK and direction of rows were not adopted by a large majority of the respondents due to lack of knowledge about these practices. However, recommended seed rate, time of sowing and harvesting were adopted to a great extent.

2. ADOPTION OP PLANT PROTECTION MEASURES

2.1. Wheat

Adoption of plant protection measures against wheat diseases and insects like ear cockle, khapra, and red flour beetle were quite significant. Besides, awareness of root rot, loose smut, yellow rust and cutworm was there but plant protection measures were not adopted by a large majority of the respondents because of lack of information.

2.2. Maize

There was 100 percent awareness of seedling blight, maize borer, jasid etc. while plant protection measures were taken only against maize borer by not more than 20 percent of respondents. The reasons quoted for non-adoption included non availability and high cost of chemicals and non-co-operation of the extension field staff.

2.3. Cotton

The adoption of chemical control measures against insects pests and diseases of cotton crop was low. Reasons for non-adoption were, lack of interest, lack of resources, lack of labour, pest management problem and non-availability and high cost of pesticides and spraying machinery. The studies further concluded that age of respondents had non-significant relationship with the adoption of recommended plant protection measures. However, education and size of land holding had positive relationship with the adoption.

2.4. Sugarcane

Majority of the respondents did not adopt plant protection measures due to poor financial position and lack of information about the plant protection measures against the insects/pests and diseases of sugarcane crop.

2.5. Rice

About one-fifth of the respondents adopted recommended plant protection measures against insects/pests of rice crop. Main hurdles in the adoption were: lack of finance, non-availability and high cost of insecticides and non-co-operation of extension field staff. The studies further concluded that there was significant co-relation between: age, education, tenureship, size of land holding, and social status of respondents; and the adoption of plant protection measures against insect pests of rice crop.

2.6. Citrus fruit

The adoption of plant protection measures against insect pests and diseases of citrus fruit was encouraging. However, effectiveness of plant protection measures as quoted by the fruit growers was not satisfactory to great extent. The reasons for the failure were sub-standard chemicals and their untimely application. The respondents came up with certain difficulties faced by them in the adoption of plant protection measures. These included: high cost of machinery, high cost of pesticides, lack of finance, lack of technical skills non-availability of pesticides and lack of technical knowledge. The studies further concluded that there existed positive relationship between age, education, social status, size of land

holding and size of orchards of respondents; and adoption of plant protection measures.

3. ADOPTION OF CHEMICAL FERTILIZERS

Some studies were conducted on the adoption of chemical fertilizers by the farming community. The results revealed that chemical fertilizers were being used frequently but recommended N.P.K. ratio was not known/used by majority of them. Besides, time of application of different doses was not taken care of. The reasons given by non-adopters were: high price of fertilizers, lack of irrigation water, lack of knowledge and non availability of fertilizers at proper time.

4. ADOPTION OF LAND RECLAMATION PRACTICES

The studies on adoption of land reclamation practices show that the respondents adopted various recommendations like lay out and levelling of fields, leaching down the salts with irrigation water, sowing of salt tolerant crops, field drains and pumping out of sub-soil water by tube-wells. However, cropping pattern corresponding to the situation was not adopted by majority of the farmers of salinity affected areas. Furthermore chemical treatment to reclaim the soil was not at all practised by any of the respondents. The reasons for non-adoption were reported to be; lack of capital, lack of information, insufficient supply of irrigation water and lack of co-operation extended by the Reclamation Department.

5. COMMUNICATION MEDIA

Mass Media were used to disseminate latest agricultural technologies among the farming community. These media had been found supplementary and complementary to one another. Radio was found significantly effective medium in disseminating information to the farmers. Agricultural programmes (Zarii Programme) were liked by most of the respondents irrespective of having or not having radio sets. In a study "Zarii University Magazine" a fortnightly radio programme, was evaluated. It was found that majority of the farmers was dissatisfied with this programme. They suggested that the topics of talks should be selected according to the felt needs and problems of the farmers. Exhibitions were also found effective source of information for the farming community. The use of Cinema Van in agricultural extension was found very rare. Majority of the movies shown through cinema van were not related to agriculture. It was revealed that movies shown did not impart any information about variety or seed rate of any crop except that of maize crop. Most of the information received through movies did not relate to Pakistani conditions. Fortnightly 'Zaraat Nama' published by Agricultural Information Bureau, Lahore was evaluated. It was found that the farmers were quite satisfied with the present arrangement of distribution, physical appearance, price, contents, quality and quantity of subject matter covered in it.

6. TRAINING NEEDS OF EXTENSION PERSONNEL

6.1. Training needs of tube-well operators for extension work

A study was taken-up to know the training needs of the tube-well operators for serving as voluntary extension agents. The data of the study revealed that majority of the respondents liked the training programme to work as voluntary extension agents and viewed that voluntary extension work by them would be a great service to farmers. Most of them wished to have Agronomy as their major subject of in-service training.

6.2. Attitude of the extension workers towards the necessity of in-service training

A study was designed to explore the attitude of the extension workers of Multan and Vehari districts towards the necessity of their in-service-training. In these districts strength of Agriculture Officers and Field Assistants was 58 and 245, respectively. Fifty per cent from each category of extension workers

were selected at random to serve as respondents. Apart from these, 28 farmers were also interviewed. The study revealed that almost all the extension workers studied all the subjects related to agriculture and also received in-service training continuously to strengthen their extension work and to enhance their professional competency. Moreover they reported that the arrangements of in-service training at present made by the department were not satisfactory.

6.3. An appraisal of the training needs of the agricultural extension personnel (Fields Assistants)

According to the results of this study, subjects of Agricultural Extension, Plant Protection and Agronomy were placed first, second and third priority respectively on the basis of their usefulness in the field. The respondents, in general, emphasized the need of comparatively more and intensive training in those subjects in pre-service and in-service training.

7. NEED FOR PARADIGM SHIFT

The present study was conducted to explore the perceptions of farmers, organizational staff including the change agents commonly called as extension workers, and their supervisory staff regarding the need for paradigm shift from top-down to participatory extension in the governmental agricultural extension system in the Punjab province, Pakistan. Based on the perceptions of stakeholders an analysis of the currently practiced governmental top-down agricultural extension system and the participatory extension system of selected NGO (PRSP) was conducted. The questions “Is there a need for the paradigm shift from top-down to the participatory extension in the Punjab? How should this change take place? And what are the perceived implications for this change? were answered.

The organizational staff which includes change agents and their supervisory staff of both systems (Top-Down and Participatory Extension); and their joint contact farmers were contacted to collect the needed information from Faisalabad district which is one of the prominent and important district of the Punjab province. The data were collected through the research instrument, which was tested for its reliability and validity. The data collected were thus analyzed using statistical package for social sciences (SPSS). The respondents agreed that the Participatory Extension System (PES) had more strengths than that of the Top-Down Extension System (TDES). They indicated a need for Paradigm shift from TDES to PES in the governmental extension system. They indicated that the change should take place step wise in one year. The most important implications of this change were identified as:

The country will be self sufficient in all major cash crops; the traditional knowledge of farmers will improve; there will be visible change in the socio-economic conditions of farmers. The main characteristics of the perceived future participatory extension system were identified as: It should address the real problems of farmers; multidisciplinary teams of researchers, extension workers, and farmers should work together for information generation and dissemination; It should ensure sustainability; there should be working relationship between government, rural communities and other agencies like banks, donor agencies and government line agencies; there should be strong and regular feedback regarding the solutions of problems related to farming community; it should be run by the government through participatory extension approach; it should use farmer friendly mode; It should ensure maximum farmers’ participation; the need for the physical infrastructure schemes be initiated by the people themselves; Department of Agricultural and it should be run through the active involvement of CBOs; Department of Agriculture (extension) should be run on partnership basis.

8. IDENTIFICATION AND RANK ORDER DEVELOPMENT OF SELF PERCEIVED COMPETENCIES POSSESSED BY AGRICULTURAL EXTENSION AGENTS IN THE PUNJAB, PAKISTAN

The Agricultural Officers (AOs) are the development professionals in the field of agriculture in Pakistan. The agricultural extension service which is a provincial responsibility in Pakistan tries to educate farmers

regarding the adoption of latest technology. Recently they have been requested to work under a different paradigm *i. e.* Decentralized Extension which required the role change of AOs from supervision and officer to front line extension worker. Therefore this study was designed to identify and prioritize the training needs of AOs regarding professional and technical competencies in the Punjab, Pakistan.

The study used a descriptive survey research methodology. Out of 341 agricultural officers, a random sample of 181 was taken. A questionnaire was developed by the researcher from the synthesis of related literatures and organizing series of workshop. The questionnaire was consisted of four sections: (1) Demographic information; (2) Assessment of professional competencies; (3) Assessment of technical competencies; (4) Appropriate time and method of in service training. It was also tested for validity and reliability. The Cronbach's alpha for various categories of competencies ranged 0.84 to 0.97. The questionnaire comprised 105 professional competencies and 38 technical competencies. Each competency statement required the respondents to rate the item on two similar 1-5 point Likert scales. One rating was for possessed level of competency and the other for importance level of competency. The overall response rate was 79.5% (144) out of the 181 respondents. The data were analyzed statistically using computer soft wares "Statistical Package for Social Sciences (SPSS)".

The discrepancy values between importance and possessed level of competencies (training needs) AO's were positive values for all professional competency categories ranging from lowest value 0.61 to highest value 2.18. It was concluded that priority wise professional areas of competence in which agriculture officers need training included: computer skills and their application in agricultural extension, use of modern audio visual aids; participatory extension methodology; professionalism; human behavior/ public relations; program planning; extension teaching methods; and supervision and administration.

The discrepancy values between importance and possessed level of competencies (training needs) were positive values for all technical competency categories ranging from lowest value 0.50 to highest value 1.18. It was concluded that priority wise technical areas of competence in which agriculture officers need training included: use farm machinery; application of plant protection measures; horticultural crops; and agronomic practices.

9. DEVELOPING A STRATEGY FOR MOBILIZING RURAL YOUTH FOR THE DEVELOPME3NT OF AGRICULTURE IN NWFP, PAKISTAN

In Pakistan, approximately two-third of the population is living in rural areas, which is mainly engaged in farming. At present, about one-fourth population consists of youth. They are facing a number of problems. There is no effective youth development program. The agricultural extension services are still ignoring youth as dynamic partners of extension work. Realizing the importance of youth as an important sector of society and their potential contribution towards development, the government of Pakistan announced youth policy in 2002. It aims at turning young people into good citizens and providing them environment for harnessing their physical and mental facilities to become responsible and productive members of the society. Majority of Pakistani youth live in rural areas. This study was therefore planned to develop a strategy (recommended course of action) for mobilizing rural youth for the development of agriculture in NWFP, Pakistan. The study was conducted in Chokara Union Council of District Karak, NWFP. A simple random sample of 313 out of 1680 households was taken. All the youth (460) of the selected households were studied through personal interviews. The data thus, collected were analyzed statistically to draw conclusions and to suggest a course of action (strategy), which may be helpful for the administration of the Department of Agriculture (Extension), Government of NWFP; NWFP Agricultural University, Peshawar, Local Government, and NGOs to mobilize rural youth for agricultural development. It was suggested that there should be separate wings for male youth called "Quaid-e-Azam Youth Organization" and for female youth "Fatima Jinnah Youth Organization" within the provincial department of agriculture (extension). Separate male and female but activity based youth clubs having 10-15 members should be organized at village level.)

CONTINUING EDUCATION

Continuing Education

A demand driven research has been conducted through assessing and developing short courses in the field of Agriculture, Veterinary Sciences, Economics and General Sciences. In this regard a sizeable number of short courses have been developed and offered which are being conducted around the year depending upon the facilities and willingness of the end beneficiaries.

Agronomy

Allelopathy as a tool for combating the menace of weed has been probed and has been found very successful to reduce the losses of weeds in different crops with special reference to maize crop. More over a very suitable row sowing maize technology has been developed with different plant spacing for better quality of high yield. Similarly an inter cropping production technology of wheat crop with different combinations of short stature crops have been developed.

Agricultural Extension

Prioritized training needs of Agriculture Extension workers regarding their Professional and Technical Competencies in the Punjab province. The main Prioritized training such needs are in the area of Computer Skills, Use of Audio Visual Aids, Participatory Extension Methodology, Human Behavior, Program Planning, Extension Teaching Methods and Supervision & Administration.

Plant Protection

The research work completed on different generas from time to time is given below

1. ***Genus Neoseilus Huges.***

- Under this genus described two new species from Pakistan
- *Neoseilus ostium* new species from madyan and *Neoseilus deplo* new species from kalam

2. ***Genus Amblyseius Berlese***

- In this genus Amblyscius Berlese described seven new species,
- Amblyseius carnis new species and Amblyseius celsus new species from abbotabad,
- Amblyseius bulga new species, Amblyseius humilis new species from balakot,
- Amblyseius forefox new species, from behrain, Amblyseius caladium new species from sama sattaand Amblyseius animas new species from Karachi, respectively

RURAL HOME ECONOMICS

1) Department Overview:

The department of Rural Home Economics was established in 1980 with the initiation of One Year Diploma Course in Rural Home Economics. The main purpose of this diploma was to produce trained home economics teachers for middle schools in addition to preparing them as the trained home economics agents & housewives.

At present the following programmes are offered by the department:

1. M.Sc Home Economics (Food & Nutrition)
2. B.Sc Home Economics
3. One Year Diploma in Rural Home Economics

The scheme of Studies B.Sc Hons Home Economics Four year degree programme and M.A. Fine Arts is submitted to the Academic Council for approval to be initiated with effect from winter semester 2005-06 only for female candidate.

History of Department:

The department initiated B.Sc. Home Economics degree programme in 1990. The duration of this degree Programme is four semesters after F.Sc. (Pre-Medical). The present two year degree Programme of B.Sc.(Hons.) is being converted into four years B.Sc (Hons.) Home Economics degree programme. The graduates of this degree Programme may take admission to various M.Sc. degree Programme (Computer Science & Rural Sociology) in the University in addition to M.Sc. degree programme in Home Economics (Food & Nutrition), which has started from spring semester 1995. It is hoped that M.Sc. Home Economics (Food & Nutrition) degree holders would be able to get jobs in hospitals, medical colleges and related organizations in public sectors.

2) Programme and Courses:

Undergraduate:

To produce graduate of international caliber with knowledge and skills needed for the cultural, social economic and political development of the society. The main purpose of one year diploma course was to produce trained Home Economics for middle schools in addition to preparing them as the trained home economics agents & housewives. A Total number of 1401 students successful in completed the diploma in Home Economics and 3065 students of Home Economics have pass out.

Postgraduate:

196 students have been awarded degree of M.Sc. Home Economics (Food & Nutrition) their research finding was on malnutrition disorders. The department has its on research facility in the form of well equipped and functional nutritional laboratories.

Others:
The following short course offered by the department

1. Short course in Baking (for girls only)

2. Short course in Art & Craft (for girls only)
3. Short course in painting (for girls only)
4. Short course in dry flower arrangement (for girls only)

3) RESEARCH ACHIEVEMENTS:

1. Glycemic index of local food has been determined.
2. Study of nutritional disorders.
3. Mal Nutritional status of different socio economic class have been evaluated for the last six years and recommendation have been published I various national and international Journals.

The staffs of the department of Rural Home Economics have conduct research projects on various aspects of human nutrition:

1. Dietary Effects on Blood Lipid Profile of Elderly People Belonging to high Income Group.
2. Metabolic, Minerals and Thyroid Profile During Early Dialysis.
3. Dietary Influence on Hemolipid Profile in Children of Middle Income Group.
4. Effect of Various Nutritional Diets and Honey in Healing of Burn Wound in Children with More Than 20% Body Surface Area.
5. Effect Of Chromium Supplement On the Haematocemicals, Minerals and Thyroid Hormone Profile of Female Rats
6. Hematochemical Alteration in Obese Human Females.
7. Changes In Some Haematochemicals, Minerals and Hormonal Profile ofYoung Rats Induced By Abamectin And Bifenthrin
8. Metabolic, Minerals and Thyroid Hormone In Renal Failure.

Title/ Summaries of M.Sc Thesis produced

1) Effect of Different commercial Fruit Juices on Blood Glucose Levels of Normal and Diabetic Volunteers

Diabetes has become a world health problem. It is possibly the fastest growing metabolic disease and about 120 million people in the world are suffering from diabetes, in the year 2025 the figure would reach about 250 million. For the determination of blood glucose response of 25g a-D-glucose and to compare it with 25g portion of carbohydrates in test juices, a total of sixteen individuals, eight normal and eight diabetic were selected. All the subjects of study were in post absorptive stage. The blood glucose response of a D-glucose and test juices were determined by ACCU TREND glucometer. In both normal and diabetic subjects variations among the subjects were highly significant ($P<0.001$).

2) Effect of "Plas papra" Fruit on Blood Glucose Level and Lipid Profile of Normal Subject and Human Patients.

Certain indigenous medicinal plants have been found to contain principles. Such plants can prove useful for the treatment of diseases not curable by the conventional drugs. This pertains especially o the diabetes powdered Butea monosperma (Plas papara) leaves on blood glucose levels and the lipid profile in normal and diabetic human volunteer. In addition lipid profile parameters were determined in the serum

of normal and diabetic male and female adults of 30-60 years of ago. The parameters recorded include total lipids, triglycerides, total cholesterol, low density lipprotein cholesterol (LDL-C) and high density lipoprotein cholesterol (HDL-Cholesterol). In present study a total of 128 blood samples were collected. Sampling was done from in and around Faisalabad city, especially from Khadija Memorial Trust Hospital and the medical centre, University of Agriculture, Faisalabad. The diagnosis of diabetic patients was made on the basis of levels of blood glucose of subjects whereas lipid profile parameters in serum were determines with RANDOX reagent kits. The data, thus collected was analyzed statistically.

3.) Haematochemicals, Minerals and Thyroid Hormones Profile in Children with Acute Diarrhea.

Diarrhea means frequent, loose, liquid stools. There may be a gripey abdominal pain, which is less after stool is passed. Acute diarrhea comes on suddenly and lasts for a short time period of seven days. It is clear from literature that certain plasma biochemical, minerals and thyroid hormonal profile in children with acute diarrhea have been ignored. Therefore, a research project has been planned to determine the changes in plasma of acute diarrhea hildren. To meet these objectives, a total of forty(40) blood samples were collected from normal children as well as children with acute diarrhea. The physical parameters i.e. age, height, weight and body temperature were recorded in normal and acute diarrheal children. BMI was calculated by using the formula. Analysis of glucose, cholesterol, trighcerides, high-density lipoprotein (HDL), low density lipoprotein (LDL), total proteins, albumin and globulin were made by using commercial kit. Plasma enzymes, glutamate pyruate transaminase by (GPT) and glutamate oxaloacetate transaminase ((GOT) were determined by Reitman-Frankel colorimertric method. For analysis of electrolyte (Na, K, Ca and Mg) and trace elements (Cu, Zn, iron and Mn) all blood samples were subjected to wet digestion.

4. Haematochemicals, Minerals and Thyroid Hormone Profile in Children with Chronic Diarrhea.

The function of the gastrointestinal tract is to remove the digested waste products from the body. Any defect in its absorption may lead to diarrhea. Chronic diarrhea is defined as “diarrhea which persistes for more than two weeks. In chronic diarrhea excessive losses of water and electrolytes can take place. It is caused by inflections, inflammatory bowel diseases and endocrine disorders. Previous stiudies have ignored plasma biochemical, transaminases, thyroid and most of the essential trace mineral profiles in diarrheal children. A total of (40) blood ten (10) from male and ten (10) from female children with chronic diarrhea were obtained. Low density lipoprotein (LDL) and globulin were determined using formula.

5. Effect of Chromium Supplement on the Haematochemicals, Minerals ans Thyroid Hormone Profile of Female Rats.

Chromium is naturally occurrinf element that activates enzymes, maintains stability of proteins and nucleic acid. Chromium influence carbohydrate lipid and protein metabolism. It potentiates the action of insulin. Toxicity of chromium may cause skin, lung and gastrointestinal tract irritation. Chromium deficiency includes impaired glucose tolerance, impaired growth and glycosuria. The project has been designed to evaluate the plasma biochemistry, enzymes, electrolytes, trace element and thyroid hormone status in rats when fed with 400ug of chromium picolinate. 20 female rats were divided into four groups were one young and one old female groups kept on control diet other group one young and old treated with chromium picolinate.

6. Nutritional Megaloblastic Anemia Due to Folic Acid Deficiency in Malnourished Children

The study was planned with the objective to observe the prevalence of folic acid deficiency either clinically or biochemically apparent in children (Aged 6 months-10 years). The study involve 100 cases. Among these 50 children will be diseased and other 50 age matched healthy controls. Blood samples will be individually collected from all these children for the analysis of folate contents through slide

microscopic method. The data thus obtained will be subjected to statistical analysis using Completely Randomized Design(CRD).

7. Study On Heart Attack with Special Reference to Life Style and Obesity in people of Different Socio-Economics Status Age and Gender

Obesity is a major risk factor for cardiovascular disease. There are certain other risk factors that are the cause of heart attack. Alterable risk factors contain sedentary life style and obesity which are parallel and interrelated that contribute to increased with heart attack among local people of different socio economics status. Biochemical parameters e.g. serum total cholesterol, HDL,LDL triglycerides. Blood urea will be tested and appropriate statistical analysis will be applied.

8. Biochemical Changes In the Blood Due to Hepatitis-B

Hepatitis B is a viral disease which is widespread now-a-days. This disease alters the levels of glucose, protein, creatinine, urea, cholesterol and electrolytes in the blood of patients. Different tests will be performed to determine the level of above mentioned components in the blood of hepatitis-B patients and appropriate statistical techniques will be applied to interpret the results.

9. Nutritional Status of Female Prisoners with Special Reference to Anemia.

Nutritional status refers to the state resulting from the balance between the nutrient intakes and energy expenditure. Nutrition is the basic factor that influences the physical and mental approach of a community and anemia is the basic health problem especially in females, which may results from the poor nutritional status and some other reasons. It is also a basic problem in female prisoners. The project is designed to determine the nutritional status, anthropometric measurements and health problems like anemia in female prisoners. Blood samples will be separated in small aliquots and stored at -4^0C. Plasma samples will be analyzed for the determination of iron serum, Hemoglobin level (Hb) and for the blood cell count packed cell volume (PVC). Appropriate statistical analysis will be applied to analyze the date.

10. Assessment of Oxalate Absorption from Some Local Vegetables and Beans

High oxalate levels are suspected to be present in different foods of Pakistan. Absorbed dietary oxalated have been repoted to significantly increase the urinary oxalate levels, which would be a major risk factor for kidney stone formation. Therefore it considered worthwhile to determine oxalate levels in some local foods. At least 6 stone formers and 6 non-formers individuals will be selected. Oxalate levels in vegetables and beans will be determined by using capillary electrophoresis and enzymatic methods. Oxalate levels in urine will be analyzed by using oxalate kit. Urine creatnine will be analyzed by using atomic absorption spectroscopy. Statistical analysis will be done by using ANOVA and Pearson correlation tests.

11. Physio-Chemical Examination of Raw Milk Sold at Various Hospital Canteens and Student Hostels/Hall in Faisalabad.

There is a common feeling that milk produced and marketed under very unhygienic conditions. Unhygienic conditions, no doubt, can affect the physio-chemical characteristics of milk. Therefore, this project is planned to determine the physio-chemical quality of raw milk sold in Hospital Canteens and student Hostels in Faisalabad City. Eighty samples of raw milk will be collected will be analyzed by using appropriate statistical methods for proper interpretation of results.

12. Determination of Total Cholesterol, Omega-3 and Oleic Acid in Various Types of Butter, Ghee and Oils Used as Dietary Fats.

The role of cholesterol in the body has been established to be that of a raw material for many other steroids. A high level of cholesterol in blood has been found to be an important risk factos for the consumers. On the other hand omega-3 and oleic acid tends to lower bad LDL cholesterol and increases the levels of cholesterol and these fatty acids in various types of commonly used dietary fats. Different samples of fats including butter and "desi ghee" and vegetable ghee like Kashmir, Kisan, Tullo, Dalada, etc. and oils including Sunflower, Canola, Olive oil, etc. will be purchased from the local market. Representative samples will be taken and analyzed to determine total cholesterol, omega-3 and oleic acid contents by following the standard methods. The data will be analyzed statistically.

13. Blood Glucose Responses To Traditional Pakistani Leguminous Dishes in Normal and in Diabetics.

It has been suggested that the knowledge of glycaemic response of food may be useful in rationalizing diabetes diet therapy. The study has been designed to determine the blood glucose response of five traditional Pakistani leguminous dishes containing rice along with Mash (Vigna mungo), Mung (Vigna radiate), Masoor (Lens esculenta), Chickpea (Cicer arietinum) and chicken baryani in the people of Faisalabad. The proximate analysis of five different test meals will be done for determination of carbohydrates, protein, fats, ash and dietary fibre. A group of six normal and six diabetic human volunteers will be selected. The carbohydrates portion of five different test meals will be determined randomly after an over night fast. The response of bread and eggs will be taken as control. Blood samples of diabetic volunteers will be taken by finger pricks at 0,30,60,90,120,& 180 minutes and in normal volunteers will be at0,15,30,45,60,90,120 minutes. Glycaemic index will be calculated by standard formula.

14. Chemical and Hygienic Quality of Locally Available Brands of Processed Milk.

Chemical and hygienic quality of UHT treated being sold in small packets by various milk plants in Punjab will be determined. Eighty samples of milk of four different brand names from four different lots would be analyzed using standard methods as recommended by A.O.A.C and American Public Health Association. Data thus obtained will be anlaysed by employing appropriate statistical techniques. The results will help find out the quality of milk being marketed by various milk processing plants.

15. Alteration of Plasma Biochemistry in Burned Patients.

Burn injury is extremely stressful, and data characterizing the systemic body stress response to this injury and sparse. The project has been designed to evaluate the plasma biochemistry, enzymes, electrolytes, trace elements and thyroid hormone status in burned patients. Patients will be of three categories that is I,II, and III degree burn. Ten blood samples of each categories nearly of about same age group within the category will be collected, so total will be 30 samples. And 30 samples will be collected from normal people of some age group within each category. So total 60 samples will be collected with EDTA and then will be centrifuged for collection of plasma.

16. Correlation Between Plasma Haemato Chemicals Thyroid Hormones, Macro and Micro Minerals and Myocardial Infarction

Coronary artery disease is a condition in which fat deposits in the cells lining the wall of the coronary arteries. These fat deposits build up gradually in the two main arteries, which encircle the heart, which is the main source of blood supply to heart. These fat deposits result in narrowing and hardening the blood vessels which supply blood and oxygen to the heart. This can cause damage to heart muscle by little or complete designed to evaluate the plasma biochemistry, enzymes, electrolytes, trace elements and thyroid hormones sattus in myocardial infracted humans. Forty volunteers will be divided into 4 group

according to gender. Each group will consist of 10 volunteers, two control and analyzed for biochemical, minerals, enzymes and hormonal profiles to see any difference between normal and myocardial infracted patients.

17. Effect of Iron Toxicity on Plasma Biochemical Minerals and Thyroid Hormones of Young Rats.

Iron (Fe) is an essential nutrient that forms part of oxygen proteins, hemoglobin in red blood cells and myoglobin in muscles. Its absorption can be impaired by Zinc and calcium. It is also essential for regulation of cell growth and differentiation. There is a considerable potential for iron toxicity because little is excreted from body and accumulate in body resulting in hemochromatosis. The project has been designed to evaluated the plasma biochemistry, liver enzymes, trace element and thyroid hormones status in young male and females rats fed high doses of iron. Twenty-four wistar rats will be divided into four groups, each will consist of six rats, two contol and two experimental groups. One male and other female group will be kept on basal diet and water ad libitum and will serve as control. The other two groups comprising male and females rats will be subjected to high doses of iron and will be designated as experimental groups. Plasma samples and organs from each rat will be collected to analyze the biochemical, minerals, enzymes and hormonal profiles to investigate the toxic effects of iron.

The chairperson of the department has written more than 30 research papers in various national and international Journals. Furthermore 35 research papers have also been written by the faculty members of the department of Rural Home Economics.

1. Three chapters and the book entitled “Fundamentals of Animals Nutrition” published by the department of Animal Nutrition, University of Agriculture, Faisalabad have been written by Dr. Nighat Bhatty, Associate Professor/ Chairperson Department of Rural Home Economics Faisalabad, 2001.
2. Seven chapters in the book entitled “Poultry Feeds and Nutrition” have been written by Dr. Nighat Bhatty Department of Rural Home Economics, Faisalabad Published by Kitabiatan Publishing Co. 38- Urdu Bazar Lahore. 2001.

4) OTHER RELATED LINKS:

1. Society of Home Economics was established in 1996, to prepare the women folk to participate in improvement of lifestyle of a society in the area of Home Economics.
2. The linkages with the collage of home economics Lahore, has also been established.
3. MOU between the University of Agriculture, Faisalabad and Khadeeja Mehmood Trust Hospital, Faisalabad has also been signed to facilitate postgraduate students of the major subject i.e. Food & Nutrition.

MISSION

- To educate woman folk.
- Import scientific knowledge of nutrition and hygiene in order to promote health.
- To utilize natural resources through women folk.
- To develop creativity by means of learning experiences.
- To develop base to finance transactions and budget planning.

- To develop the skills for income generation.

VISION

- To impart training in the field of Home Economics with special reference to Food And Nutrition, Child Development, Home Management, Clothing And Textiles, Related Art and Fine Arts.
- To develop skilled women power for teaching, nutrition, food at different level, i.e. school, college, university level.
- Ural and urban development through education of the women.
- Up grading the status of Department of Rural Home Economics to the Faculty of Rural Home Economics as Approved under the Act 1973.

COLLEGE OF AGRICULTURE, D.G. KHAN

1. Effect of spatial variability of soil salinity and sodicity on the performance of *eucalyptus camaldulensis*.

Revegetation of the wastelands with salt tolerant tree species is an attractive and economical alternative. Nevertheless, growth of salt tolerant species such as *Eucalyptus camaldulensis* in wastelands is not uniform. In one of the study conducted at two sites, causes of such differential growth were investigated on three years old *Eucalyptus camaldulensis* plantation. Soil under *E. camaldulensis* at both the sites were saline sodic in nature; site I: ECe 16.1-37.7, pHs 7.4-8.9, SAR20.2-47.6, texture, sandy clay loam to loamy clay; site II: ECe 8.0-39.9, pHs 8.0-8.9, SAR 11-30.2, texture, clay loam to silty clay loam. To evaluate the effect of salinity on plants and effect of plant on soil characteristics on these two sites, 24 plants were selected on each site randomly on the basis of their visual growth. Amongst the selected plants eight plants were good, eight plants poor, and eight very poor in growth. Soil samples under the canopy of each category of plant were collected up to the depth of 150 cm and analyzed for ECe, SAR, pHs, and texture. Field infiltration rate was also measured. Eucalyptus growth in terms of plant height and girth were recorded. Results reveal that the differences in growth were due to spatial variability in soil salinity and sodicity. Although soil salinity (ECe) is believed to be having a pronounced effect on plant growth, the effect was mainly because of accompanying soil sodicity (SAR). Root zone salinity, pHs and SAR of plants showing good growth was low as opposed to the plants showing very poor growth. The pronounced differences in two categories of plants i.e good and very poor were because of root zone salinity and soil permeability characteristic.

2. Growth Response and Leaf Composition of Selected Eucalyptus Species Exposed to Saline and Hypoxic Stress

A Solution culture study on selected Eucalyptus species (E. occidentalis*, E. tereticornis, E. camaldulensis-var. Silverton, and E. camaldulensis*-Local) was conducted under saline and hypoxic conditions to determine the effect of treatments on growth and leaf composition. The treatments were non-saline, aerobic (control), saline aerobic (150 mol m-3 NaCl) and saline + hypoxic. Solutions in case of non-saline aerobic and saline aerobic were aerated continuously while hypoxia was induced by surface sealing (oxygen concentration 2-3 ppm). Twenty five days after salinity/hypoxic stress, plants were harvested. Salinity negatively affected all the growth parameters (plant height, stem thickness, and root and shoot fresh weights) and the effect was further aggravated when it was associated with water logging. Among the species *E. camaldulensis*-Local and *E. camaldulensis*-var. Silverton were found better under saline conditions and *E. camaldulensis*-Local under saline hypoxic conditions. Young leaves of all the species had lower concentrations of Na and Cl as compared to old leaves, and concentrations of Na and Cl in the leaves of both categories were the highest under saline hypoxic conditions followed by saline treatment. Potassium: sodium ratio was better in the young leaves of all the species compared to fully exposed old leaves, and the ratio was better also under favourable conditions. From amongst the species, *E. camaldulensis*-Local had low Na and better K: Na ratio in its leaves. Mean rate of growth measured as coefficient offshoot elongation (CSE) was the lowest in E. tereticornis whereas; all the shoot fresh weight was the highest and significantly superior to all the species in *E. camaldulensis*-Local.

3. Phosphorus Nutrition of Cotton Cultivars under Deficient and Adequate Levels in Solution Culture.

In low-input agricultural systems that characterize most of the developing world, nutrient- efficient crop

cultivars may play significant role in improving crop productivity. Phosphorus (P) deficiency is a common phenomenon in cotton growing areas of Pakistan while farmers are reluctant to apply it due to its cost-intensive nature and fear of lack of response. A solution culture experiment was conducted to evaluate ten commonly grown cotton cultivars for their relative efficiency to utilize deficiently and adequately supplied P, using Johnson's solution. Phosphorus deficiency markedly reduced shoot dry weight (SDW), root dry weight (RDW), whole plant dry weight (WPDW), leaf area per plant (LA), P-concentration in roots and shoots, P contents on root, shoot and whole plant basis and absolute (AGR) and relative growth rates (RGR) of the cultivars. Root: shoot ratio (RSR) and specific P-absorption rate (SAR) was substantially increased due to P deficiency, where as, P-utilization efficiency (PUE) and specific P-utilization rate (SUR) remained un-affected. The cultivar 'FH-634' exhibited minimum stress due to p-deficiency in terms of relative reduction in SDW production (PSF=6%) while seven out of ten cultivars showed PSF of about or more than 50%. The effects of cultivars (C) and cultivar-by-P-level (CXP) interactions were statistically significant for most of the parameters studied. Phosphorus-utilization efficiency was positively related to SDW, RDW and WPDW (r>0.88;n=10) in P-devicient as well as control treatments and there was no interaction between PUE and P-uptake by the ;cultivars. Rate of P-absorption was found to be controlled by plant P contents under P deficient conditions suggesting an internal regulation on addition to the influence exerted by external P supply. The conclusions from experiment were that differences in growth existed among cotton cultivars exposed to same P concentration on the growth medium. Cultivars, which were efficient in both P-acquisition and P-utilization, were efficient accumulators of biomass under adequate as well as deficient level of P supply.

4. Differential Growth Response of Cotton Cultivars to Applied Phosphorus

Identification/selection of cotton cultivars that are efficient utilizers of native or added P can help in maintaining high productivity on soils of cotton growing tract of Punjab (Pakistan), which being alkaline calcareous in nature are frequently deficient in plant-available P.Six cotton cultivars were grown in pots for 65 days after sowing, using a soil deficient in NaHCO3-extractable P (4.10 mg Kg-1) with (+P=56 mg P kg-1 soil) or without P addition (0P). Phosphorus deficiency reduced biomass production, P-concentration in roots and aboveground plant parts, and P-uptake by roots and shoots. However, parameters such as root: shoot ratio (RSR) and synthesis of biomass per unit of absorbed P (calculated on the basis of P-concentration in leaf blade: PUEL) remained unaffected due to P-deficiency. Reduction in shoot dry weight (SDW) as a result of P-deficiency i.e. P-stress factor (PSF) ranged from 40% (in 'NIAN-92') to 77% (in 'NIAB-78'), indicating variations in P-deficiency stress tolerance of these cultivars. Intra specific variations were statistically significant for most of parameters studied, while cultivar (C) x P-deficiency, the cultivars that produced higher root biomass were able to accumulate higher total plant P uptake (r=0.933**), which in turn was related positively to production of SDW and total biomass (r > 0.88*) and negatively to PSF (r = -0.893*). Wide differences of growth observed on this experiment encourage screening of more germplasm, especially in the field, to identify P-efficient cotton cultivars.

5. Role of calcium in the salinity tolerance of rice

Solution and soil culture experiments were conducted to investigate the effect of calcium (Ca) on salinity tolerance of rice, using two rices of differential salt tolerance (NIAB 6: salinity tolerance; IR 1561: salinity sensitive) grown with (100 mol m-3 NaCl) and without salinity. Different Ca concentrations (20, 40, 60, 80, 120 and 160 ug Ca mL-1) were developed with the addition of CaCl2, whereas, in the case of soil culture gypsum (CaSO4.2H2O) at the rate of 10, 25, 50 and 100% gypsum requirement (GR) was applied to both saline and saline sodic soils as a Ca source. The results of both the studies reveal that Ca application improved growth parameters in solution (40-60 ug Ca mL-1) and soil culture. Gypsum application @ 25% GR produced maximum paddy yield compared to its lower and higher rates in salt affected soils. In addition, Ca application tended to improve K+: Na+ratio of the tissues. The amelioarative effect of Ca was because of Ca2+: Na+ ratio in the growth medium. Nevertheless, excessive rates of Ca either in solution or soil were found detrimental for plant growth and paddy yield.

6. Feasibility of using hill-torrent water in Rod-Kohi area of Dera Ghazi Khan

This research project has been approved by the Directorate of Research, University of Agriculture, Faisalabad vide No. 184-94/DR dated January 25, 2001 for a cost of Rs.45, 000/-. The basic objective is to prepare feasibility for harnessing stray waters of Hill-torrents of Dera Ghazi Khan and Rajan Pur districts for their utilization for increasing agricultural productivity of over 0.81 Mha where no other potential source of irrigation water is available. Survey of the area has been initiated for evaluating/analyzing its research and development needs in context with the use of hill-torrent waters for agricultural purposes. A detailed development-cum-research project will then be prepared in the light of the outcome of preliminary work.

7. Effect of compact salt affected soil on the growth of *eucalyptus camaldulenses* (local)

Deterioration of soil structure because of dispersion of soil particles in saline sodic/sodic soils is a common phenomenon, whereas, occurrence of compact layers at lower horizon on these soil because of downward clay movement is not conducive for root development. A pot culture study was conducted with a naturally salt affected soil (clay loam, ECe 19.6 dS m-1, pHs 8.4, SAR 22.7 [mmolL-1]1/2, p£ 0.91 Mg m-3) at two bulk densities (p£ 0.91± 0.02 and 1.36±0.02 Mg m-3) to study the effect of soil compactness on the growth of Eucalyptus camaldulensis, Local. The bulk density of 1.36 Mg m-3 was developed in pots artificially. Plants showed significant differences in growth after 22 weeks of planting: growth (plant height, shoot and root fresh and dry weights) depressed significantly in compact salt affected soil compared to non-compacted soil. Root growth was less affected as compared to shoot growth.

8. Phosphorus acquisition by cotton cultivars under deficiently-buffered-p conditions

To evaluate P-acquisition ability of six cotton cultivars, pre-germinated seedlings were grown in nutrient solutions containing tri-calcium phosphate (TCP) @ 0.5 gL-1 as P source, in a bid to maintain deficiently-buffered solution-P concentrations throughout growing period. The cultivars harvested 15 days after transplanting, exhibited substantial growth differences in terms of biomass production, P-accumulated by 'NIAB-92' followed by 'CIM-443' and 'CIM-1100'. The other three cultivars ('NIAB-78', 'FH-634' and 'S-12') produced significantly lower SDW. A positive correlation existed between root dry weight (RDW) and SDW of the cultivars, and increased RDW of efficient cultivars was not due to preferential translocation of photosynthates to roots at the cost of aerial plant parts. Phosphorus concentration in roots of the cultivars was higher as opposed to shoots, and a negative correlation existed between root-P concentration and shoot as well as root dry weights (SDW & RDW) r = -0.84*, RDW r = -0.93**). Phosphorus concentration of nutrient solutions remained fairly constant during growing period and no evidence of rhizosphere acidification was observed. Higher SDW of the cultivars was related to their better P-acquisition ability, which in turn was related to higher Ca uptake. Thus, cultivars having efficient Ca accumulation ability can acquire higher amounts of P from P-deficient soils and adapt well to such P-deficient soil condition.

9. Effect of salinity+ hypoxia on some physiological parameters of two wheat cultivars

Salinity and water logging are serious threats to the agriculture of Pakistan. Wheat being an upland crop is affected to a great level by water logging particularly when coupled with salinity. A hydroponics culture study was conducted to compare two wheat cultivars (Blue Silver and 7-Cerrus) for their physiological characters under saline and hypoxic conditions. Carbon dioxide assimilation rate decreased with the imposition of salinity, hypoxia and combination. Blue Silver showed mre CO2 assimilation rate than 7-Cerrus under stress conditions. Transpiration rate decreased with hypoxia indicating less availability of water but salinity showed no response and cultivars also showed similar response under all treatments. Stomatal conductance decreased with the imposition of either hypoxia or salinity and Blue Silver had higher stomatal conductance than 7-Cerrus. Concentration of CO2 in the sub-stomatal cavity decreased

with salinity but hypoxia did not cause any change.

10. The Estimates of genetic parameters for some plant traits among cotton genotypes grown under phosphorus-deficiecy stress.

The success of any crop-breeding program largely depends upon the presence of genetic variability in the breeding material at hand. The estimates of genetic parameters help in understanding the role of various plant traits in establishing the growth behavior of genotypes under a given set of environmental conditions. Six cotton cultivars were grown in a P-deficient sandy loam soil for 65 days after sowing (DAS) i.e pre-flower initiation stage. The highest estimates of broad sense heritability (h2 = 0.86) and relative expected genetic advance (84.39%) were noted for root dry weight (RDW), while the estimate of expected genetic advance at 10% selection intensity was quite high (ΔG = 88.75 cm2) for leaf area per plant. The estimates of coheritability were positive and relatively higher for root: shoot ratio in combination with shoot dry weight (coh2 = 1.88) and phosphorus use efficiency (coh2 = 1.57), whereas coheritability estimates were negative between leaf area per plant and root: shoot ratio (coh2 = -0.32) indicating lack of association between these traits.

11. Potential contribution of public parks in urban environment

A social survey of visitors of two main parks of Faisalabad was conducted to study the role and value of public parks as perceived by city dwellers. Purposive sample of 246 respondents was selected and they were interviewed. Respondents were divided into different socio-economic groups based on age, profession, and nature of visit. Survey revealed that walking, jogging, and exercise were the main reasons of visiting the parks. People reported several benefits from the parks being health benefits on the top followed by personal, psychological, and social benefits. Greenery was the main source of enjoyment, which reflects towards the importance of plants in improvement of environment. People also highlighted role of parks in improvement in quality of life.

12. Value of small public parks in a modern city

Public parks and green spaces are important in urban environment as they contribute heavily in providing quality of life to city dwellers. A social survey of visitors of main city parks was conducted to study the role and value of small green spaces designated for parks in residential areas as perceived by the people. Purposive sample of 246 respondents was selected and they were interviewed on structured format. Respondents were divided into different socio-economic groups based on age, profession, income, and nature of visit. Survey results revealed that the parks provide and excellent opportunity for exercise, health & fitness, mental relaxation and satisfaction moreover green spaces help in checking pollution and provide greenery. These parks have and effective role in controlling the problems like increased pollution due to industrialization by provision of clean air and thus having a potential contribution towards creation of environment suitable for people. Small parks particularly in the residential areas of the people are very important which can reduce the vehicle use and pollution control along with provision of all the enjoyments and benefits to the people.

13. Feasibility of using hill-torrent water in Rod-Kohi area of Dera Ghazi Khan

This research project has been approved by the Directorate of Research, University of Agriculture, Faisalabad vide No. 184-94/DR dated January 25, 2001 for a cost of Rs. 45,000/-.The basic objective is to prepare a feasibility for harnessing stray waters of hill-torrents of Dera Ghazi Khan and Rajan Pur districts for their utilization for increasing agricultural productivity. Baseline data on Rod-Kohi area have been collected and is in process.

14. Analysis of the factors affecting biomass production of cotton cultivars under phosphorus

deficiency stress.

The estimates of correlation coefficients and path coefficients can help to understand the role and relative contribution of various plant traits in establishing growth behavior of crop genotypes under a given set of environmental conditions. Six cotton cultivars were allowed to grow in a sandy loam soil, deficient in $NaHCO_3$-extractable P (4.1 mg P kg^{-1} soil) for 65 days after sowing in pot culture. Statistically significant positive correlations were observed between shoot dry weight (SDW) and some other plant traits such as root dry weight, leaf area per plant, P-uptake, and P-utilization efficiency (PUE), at both genotypic and phenotypic level. The correlations of SDW with root:shoot ratio (RSR), however were not statistically meaningful, implying that relative partitioning of biomass into roots or shoots had little role to play in SDW production by cotton cultivars under P-deficiency stress. Path coefficient analysis revealed that favorable impact of RDW and leaf area per plant on SDW production was indirect: through positive effect of these parameters on P-uptake and PUE. Thus under P-deficiency stress, better P-acquisition and efficient P-utilization by the efficient cultivars for biomass synthesis collectively formed the basis of higher SDW production by the efficient cultivars.

15. Effect of salinity and sodicity on growth and ionic relations of different wheat genotypes.

A pot experiment was conducted in greenhouse to study the effect of salinity and sodicity on growth and ionic relations of different wheat genotypes. Three treatment including control, saline and saline-sodic were implied in soil culture. For control treatment soil was collected from normal field having EC_e 1.8 dSm^{-1} and in case of saline treatment the EC_e of this soil was raised to 15 dSm^{-1} and SAR 35 (mmole L^{-1})$^{1/2}$. Data on different growth parameters like shoot fresh weight, shoot dry weight and shoot length were recorded and leaf ionic composition regarding Na^+, K^+ and Cl^- were determined. Salinity as well as sodicity caused a significant reduction in all the growth parameters studied. However, the effect of saline-sodic conditions was significantly higher as compared to salinity alone. The concentration of Na^+ and Cl^- increased significantly due to salinity and sodicity while the concentration of K^+ and K^+: Na^+ ratio decreased significantly in leaves of all the wheat genotypes. The variation among genotypes regarding growth parameters was also reduced under stressed conditions.

16. Growth response of Atriplex species to salinity and hypoxia

Growth response of two Atriplex species (*A. amnicola* and *A. lentiformis*) to salinity and hypoxia was studied under hydroponic green house conditions. Two-month-old seedlings were transferred to ½ strength Hoagland nutrient solution in plastic containers. Salinity levels (50 and 400 mol m^{-3} NaCl) were developed in five equal increments and hypoxia was induced by disconnecting the aeration of nutrient solutions. The combined effect of high salinity and hypoxia severely reduced the growth of both shoot and root. *Atriplex amnicola* produced more biomass than *A. lentiformis*. On relative growth basis, *A. lentiformis* showed better tolerance than *A. amnicola*. Role of osmotic adjustment in relation to leaf water balance and stress tolerance is discussed.

17. Screening of wheat genotypes against hypoxia-salinity interaction

Genotypic responses of nine wheat cultivars to different salinity and hypoxia levels and in combination were studied in matrix culture for growth and ionic relations. Wheat exhibits genotypic differences in tolerance to salinity but such differences in response to hypoxia alone and in combination have not been much explored. Under waterlogged conditions the effects of salinity stress are expected to be accentuated further. This experiment was laid out at three salinity levels (0, 7.5 dS m^{-1}, 15 d S m^{-1} EC that was developed by NaCl + $CaCl_2$ in the ratio of 10:1) and two aeration levels (aerobic and hypoxic). Hypoxic conditions were developed by stagnating the solution in root zone. The tolerant variety (Pb.85) produced comparatively more biomass while, the least was found in the sensitive cultivars compared with tolerant one whereas, K^+ and Cl^- was more in sensitive cultivars compared with tolerant one whereas, K^+

concentration reflected the opposite trend.

18. Variations of growth and phosphorus acquisition by cotton cultivars

Cotton cultivars capable of efficiently acquiring P from P-deficient soils are desirable to sustain good crop yields in resource-poor environments and to increase utilization efficiency of added P. In a pot experiment, six cotton cultivars (FH-634, CIM-443, CIM-1100, NIAB-92, S-12 and NIAB-78) were grown to pre-flower initiation stage, to evaluate their growth performance and P-acquisition from a P-deficient (4.1 mg $NaHCO_3$ extractable P Kg^{-1} soil) sandy loam calcareous soil, with (50 mg P Kg^{-1} soil) or without P application. Phosphorus deficiency exhibited deleterious effects on various parameters of growth and P-uptake of cotton cultivars, and cultivar differences were statistically significant for most of these parameters. The cultivars FH-634 and NIAB-92 proved to be relatively sensitive. A strong positive correlation (r >0.92**) existed between total P uptake and SDW of the cultivars at both P levels. Under P-deficiency stress, increased Ca uptake had positive influence on P-acquisition by efficient cultivars, which may have contributed to their better growth performance under these conditions.

19. Nutritional role of Calcium in improving rice growth and yield under adverse conditions

Investigation on the nutritional aspects of Ca in improving rice growth and yield were conducted in solution and soil cultures and in naturally salt-affected field. In the case of solution culture, Ca at the rate of 5,10,20,40,80 and 160 µg Ca mL^{-1} was applied in the presence (80 mol m^{-3}) and absence (0 mol m^{-3}) of NaCl salinity; whereas in case of soil culture Ca @ 0, 50, 100 and 200 kg ha^{-1} was applied to artificially saline (EC_e 9 dSm^{-1}, SAR 5.46, pH_s 7.8), saline-sodic (EC_e 9 dSm^{-1}, SAR 28.2, pH_s 8.2) soils and in naturally salt affected field (EC_e 6 dSm^{-1}, SAR 16.1, pH_s 8.2). Three cultivars of differential salinity tolerance used to investigate the ameliorative nutritional aspects of Ca were: KS-282 (Salt tolerant), BG 402-4 (Mixed behavior) and IR-28 (Salt sensitive). Application of Ca improved all growth characteristics (tillering capacity, shoot and root lengths, shoot and root weights) because of external Ca supply @ 20-40µg Ca mL^{-1}in solution culture in the presence of NaCl salinity. Shoot Na^+ and Cl^- decreased; whereas, K^+ concentration and K^+: Na^+ ratio improved because of Ca supply to saline medium. Paddy and straw yields, plant height and panicle length were significantly higher in saline as compared to saline-sodic soil. Application of 200 Kg Ca ha^{-1} proved statistically superior to control in respect of panicle length, number of tillers, paddy and straw yield under both saline and saline-sodic soils as well as in naturally salt affected field. The ameliorative effect of Ca was due to reduced shoot Na^+ and Cl^- concentration and better ratio of K^+ to Na^+ in shoot. Seed setting was improved in all the three cultivars because of Ca supply to saline and saline-sodic soils.

20. Feasibility of using hill-torrent water in Rod-Kohi area of Dera Ghazi Khan

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21. Interactive effect of salinity and hypoxia on wheat and triticale

Performance of six wheat and three triticale varieties was studied for salinity x hypoxia interaction. Plants were raised in matrix culture (mixture of gravel, compost and vermiculite) by applying Hoagland's nutrient solution. Salinity was applied stepwise by adding NaCl while waterlogging was imposed by flooding the

root zoone. Among the wheat varieties, Blue Silver showed better tolerance to salinity as well as the combined stress of salinity and hypoxia. Amongst triticales, Arabian was comparatively better tolerant to salinity and Basum perormed better under the combined stress of salinity and hyposia while 7-Cerros showed opposite trend. Borba showed better control over Na+ uptake under saline hypoxic conditions. Blue Silver depicted thehighest K:Na ratio while in7-Cerros the least K:Na ratio was observed in the leaf tissue under saline hypoxic treatment.

22. Physiology and root anatomy of two wheat varieties exhibiting differential growth response to salinity and hypoxia

Wheat is the major cereal sown in saline-waterloged, sodic, compact saline soils, and is likely to be faced with waterlogging during winter. Under waterlogged conditions, the effects of salinity stress are intensified. The study was carried out with modified Phostrogen nutrient solution in matrix culture at two salinity levels (0 and 100 mol m-3 NaCl+10mol m-3 CaCl2) and two aeration levels (aerobic and hypoxic)applied to measure tolerance of wheat cultivars of differential response to the combined stress of salinity and hypoxia. Hypoxic conditions were developed by allowing the solution to continuously stand on the root zone. The tolerant variety (Blue Solver) produced comparatively more shoot and root fresh weight then the sensitive variety (7-Cerros).

Accumulation of Na+ was higher in the youngest fully expanded leaf of the sensitive variety as compared with the tolerant variety, whereas the concentrations of K+ were opposite. The CO2 assimilation rate was higher in Blue Silver, while no difference in transpiration rate under saline-waterloged conditions was observed. The tolerant variety developed more aerenchyma in the whole root up to its tip as opposite to the sensitive variety which had very few aerenchyma close to the root tip. The activity of lactate dehydrogenase (LDH) was higher and that of alcohol dehydrogenase (ADH) lower in the roots of Blue Silver, indicating a favorable biochemical pathway adopted by this variety.

23. Tissue Na concentration as affected by salinity x hypoxia interaction in two wheat varieties of differential stress tolerance

The study was carried out in matrix culture in pots (20x30x20 cm3) at two salinity levels (0 and 100 mol m-3 NaCl + 10 mol m-3 Ca Cl2) with and without hypoxic conditions by growing tolerant (Blue Silver) and sensitive (7-Cerros) varieties of wheat. Plant nutrition was supplied through modified Phostrogen solution. Hypoxic conditions were developed by keeping the root zone continuously submerged with saline and non-saline nutrient solutions. Blue Silver produced comparatively more root and shoot fresh weight than 7-Cerros. The concentration of Na+ was lower in the first, second and third youngest fully expanded leaves of Blue Silver than the corresponding leaves of 7-Cerros under the combined stress of salinity + hypoxia. Contrarily, K+ concentration was higher in the tissue sap of all the three leaves of Blue Silver. K+Na+ ratio and K+ + Na+ were remarkably higher in Blue Silver than 7-Cerros under the dual stress of salinity and hypoxia. Over all, comparing the Na+ concentration in the leaf sap verses shoot fresh weight revealed relatively low toxicity of Na+ under the saline hypoxic conditions compared with saline conditions.

24. Effect of salinity x hypoxia on some physiological parameters of two wheat cultivars

Salinity and water logging are serious threats to the agriculture of Pakistan. Wheat being an upland crop is affected to a great level by water logging particularly when coupled with salinity. A hydroponics culture study was conducted to compare two wheat cultivars (Blue Silver and 7-Cerrus) for their physiological characters under saline and hypoxic conditions. CO2 assimilation rate decreased with the imposition of salinity and hypoxia and their combination. Blue Silver showed more CO2 assimilation rate than 7-Cerrus under stress conditions. Transpiration rate decreased with hypoxia indicating less availability of water but salinity showed no response and cultivars also showed similar response under all treatments. Stomatal

conductance decreased with the imposition of either hypoxia or salinity and Blue Silver had higher stomatal conductance than 7-Cerrus. Concentration of CO2 in the sub-stomatal cavity decreased with salinity but hypoxia did not cause any change.

25. Growth response and leaf composition of selected Eucalyptus species exposed to saline and hypoic stress

A solution culture study on selected Eucalyptus species (E. occidentalis, E. teriticornis, E. camaldulensis-var. Silverton, and E. camaldulensis-local) was conducted under saline and hypoxic conditions to determine the effect of treatments on growth and leaf composition. The treatments were non-saline aerobic (control), saline aerobic (150 mol m-3 NaCl) and saline + hypoxic. Solutions in case of non-saline aerobic and saline aerobic were aerated continuously while hypoxia was induced by surface sealing (oxygen concentration 2-3 ppm). Twenty five days after salinity/hypoxic stress, plants were harvested. Salinity negatively affected all the growth parameters (plant height, stem thickness, and root and shoot fresh weights) and the effect was further aggravated when it was associated with waterlogging. Among the species E. camaldulensis-local and E. camaldulensis-var. Silverton were found better under saline conditions and E. camaldulensis-local under saline hypoxic conditions. Young leaves of all the species had lower concentrations of Na and Cl as compared to old leaves, and concentrations of Na and Cl in the leaves of both categories were the highest under saline hypoxic conditions followed by saline treatments. Potasium: sodium ratio was better in the young leaves of all the species compared to fully exposed old leaves, and the ratio was better also under favourable conditions. From amongst these species, E. camaldulensis-local had low Na and better K: Na ratio in its leaves. Mean rate of growth measured as coefficient of shoot elongation (CSE) was the lowest in E. tereticornis, whereas, all the other species had almost similar values of CSE. Nevertheless, the absolute mean shoot fresh weight was the highest and significantly superior to all the species in E. camaldulensis local.

26. Value of small public parks in a modern city

Public parks and green spaces are important in urban environment as they contribute heavily in providing quality of life to city dwellers. A social survey of visitors of main city parks was conducted to study the role and value of small green spaces designated for parks in residential areas as perceived by the people. Purposive sample of 246 respondents was selected and they were interviewed on structured format. Respondents were divided into different socio-economic groups based on age, profession, income, and nature of visit. Survey results revealed that the parks provide and excellent opportunity for exercise, health & fitness, mental relaxation and satisfaction moreover green spaces help in checking pollution and provide greenery. These parks have and effective role in controlling the problems like increased pollution due to industrialization by provision of clean air and thus having a potential contribution towards creation of environment suitable for people. Small parks particularly in the residential areas of the people are very important which can reduce the vehicle use and pollution control along with provision of all the enjoyments and benefits to the people.

27. Feasibility of using hill-torrent water in Rod-Kohi area of Dera Ghazi Khan

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28. Growth Response and leaf Composition of Selected Eucalyptus Species Exposed to Saline and Hypoxic stress

A solution culture study on selected Eucalyptus species (E. occidentalis, E. camaldulensis-var. Silverton, and E. camaldulensis-local) was conducted under saline and hypoxic conditions to determine the effect aerobic of treatments on growth and leaf composition. The treatments were non-saline aerobic (control), saline aerobic (150 mol m^{-3} NaCl) and saline + hypoxic. Solutions were aerated continuously in case of non-saline aerobic and saline aerobic while hypoxia was induced by surface sealing (oxygen) concentration 2-3 ppm). Twenty-five days after salinity/hypoxic stress of 25 days, the plants were harvested. Salinity negatively affected all the growth parameters (plant height, stem thickness, and root and shoot fresh weights) and the effect was further aggravated when it was associated with waterlogging. Among the species, E. camaldulensis-local and E. camaldulensis-var. Silverton were found better under saline conditions and E. camaldulensis-local under saline hypoxic condition. Young leaves of all the species had lower concentrations of Na and Cl as compared to old leaves and concentration of Na and Cl in the leaves of both categories were the highest under saline hypoxic conditions followed by saline treatment. Potasium: sodium ratio was also better under favorable conditions. Amongst the species, E. camaldulensis-local had low Na and better K:Na ratio in its leaves. Mean rate of growth measured as coefficient of shoot elongation (CSE) was the lowest in E. tereticornis, whereas all the other species had almost similar values of CSE. Nevertheless, the absolute mean shoot fresh weight was the highest and significantly superior to all the spesies in E. camaldulensis-local.

29. Anatomical, Morphological and Physiological Changes in Sunflower Variety because of NaCl Salinity

Self-sufficiency in edible oil can be achieved by increasing yield potential of oil seed crops. For this purpose, high yielding varieties should be developed for good lands as well as for marginal lands like salt-affeted lands where these crops are grown with little attention. An experiment was conducted to observe the effect of NaCl salinity on two varieties of sunflower namely Shamas and Noor in the hydroponic culture. The salinity levels: 0, 100, 150 and 200 mol m^{-3} NaCl were imposed at seedling stage in a step-wise manner (4 equal installments). After a stress period of 40 days, the plants were harvested. Shoot length, number of leaves, fresh weight of leaves and total leaf area decreased with salinity but the extent of decrease was less in the case of Noor compared with Shamas. Average number of vascular bundles, area of xylem, area of phloem and schelerenchyma decreased due to salinity with no significant difference between varieties. Average number of stomata and number of xylem vessels in central bundle increased with salinity and this increase was more pronounced in Noor than Shamas. Sodium content of shoot increased with salinity but that of K and K: Na ratio decreased. These ionic changes were more pronounced in Shamas than in Noor indicating that Noor was less affected because of the external NaCl particularly by maintaining low shoot Na and better K:Na ratio.

30. Salinity tolerance of rice as affected by boron

The effect of boron on the yield and ionic composition of rice cultivars having differential salt tolerance, grown in artificially prepared saline (EC 9 dS M^{-1}: SAR 5.5) and saline sodic soils (EC 9 dS m^{-1}: SAR 28.2) was investigated. The cultivars were KS 282 (salt tolerant) IR 28 (salt sensitive) and BG 402-4 (mixed behaviour). Recommended dose of N, P and K was applied with and without boron @0, 1.5, 3.0 and 6.0 kg ha^{-1}. The cultivars were allowed to grow up to maturity. Before panicle initiation top three leaves of mother shoot of each plant were collected and processed for analysis. The results revealed an ameliorative effect of boron supply to salt affected soils in enhancing yield and growth of rice regardless of their salinity tolerance. Although the ameliorative effect on paddy and straw yield, paddy: straw ratio was recorded at all external B supplies compared with control, the highest improvement was recorded at 1.5 kg B ha^{-1} in the saline and saline-sodic soils. Nevertheless the highest B supply @ 6kg B ha^{-1} had shown an adverse effect on paddy and straw production in saline sodic soils in all the cultivars compared with all the other B rates and control.

The over all yield in all the cultivars were higher in saline than in saline-sodic soil. The leaf NaCl concentration were the lowest, whereas the K:Na ratio was the highest in all rices in saline and saline-sodic soils because of B application @ 1.5 kg ha^{-1}. Although the absolute paddy yield was the highest in KS 282 both in saline and saline-sodic soils, the ratio of improvement in paddy yield was the highest in both the soils in case of IR 28 (the salt sensitive cultivar). Similarly tye spike sterility was minimum in all cultivars in both the soils at 1.5 kg B ha^{-1}. The investigations clearly demonstrate the beneficial effect of B @ 1.5 kg Bha-4 for improving paddy production from adverse lands.

31. To determine the self-perceived levels of competence of Agriculture Officers in the Punjab, Pakistan

This study was designed to determine the self-perceived levels of competence of Agriculture Officers in the Punjab, Pakistan. The study used a descriptive research design. Out of 341 Agricultural Officers (N=341), a random sample of 181 Agricultural Officers was drawn. Researcher developed the questionnaire which was tested for its validity and reliability. The Cronbachs' alpha calculated for program planning competency statement was 0.83. It was comprised of seven professional competencies. Each competency statement required the respondents to rate the item on two similar 1-5 point Likert scale. One rating was for possessed level of competency and the other for importance level of competency. Data were collected by using mail questionnaire. The overall response rate was 79%. The data were analyzed statistically using SPSS "Statistical Package for Social Sciences". In the data discrepancy values (DVs) on the basis of differences between the importance levels and the possessed levels of competencies for job performance were calculated. These differences were considered as the felt levels of training needs in the identified competencies. It was found that out of seven training needs of AOs, the two most important were:I) the ability to identify the clients' needs (DV=0.76); and 2) the ability to prioritize the identified needs (DV=0.76). The training needs with the lowest importance level included:I) the ability to conduct situation analysis for extension program planning (DV=0.65); and (2) the ability to set objectives for an extension program (DV=0.68). The discrepancy values for all professional competencies were positive, ranging from lowest value 0.65 to highest value 0.76. It means that AOs needed training in all seven competencies in "Extension Program Planning"

32. To Identify and Prioritize the Self Perceived Competencies Possessed by Agriculture Officers in the Punjab, Pakistan

This study was conducted to identify and prioritize the self perceived competencies possessed by Agriculture Officers in the Punjab, Pakistan. The study represented a descriptive survey research. Target population was 341 Agriculture Officers from which a random sample of 181 Agriculture Officers was taken. The population frame was obtained from D.G. Agriculture Extension office. A questionnaire was developed by the researchers from the synthesis of related literature and organizing series of workshops. Instrument was tested for validity and reliability. The Cronbachs' alpha calculated was 0.90. Instrument consisted of 18 professional competencies. Each competency statement required the respondents to rate the item on a Likert type scale ranging from 1-5. Data were collected through mail questionnaire. The response rate was 79% (144 out of 181) respondents. Data were analyzed using Statistical Package for Social Sciences (SPSS). It was found from data that possessed levels of competencies at the top for job performance of AO were; I) the ability of answer the questions raised by farmers (M=3.99); 2) the ability to conduct group discussion among farmers (M=3.88). It was concluded that respondents were deficient in the following competencies and so they required/needed training in those areas (1) ability to conduct panel discussion as a moderator;(2) the ability to conduct farmers' fair;(3) and ability to design exhibition and educational booths.

33. Impediments in the Adoption of Recommended Sugarcane Cultivation Practices

Sugarcane (an important cash crop) has prominent position in the economy of Pakistan. The sugarcane

yield in Pakistan is far below than other countries of the world. The present study was designed to explore the possible barriers that create hindrance in the adoption of latest cultivation practices by the farmers, and are responsible for low productivity. The random sample of this study consisted of 150 sugarcane growers from tehsil Kamalia. Tha major difficulties faced by the respondents in the adoption of recommended sugarcane practices were: the high costs of farm machinery, high cost of weedicide/pesticides, scarcity of irrigation water, lack of credit facilities, lack of finance and lack of awareness.

34. Training Needs of Agricultural Extension Administrators in Planning Extension Activities in Punjab-Pakistan

This study represents descriptive survey research on the training needs of agricultural extension administrators in planning extension activities in the Punjab Province. The population for this study consisted of 134 Extension Administrators (EAs) employed in the Punjab Province. One hundred and twelve respondents were selected randomly. Face and content validity of the instrument was established by the panel of experts. Questionnaire containing 14 competency statements, were mailed to 112 respondents. The useable response rate was 63%. Data was analyzed by using Statistical Package for Social Sciences (SPSS). The discrepancy values based on the mean perceptions of EAs were positive values for all competencies ranging from lowest value 1.38 to highest value 1.82. It was concluded that EAs needed training in all 14 competencies in planning extension activities/programs.

35. Rank Order of the Training Needs of Agricultural Extension Administrators in Information Technology in Punjab

Information Technology has assumed unprecedented importance in the global economy. No doubt, this is an era of information wave, which requires the generation, dissemination, and use of information rapidly. The current technological developments will have a big impact on the future direction of extension and rural development programs. Realizing the abruptness of the new technology, Government of Pakistan has accorded a very high priority to this sector. For this purpose, recently they have been asked to work under a different paradigm i.e., Devolution of Power Plan 2001. That is why the present study has been designed which represented a descriptive survey research. The population for this study consisted (N=134) extension administrators employed in Punjab Province, Pakistan. One hundred and twelve (S=112) respondents were selected by random sampling. The panel of experts established face and content validity of the instrument. The questionnaires were mailed to the respondents. The useable response rate was 63%. Data were analyzed by SPSS “Statistical Package for Social Sciences”. The discrepancy values based on the mean perceptions of EAs were positive values for all 17 competencies ranging from lowest value 2.27 to highest value 3.04. It means that EAs needed training in all 17 competencies of Computer knowledge / skills.

36. Competencies Regarding Extension Methodology Possessed by Agriculture Officers in Punjab, Pakistan.

The Agricultural Officers (AOs) are the development professionals in the filed of agriculture in Pakistan. The agricultural extension service, which is a provincial responsibility in Pakistan, tries to educate farmers regarding the adoption of latest technology. Recently they have been requested to work under a different paradigm, i.e. Decentralized Extension which required the role change of AOs from supervision and officer to front line extension worker. This study has therefore been designed to assess self-perceived competence levels of Agricultural Officers (Ext.). Department of Agriculture, Government of the Punjab, Pakistan. One hundred and eighty one out of 341 AOs (Ext.) were studies through carefully developed mail questionnaire having a reliability range of 0.84 to 0.97. The data collected were analyzed statistically using computer software “Statistical Package for Social Sciences” and Microsoft Excel. It was concluded that priority wise professional competence in the area of extension methodology in which agriculture

officers need training included: the ability to conduct panel discussion as a moderator; the ability to conduct farmer's fair; and the ability to design exhibition and educational booths.

37. Prioritizing the Training Needs of Agricultural Officers in Extension Program Planning in Punjab, Pakistan.

This is an era of information wave, which requires the generation, dissemination, and use of information rapidly. The concepts of technology boom and globalization are often talked about. Now the institution of higher learning seldom grants lifetime licensure. The knowledge and skills learnt by professionals become obstacle after sometime and require retraining according to the changed situation at work. The Agricultural Officers (AOs) are the development professionals in the field of agriculture in Pakistan. They have been asked to work under a different paradigm, i.e. Devolution Plan. Therefore this study was designed to identify and prioritize the training needs of AOs regarding extension program planning competencies in Punjab, Pakistan. One hundred and eighty one out of 341 AOs (Ext.) were studied through carefully developed mail questionnaire having a reliability of 0.83. The data were analyzed statistically using computer software SPSS "Statistical Package for Social Sciences". It was concluded that priority wise professional competencies in which agriculture officers need training regarding program planning included: the ability to identify the clients' need (DV=0.76); and (2) the ability to prioritize the identified needs (DV=0.76).

DIRECTORATE OF RESEARCH

INTRODUCTION

Since its inception in March, 1976 the Directorate of Research under the leadership of eminent and senior most professor/researcher of the university is working for the achievement of following objectives:

Objectives

1. To advise the University Authorities on all matters connected with the promotion of research and publications of results of research.
2. To advise University Authorities about research problems and research projects launched by different funding agencies like HEC, PARC, (ALP), PSF, MOST and STED etc.
3. To process faculty research and other research projects especially promotion of research projects for their processing, monitoring and evaluation.
4. To correspond with national and international funding agencies supporting research projects at UAF.
5. To assist Advanced Studies and Research Board in reviewing faculty research projects, and other projects financed by national and international research supporting agencies.
6. To hold meetings of the Advanced Studies and Research Board to execute the policies and decisions of the Board in connection of research.
7. To organize at the Campus and Co-ordinate in the holding of seminars, conferences, symposia or workshops at national or international level.
8. To execute the scholarship funded by Higher Education Commission and other agencies for graduate and postgraduate studies.
9. To collect and compile the data regarding publication of books, monographs, technical reports and laboratory manuals published by the faculty members and to facilitate them in their publications.
10. To provide partial support and monitoring of quality of scientific journals published from the university by holding meetings of the publishers time to time.
11. To collect the data about the publication of research findings in the form of bibliography for the use of posterity.

RESEARCH ACTIVITIES

1. SCHOLARSHIPS

The realization of the Government of Pakistan the importance of higher education in contributing the sustainable socio-economic development as well as poverty reduction, stimulated a chain of events that led to the establishment of Higher Education Commission Founded by Presidential Ordinance on September 11, 2002 which made a concrete progress in the right direction at right time. The detail of the scholarships is as under.

Name of Scholarship	Merit Scholarsh-ips for Ph.D.	Indigenous Ph.D. Scholarships	Indigenous Ph.D. Fellowships	Ph.D. Scholarships for Social Science, Arts & Humanities	PAK-US Need Based Scholarships		Internship Program	JICA Schola-rships
					BSc	MSc		
Number	32	32	48	2	90	47	1st Year 643	220
Amount (million)	31.10	62.15	55.75	11.36	38.52	10.05	42.64	Under process

2. RESEARCH PROJECTS

Funding Agencies

The HEC, PSF, International Foundation for Science (IFS), PARC, under Agricultural Linkages Programme (ALP), MINFAL, World Wide Fund (WWF), Cane Commissioner Punjab, Pakistan Telecommunication Company, Ltd. and Ministry of Science and Technology floated a number of programmes for supporting research activities in universities and other R&D organizations.

The following summary statement clearly indicates that there is a drastic difference between the allocation of funds prior and after the present government.

Detail	99-00	00-01	01-02	02-03	03-04	04-05
No. of Research Projects	77	129	144	88	127	121
Amount (million)	32.90	203.44	192.51	390.28	514.88	403.54

3. RESEARCH PUBLICATIONS

i. Research Papers

It is a matter of axiom that a scientific discovery, no matter how fateful it may turn out to be, shall not be recognized so long as it remains held up as a secrete with a scientist. Even if it be published but not corroborated and confirmed by another scientists it would still not attain a scientific status. To fill this gap Directorate of Research has collected the data about the publications (Research Papers) of different faculty members as under:

Detail	99-00	00-01	01-02	02-03	03-04	04-05
No. of Research Papers	612	566	608	680	576	697

ii. Books/Technical Reports/Lab. Manuals and Monographs

Faculty/ Directorate/ Institute	1961-1999				2000-2004			
	Books	Lab. Manual	Tech. Reports	Monogr aphs	Books	Lab. Manual	Tech. Reports	Monogr aphs
Agriculture	30	17	30	10	24	4	25	5
Agri. Economics & R.S.	-	-	-	-	-	-	-	-
Agri. Engg. & Tech.	-	5-	-	4	-	1	3	2
Sciences	1	-	-	-	25	-	-	-
Veterinary Sciences	11	7	11	2	23	6	6	8
Animal Husbandry	5	5	2	1	13	1	3	2
Division of Edu. & Ext.	11	-	2	5	7	-	-	8
TOTAL	**58**	**34**	**45**	**22**	**92**	**12**	**37**	**25**

4. SEMINARS

The Directorate of Research also tries to find opportunities for interaction of the Faculty Members of this university and other universities and the Scientists of various R&D organizations for exchange of ideas/sharing of expertise and for the development of linkages with national and international research organizations. The organization of Seminars/Symposia/conferences/workshops is one of the regular activities of this Directorate. Moreover, University of Agriculture, Faisalabad organized with the coordination of Directorate of Research, Seminars of professional importance at faculty level at university campus to update the knowledge of researchers as well as postgraduate students. The topics of these seminars were identified by the experts. The high-ups of the Agriculture Departments other than UAF participated in most of the Seminars which provided a platform for peer interaction and research dissemination.

Year	99-00	00-01	01-02	02-03	03-04	04-05
No. of Seminars/ Conferences/ Symposia/ Workshops conducted	2	6	5	7	8	87

5. FOREIGN FACULTY HIRING PROGRAMME

A well qualified and research oriented faculty is essential for such an andeavour.
Foreign faculty members, who can bring a wealth of knowledge and research experience will be expected to impart a modern land progressive outlook to research based academic programmes in Pakistani universities, and would be expected to set norms of international academic standards to be emulated by their local colleagues.

This project will generate linkages between local and foreign institutions, encouraging long-term sustainable scientific collaborations.

List of Scientists under Foreign Faculty Hiring Program

Number of Scientists who have joined the university under Foreign Faculty Hiring Programme	Number of Scientists who have shown their willingness to join this university under (FFHP)
5 Scientists belonging to USA and Tajikistan have joined this university	Number of 11 Scientists from USA, Germany, Canada, Australia have shown their willingness to join the university

6. CENTRAL HI-TECH LAB.

It is quite impossible for any institution to provide high priced Lab. Equipment in all the labs. For the smooth functioning of the research activities round the clock UAF has set a good example for other institute to establish a Central Hi-Tech Labs. to facilitate the researchers to achieve their goals and objectives.

Modern and very sophisticated equipment/instrument amounting to Rs.90.0 millions have been installed in this Lab. which are working efficiently while newly introduced equipments at world level are being installed amounting to Rs.31.209 millions under process.

Japan International Cooperation Agency (JICA) in 1997 opened a new horizon for the researchers/students of this University as well as other universities/research institutions Non-Governmental Organizations (NGO's) and industries by providing necessary/high priced equipments for

the establishment of a Central Hi-tech Lab. Modern and very sophisticated equipment/ instrument amounting to Rs.90.0 millions have been installed in this Lab. which are working efficiently while newly introduced equipments at world level are being installed amounting to Rs.31.209 millions under the project "Strengthening & up gradation of Existing Center Hi-Tech Labs. establishment & instrument repair cell" by charging very nominal charges i.e. 10% of usual cost specified for university faculty members and teacher, the Lab. has analyzed 26350 samples by generating Rs.544580/-. After the capitation of on-going project, Hi-Tech Lab. will be in a position to prepare in house samples for each instrument and to repair defective instruments at University level. Some of the high priced instruments are as under.

AMINO ACID ANALYZER

Amino Acid Analyzer is essential for checking the quality of proteins from food, feed plants, animal tissues and physiological fluids (blood, urine, milk, cell sap, etc). High speed Amino Analyzer from Hitachi (Model L-8500 A) provides fast and reliable amino acid analysis with excellent reproductibility. Analysis time is 30 minutes for sample followed by 25 minutes column washing. Single column (4.6 mm x 60 mm) packed with cation exchange resin is used for analysis.

ATOMIC ABSORPTION SPECTROPHOTOMETER

Atomic absorption spectrophotometer is from Hitachi (Z- 8200), equipped with Zeeman optical system (polarized Zeeman method is applied). Hollow-cathode lamps are available for twelve elements; Ca, Cd, Co, Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Zn. Acetylene-air flame is used (max. temp. 2250°C). Data processor with CRT and printer is attached for data processing. Graphite furnace is attached with the atomic absorption spectrophotometer for small! Sample volumes. Flame emission mode is also available in the atomic absorption spectrophotometer. Following elements can be analyzed under this mode; B, Ba, Ca, In, K, Li, Mn, Na and Sr.

GAS CHROMATOGRAPH

Gas chromatograph is from Shimadzu (GC-17A) with capillary column DB-1; 30m-x 0.25 mm) attached to it. Metal tube and glass columns are also available and can be packed according to requirement. Two types of detectors are attached to the GC; FID and ECD Liquid crystal display (211 mm Q x 132 mm H) is attached to the processor for monitoring of the peaks.

HIGH PERFORMANCE LIQUID CHROMATOGRAPH

Two HPLC systems from Shimadzu Corporation, Japan. Each system includes delivery module (LC-10 AT) attached to on-line degasser (DGU-12A) Low-pressure gradient flow control valve (FCV-10AL VP) is attached executing low-pressure gradient elutions. The system is controlled by system controller module (10A) that exerts desired degree of control over the del comprising the system and allows for fully automated operation of the system Choice of four HPLC detectors is available.

UV-Visible (SPD-10AV), Refractive Index Detector (RID-1C Conductivity Detector (CDD-6A) and Fluorescence Detector (RF-10AXL). Three different types of HPLC columns (Shim-pack CLC (M) series from Shimari are in use so far in the lab: Reversed phase ODS (15 cm), C8 (15 cm) and Nor phase Silica 25 cm.

SCANNING ELECTRON MICROSCOPE (Hitachi S-2380)

Samples from biological and material sciences are scanned on this microscope to study surface information and external morphology. Electrons (0.5 to 30 kV), after sticking the samples, are diffracted back and collected at the detector. Two types of detectors are attached: one detects back-scattered

electrons and the other secondary emitted electrons. The image is displayed on 1 -inch CRT (black/white). This microscope has resolution of 4 nm and magnification range from x20 to x200, 000. Samples are usually coated with carbon or heavy metals in order to enhance the signal. This model also has N-Sem mode (resolution 5.5 nm) in which unprepared samples can be observed under low vacuum SEM is equipped with EDX (Energy Dispersive X-Ray Analysis) for elemental analysis.

TRANSMISSION ELECTRON MICROSCOPE (Hitachi H-7500)

TEM is mostly used to get information about the internal structure of the materials. Some examples are: organelles like mitochondria chloroplasts, Golgi bodies, ribosomes; viruses and prokary; animal and plant tissues; macromolecules like proteins, nucleic acids; silicon chips, transistors, alloys, etc. Accelerating voltage of 40 to 120 kV can be applied. The resolution of TEM is 0.204 nm (lattice image) and 0.36nm (point to point). Magnification ranges from x700 to (x600, 000. Image is viewed on a fluorescent screen with 160mm viewing diameter. Camera is attached for photographs.

CENTRIFUGES

Two preparative ultracentrifuges from Hitachi are available in the lab. Both have thermoelectric cooling systems (0 to 40°C range for rotor temperature) with no chlorofluorocarbons.

X-RAY DIFFRACTO-METER (Rigaku Co.)

X-ray diffractometer (XRD) is used for compound analysis from fatal (grain size 10 um or less in diameter). It is also used to study the geometric sequence of crystals. Powdered sample is placed in the sample holder in the goniometer. X-ray is irradiated on the sample that gives particular diffraction pattern. The diffraction angle is measured under Brags law. Each Has its own diffraction pattern. Both quantitative and qualitative determinations are made. Wide range of samples can be analyzed on XRD e.g., air pollutants, chemical compounds, gun powders, plant and animal tissues, soil, metals, alloys, etc.

By charging very nominal charges i.e. 10% of usual cost specified for university faculty members and students, the Lab. has analyzed 26350 samples by generating Rs.544580/-. Detail of the sample analyzed is as under:

Year	99-00	00-01	01-02	02-03	03-04	04-05	TOTAL
Number of samples analyzed	944	5468	2265	1547	7382	8751	26357
Amount generated (Rs.) @ 10%	27460	187240	65710	26370	84560	139240	544580

7. SCIENTIFIC JOURNALS

To arrange partial supports for publication of scientific journals by the university and professional bodies every year on the request basis is the sole duty of this directorate.
Quality journals with quality research papers are preferred for support.

At present 13 Scientific Journals of international repute are being published from the different faculties of this university.

8. SPECIAL ASSIGNMENTS COMPLETED BY DIRECTORATE OF RESEARCH DURING 2004-2005

Alongwith routine activities during the year 2004-2005, Directorate of Research has compiled the

following

1. Bibliography (Research Publications of the University Scientists since 1961–2005.
2. Post-Graduate studies (Glimpses) Theses Abstracts of Ph.D. scholars since 1961–2005.
3. Farmer's Friendly Technologies developed by the University, which are ready for dissemination.
4. Priority areas of Research of the UAF 2005-06.
5. Proceedings of World Food Day (Seminar for the Celebrations).
6. Collection of information about Books/Lab. Manual/Technical Reports/ Monographs published by the University Scientists at National and International level.
7. Survey/collection of information about optimum and effective use of University Lab. Equipments.
8. Compilation of feasibility report for the establishment of National Technology Incubator at the university.
9. Preparation of working papers for the utilization of Endowment Fund by this university.
10. Necessary arrangements (lodging, bedding and placement/efficiency reports) of Foreign Faculty Members under Foreign Faculty Hiring Programme.
11. Coordinate/facilitate the teams visiting the university in connection with the evaluation of research projects funded by the concerned agencies.
12. As a Focal Person, Director Research performs his duties to facilitate the scholarship awardees by Higher Education Commission, Islamabad.
13. To process the cases of university Teachers for onward submission to Higher Education Commission, Islamabad for the inclusion of in the list of HEC approved Ph.D. Supervisors.
14. Wining and execution of Internship Program for Undergraduate students during their Last Semester amounting to Rs. 42.64 million.
15. Execution of Project for the up-gradation of Central Hi-Tech Lab. at UAF.
16. Compilation of Research Achievements (100 Years of Excellence) of Punjab Agriculture College and Research Institute, Lyallpur Volume-I and University of Agriculture, Fiasalabad Volume-II.

List of Eminant Scientists who served Directorate of Research, UAF from time to time.

Sr. #	Names	From	To
1.	Dr. A. G. Kausar (Late)	02.03.1976	09.07.1976
2.	Dr. Muhammad Aslam (Late)	10.07.176	04.09.1979
3.	Dr. Muhammad Shafique	05.09.1979	20.09.1981
4.	Dr. Abrar Hussain Gilani	21.09.1981	17.07.1991
5.	Dr. Manzoor Ahmad Khan	18.07.1991	13.09.1992
6.	Dr. Jafar Hussain Mirza	14.09.1992	11.12.1994
7.	Dr. Khalid Mahmood Khan	12.12.1994	06.01.1996
8.	Dr. Riaz Hussain Qureshi	11.01.1996	26.01.1997
9.	Dr. Abrar Hussain Gilani	27.01.1997	31.01.1998
10.	Dr. Riaz Hussain Qureshi	06.04.1998	21.03.1999
11.	Dr. Jehangir Khan Sial	22.03.1999	03.08.2002
12.	Dr. Maqsood Ahmad Gill (Late)	04.08.2002	03.11.2004
13.	Dr. Abdul Ghafoor	04.11.2004	Todate

LIST OF BOOKS PUBLISHED BY THE TEACHERS AT NATIONAL/ INTERNATIONAL LEVEL

UNIVERSITY OF AGRICULTURE, FAISALABAD

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
FACULTY OF AGRICULTURE									
DEPARTMENT OF PLANT BREEDING & GENETICS									
1	Iqrar A. khan	Tanwir A. Malik			Agricultural Biotechnology		MAS Printers, Faisalabad, Pakistan.	1996	
2	Khan, M.A.				Plant Breeding		National Book Foundation Islamabad.	1994	
3	Rehman, A.	A. Shakoor	M.A. Khan		Elements of Genetics Department of Plant Breeding and Genetics		West Pakistan Agriculture University, Lyallpur.		
4	Dr. Iftikhar Ahmad Khan				Dictionary of Genetic Engineering and Biotechnology		Personal		
DEPARTMENT OF AGRI. ENTOMOLOGY									
5	Saleem, A.M.	M. Ashfaq			Environmental Pollution and Agriculture		University Press, Multan Pakistan.	2004	
6	Ashfaq, M.	M.A. Saleem	F. Ahmad		Stored Grain Management		Pak Book Comopany, Lahore, Pakistan.	2001	In Urdu
7	Ashfaq, M.	A. Suhail			Art of Bee Keeping.		Pak Book Comopany, Lahore, Pakistan.	1999	In Urdu
8	Ashfaq, M.	W. Akram			Art of Silkworm Rearing		Pak Book Comopany, Lahore, Pakistan.	1998	In Urdu
9	Ashfaq, M.	W. Akram			A Handbook of Entomological Terms.		Pak Book Comopany, Lahore, Pakistan.	1997	
10	Suhail, A.	S. Ahmed			A Workbook Agriculture and Environmental Pollution.			2003	
11	M.A. Ghani	M. Ashfaq			A Resume of postgraduate research in Entomology		University of Agriculture, Faisalabad	1987	
DEPARTMENT OF FORESTRY, RANGE MANAGEMENT AND WILDLIFE									
12	Quraishi, Masood A.A.	Ghulam S. Khan	Shahid Yaqoob		Rang Management in Pakistan.		Kazi Publications, Ganpat Road, Urdu Bazar, Lahore.	1993	
13	Quraishi, Masood A.A.	Akram Zia			Pakistan Agriculture Management		A-One Publishers, Urdu Bazar, Lahore.	1997	
14	Quraishi, Masood A.A.				Pakistan Agriculture Resources		A-One Publishers, Urdu Bazar, Lahore.	1997	
15	Quraishi, Masood A.A.				Basics of Range Management		University of Agriculture, Faisalabad.	1999	In Press
16	Quraishi, Masood A.A.				Practical manual of Wild life Management		A-One Publishers, Urdu Bazar, Lahore.	2004	
17	Quraishi, Masood A.A.				Pakistan, Agriculture Test Guide		A-One Publishers, Urdu Bazar, Lahore.	2005	In Press

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
DEPARTMENT OF AGRONOMY									
18	Khan, N.A.	S. Ahmed	A. Tanveer		Research on weeds and their control in Pakistan - A Bibliography.		Agriculture, Dept., Govt. of the Punjab.	1993	
19	Tanveer, A.	A. Ali			Weeds and their control		Higher Education Commission, Islamabad, Pakistan.	2003	
20	Tanveer, A.	A. Khaliq	A. Ali	M. Azam Khan	Weed Research in Pakistan - A compendium.		Agriculture, Dept., Govt. of the Punjab.	2004	
21	Nazir, M.S.				Crop Production		National Book Foundation Islamabad.	1994	
22	Sardar, R.A. Khan				Crop Management in Pakistan with focus on soil and water.		Directorate of Agricultural Information, Punjab, Lahore	2001	
23	Tanvir, A.	A. Ali			Weeds and their Control.		Higher Education Commission, Islamabad, Pakistan.	2003	
24	Ata Z.	M. Farooq			Agriculture in Pakistan		Pakistan Agricultural Scientists Forum, Faisalabad, Pakistan	2005	
DEPARTMENT OF PLANT PATHOLOGY									
25	Khan, S.M.	A. Khatoon			Mushroom Cultivation		Mushroom Project, University of Agriculture, Faisalabad.	1984	In Urdu
26	Khan, S.M.	A. Khatoon			Mushroom Cultivation, Technology in Pakistan.		University of Agriculture, Faisalabad.	1986	In Urdu
27	Khan, S.M.	A. Khatoon			Mushroom Recipes		Mushroom Project, University of Agriculture, Faisalabad.	1987	In Urdu
28	Khan, S.M.				Mushroom Cultivation,. A Profitable Agri. Business Unit No.6		Allama Iqbal Open University, Islamabad.	1988	
29	Khan, S.M.	A. Khatoon	M.S.K. Rana		Mushroom cultivation Technology in Pakistan.		National Agricultural Research Centre, Islamabad.	1988	In Urdu
30	Khan, S.M.				Mushroom an Nutrition		Urdu Science Board, Lahore.	1991	In Urdu
31	Khan, S.M.				Fungus		Urdu Science Board, Lahore.	1992	In Urdu
32	Khan, S.M.	R. Ahmad	M.A. Khan		Plant Diseases of Economic importance and their management proceeding, 2nd National crop Plant Path.		Pakistan Phytopathological Society, Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan.	1999	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
33	Nasir, M.A.	M.A. Khan			Plant Pathological Terms,		Department of Plant Pathology, University of Agriculture, Fiasalabad.	2000	
34	Khan, M.A.				A Chapter "Epidemiology o Plant Diseases" Pages: 330-356, A Text Book of Plant Pathology, I Ahmad and A.R. Bhutta		Ministry of Science & Technology, Islamabad.	2004	One chapter contribute
35	Khan, M.A.				A Chapter Epidemiology of soil-borne Plant Pathogies. "Seed Pathology" A.R. Bhutta		FSCR Department Islamabad.	2004	In Press
DEPARTMENT OF CROP PHYSIOLOGY									
36	Why Jones, R.G.	R. Storey	R.A. Leigh and A. Pollard	N. Ahmad	A hypothesis on cytoplasmic osmoregulation. In: "Regulation of Cell Membrane Activities in Plants" Eds. Marre and O.Ciferri.		North Holland, Amsterdam.	1997	
37	Nawaz, A.	N. Ahmad	R.H. Qureshi		Salt tolerance of cotton 2. In: "Propects for Biosaline Research" Eds. R. Ahmad and A.S. Pietro.		Dept. of Botany, University of Karachi, Karachi, Pakistan.	1985	
38	Abdullah, M.	R.H. Qureshi	N. Ahmad		Response of L. fusca to various types of substrate salinity. In: Prospects for Biosaline Research. Eds. R. Ahmad and A. S. Pietro.		Dept. of Botany, University of Karachi, Karachi, Pakistan.	1985	
39	Qureshi, R.H.	A. Rashid	N. Ahmad		A procedure for quick screening of wheat cultivars for salt tolerance. In: Genetic aspects of plant mineral nutrition. N. El Bassam (Ed.)		Kluwer Acad. Pub., Dordrecht, The Netherlands.	1990	
40	Aslam, M.	R.hH. Qureshi	N. Ahmad		Mechanisms of salinity tolerance in rice (Oryza sativa L.) In: Towards Rational Use of High Salinity Tolerant Plants. Vol 2.H. Lieth and A. AI. Masooum (eds.).		Kluwer Acad. Pub., Dordrecht, The Netherlands.	1993	
41	Ahmad, N.	M. Qadir.			Reclamation methods for saline-sodic soils of Pakistan. In: Biology of Salt Tolerant Plants (Eds.) M.A. Khan and I.R. Ungar.		Book Crafters, Michigan, USA.	1995	
42	Qadir M.	N. Ahmad	R.H. Qureshi	M. Ilyas	Role of salt tolerant plants to reduce salination and sodification. (Eds.) M.A. Khan and I.R. Ungar.		Book Crafters, Michigan, USA.	1995	
43	Basra, S.M.A.				Seed Germination. In: Basic Concepts in Biochemistry. Khalil-ur-Rehman and M.A. Sheikh (Eds.).		Friends Scientific Publications, Faisalabad, Pakistan.	1998	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
44	Sheikh, M.A.	S.M.A. Basra			Photosynthesis. In: Basic Concepts in Biochemistry. Khalil-ur-Rehman and M.A. Sheikh (Eds.).		Friends Scientific Publications, Faisalabad, Pakistan.	1998	
45	Khalil-ur-Rehman	S.M.A. Basra	M.K. Saeed		Lead Toxicity. In: Clinical Biochemistry, Khalil-ur-Rehman and Zahoor-ul-Hassan (Eds.)		Career Books Publications, Lahore, Pakistan.	2002	
46	Khalil-ur-Rehman	S.M.A. Basra	M. Javed Asad		Protains. In: Clinical Biochemistry, Khalil-ur-Rehman and Zahoor-ul-Hassan (Eds.)		Career Books Publications, Lahore, Pakistan.	2002	
47	Basra, S.M.A.	M. Farooq	N. Ahmad		Rice Management: Pakistan Perspective.			2004	Submitted to HEC, Islamabad.
INSTITUTE OF HORTICULTURAL SCIENCES									
1	Malik, M.N.				Horticulture		National Book Foundation, Lahore, Pakistan	1994	
2	Khan, M.A.				Landscape design		Pak Book Empire, Lahore, Pakistan	1999	
3	Khan M.A.	M. Asif			Introduction to landscape plants. Department of Horticulture		University of Agriculture, Faisalabad	2001	
4	Khan, M.A.	A. Riaz			Floriculture and Gardening. Department of Horticulture		University of Agriculture, Faisalabad		Submitted for publication
5	Khan, M.A.				Environmental Horticulture. Department of Horticulture		University of Agriculture, Faisalabad		Submitted for publication
6	Khan, M.A.	A. Younis			Cultivation and extraction of rose essential oil in Pakistan (Brouchers)		University of Agriculture, Faisalabad	2004	
7	Khan, M.A.	A. Riaz			Export quality cutflower production of Roses in Pakistan (Brouchers)		University of Agriculture, Faisalabad	2004	
8	Ayub M.A.,	M.A. Pervez	M.A. Cheema		Vegetable cultivation		University of Agriculture, Faisalabad	2004	(In Urdu) (InPress)
INSTITUTE OF SOIL AND ENVIRONMENTAL SCIENCES									
1	Arshad, M.	W.T. Frankenberger Jr.			Ethylene: Agricultural Sources and Applications		Kluwer Academic Publisher, New York, USA	2002	
2	Khaliq, A.,	Z.A. Zahir	M. Arshad		An Introduction to Agricultural Biochemistry		Prime Publishers, Lahore, Pakistan	2002	
3	Qureshi, R.H.	E.G.Barrett-Lennard			Saline Agriculture for Irrigated Land in Pakistan		Australian Centre for International Agricultural Research Canberra, Australia. Better Printing Queanbeyan, Australia.	1998	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
5	W.T. Frankenberger Jr.	M. Arshad			Phytohormone = Microbiol Production and function	1st	Marcel Dekkar NY, USA	1995	
6	Ghafoor, A.,	M. Qadir	G. Murtaza		Saline Sodic Soils: Principles of Management		Allied Book Centre, Urdu Bazar, Lahore, Pakistan	2004	
7	Khalid, A.M.	M. Arshad	Z.A. Zahir		Phytohormones: Microbial Production and Applications. In: Biological Strategies for Sustainable Soil System.	N. Uhoff Ed.	Marcel Dekkar NY, USA	2005	Book Chapter
8	Ghafoor, A.,	G. Murtaza	S.I. Hussain		Fundamentals of Scientific Communication and Presenrations		Allied Book Centre, Urdu Bazar, Lahore, Pakistan	2006	
FACULTY OF VETERINARY SCIENCES									
DEPARTMENT OF CLINICAL MEDICINE & SURGERY									
1	Muhammad, G.	M. Athar			Dipetalonemiasis, toxoplasmosis, and piroplasmosis in camels. Chapter-13. In: Selected Topics on Camelids. Gahlot, T.K. (ed.).		The Camelid Publishers, Bikaner, India. Pp. 271-285.	2000	
2	Muhammad, G.	M. Athar			Anhidrosis, Dipetalonemiasis, and Haematuria. In: Field Manual on Camel Diseases. Rollefson, I.K., and P.Mundy (eds.).		ITGD Publishing Co. London.	2001	
3	Muhammad, G.	M. Athar, M.Z.Khan	A. Shakoor, Fazal-ur-Rehman	M.T. Ahmad	Surf Field Mastitis Test: An expensive new tool for evaluation of wholesomeness of fresh milk. In: Success Stories on the Transfer of Farm Technology in SAARC Countries. Abdullah,M.(ed.),		SAARC Agricultural Information Centre (SAIC),Dhaka,Bangladesh.pp.71-75.	1998	
4	Athar,M.	G. Muhammad			Tips for Practicing Vets.		Worldwide Publishers, Faisalabad.	1995	
5	Khan,M.A.				Text Book of Clinical Veterinary Medicine.		Published by the Author.	1998	
DEPARTMENT OF VETERINARY PARASIOTOLOGY									
6	Khan, M.N.	Z. Iqbal	C.S.Hayat		Janwaroan Key Ahim Tufaili Amraz Aur Un Ka Tadarak.			1998	An Urdu Booklet for Extension Workers/Farmers.)
7	Anwar, A.H.	M.N. Khan			Meat Hygiene and Inspection		Friends Publishers ,Faisalabad.	2000	
8	Iqbal, Z.	M.N. Khan	A. Jabbar		An Illustrated Textbook of Veterinary Entomology		University of Agriculture, Faisalabad, Pakistan.	2003	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
9	Akhtar, M.	M.A. Hafeez	C.S. Hayat		General Parasitology and Protozoology		The Elite Scientific Publications, Faisalabad, Pakistan.	2003	
10	Iqbal, Z.	M.N. Khan	A. Jabbar		Textbook of Veterinary Helminthology.			2004	Submitted to HEC
11	Iqbal ,Z.	A. Jabbar	M.S. Sajjid	R.Z. Abbas and Z.D. Sandhu	Techniques in Veterinary Parasitology			2004	Submitted to HEC
DEPARTMENT OF VETERINARY MICROBIOLOGY									
12	Awan,J.A.	S.U. Rahman			Microbiology Manual. Unitech Common Cation, Faisalabad, Pakisan.		Dept. of Vety. Microbiology, University of Agriculture, Faisalabad.	2002	
13	Hussain,I.	M. Akhtar	C.S. Hayat		Practical Microbiology and Immunology		Capricorn Publications, Sarfraz Colony, Faisalabad	1998	
14	Akhtar, M.	I. Hussain	M. Hafeez		Practical Poultry Farming.		The Elite Scientific Publicaitons, Faisalabad, Pakistan.	2003	
15	Hussain, I.	M. Siddique	M.S. Mahmood		Pathogenic Bacteria and Fungi.		Shaheen Publisher and Publishing Press, Aminpur Bazar, Faisalabad	2004	
16	Muhammad, K.	M. Siddique			Isolation and Identification of Veterinary Bacterial Pathogens.	Ist.	Deptt.of Vet. Microbiology, UAF	2001	
17	Muhammad, K.	M. Siddique			Practical and General Veterinary Virology		Deptt. Of Vet. Microbiology, UAF	2002	
18	Siddique, M.	K. Muhammad			Practical in Avian Immunology.		Deptt. Of Vet. Microbiology, UAF	2001	
19	Siddique, M.	M. A. Gazi	M. Z. Siddiqui		Poultry Industry in Pakistan.		University of Agriculture, Faisalabad.	1980	
DEPARTMENT OF VETERINARY PATHOLOGY									
20	Khan, M.Z.				General Pathology.		Mahmood Masaud Printing Press, Jinnah Colony, Faisalabad.	1991	
21	Irfan, M.				A text book of “Veterinary General Pathology”		University of Agriculture, Faisalabad, Pakistan.	1997	
22	Anjum A. D.				Poultry Diseases.		Lynx Grafix, 6-Moon Plaza, Chiniot Bazar, Faisalabad, Pakistan.	1997	
23	Khan, A.				“Veterinary Clinical Pathology”		University of agriculture, Faisalabad	2004	Submitted for publication
24	Javed, M.T.				“Basic Pathology” a text book on comparative general pathology	Ist	Maktaba-e-Danishwaran Publication, 8-Alfazal Market, Urdu Bazar, Lahore	2001	

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25	Hussain M.	P. Roeder	T. Javed.		"A Guide to Field Veterinarians: Collection, Preservation and Despatch of Samples for the Laboratory Diagnosis of Main Transboundary Animal Diseases in Pakistan"			2002	
26	Javed M.T.	A.D. Anjum	R. Kausar		"Necropsy Examination"	1st.	Maktaba-e-Danishwaran Publication, 8-Alfazal Market, Urdu Bazar, Lahore.	2003	
27	Javed M.T.	R. Kausar			"Necropsy Examination"	2nd	The Elite Scientific Publications, Faisalabad, Pakistan.	2004	
DEPARTMENT OF ANIMAL REPRODUCTION									
28	Ahmad, N.				Reproduction in the buffalo. In "Arthur's Veterinary Reproduction and Obstetrics" by D.E. Noakes, T.J. Parkinson and G.C.W. England (Eds)	8th	W.B. Saunders, London, UK, pp: 789-800. published in London, UK).	2001	(Dr. Nazir Ahmad contributed a chapter on "Reproduction in the Buffalo")
29	Lodhi, L.A.	H.A. Samad	Z.I. Qureshi		Reproductive Health Management in cattle and buffaloes. Deptt. Animal Reproduction		University of Agriculture, Faisalabad, Pakistan.	2001	
DEPARTMENT OF PHYSIOLOGY AND PHARMACOLOGY									
30	Irfan, M.	M. Nawaz	M. Afzal		Post-graduate Research in Veterinary Science, University of Agriculture, Faisalabad.			1982	
31	Nawaz, M.				Poultry Therapeutic Guide, Department of Physiology & Pharmacology, University of Agriculture, Faisalabad.			1996	
32	Muhammad Mushtaq	Irshad-ul-Haq	Arshad Mahmood	Zia-ur-Rahman	Training manual for Village Veterinary Workers.		Livestock and Dairy Development Department, Punjab, Pakistan.	2003	
33	Falah K.	Al-Ani.	Zia-ur-Rahman		CAMEL: Management and Diseases.	1st	Dar Ammar Book Publisher, Amman, Jordan.	2004	Chapters No.15,16,17 contributed
34	Akhtar, M.S.				Introduction to Veterinary Pharmacology.	4th	University of Agricuture, Faisalabad	2004	
35	Muhammad, F.	Riviere, J.E.,			Dermal absorption models in Toxicology & Pharmacology		Tylor Francis publishing Co. London.	2005	Releasing by the end of August
FACULTY OF ANIMAL HUSBANDRY									

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
DEPARTMENT OF POULTRY HUSBANDRY									
1	Rasool, S.	A. Haq.			Analytical Techniques in Nutrition Research.		Saleemi Printing Press, Faisalabad.	1999	
2	Haq, A.				Poultry Industry.		Pak Book Empire, Lahore.	2000	
3	Haq, A.	T. Ahmad.			Poultry Hygiene and Disease Prevention.		Pak Book Empire, Lahore.	2001	
4	Haq, A.	M. Akhtar.			Poultry Farming.		HEC, Islamabad. Govt. of Pakistan.	2004	In press
5	Haq, A.				Practical Poultry Forming		University of Agriculture, Faisalabad.	2001	
6	Mahmood, S.	M. Usman.			Broiler Production.		Rafiq Afzali Press, Faisalabad.	2000	
DEPARTMENT OF LIVESTOCK MANAGEMENT									
7	Khan, B.B.	M. Younas	S.H. Janjra		Breeds and Types of Livestock in Pakistan.	2nd	University of Agriculture, Faisalabad.	1984	
8	Younas, M.				The Chemistry of an Islamic Center.		P.O. Box 3602, Mississippi State University, MS-39762, USA	1991	
9	Raza, S.H.	S. Ahmed	A. Iqbal		Ready Recknor for Animal Scientists.		Soft Logo Desktop Publishers, Z.A. Hashmi Hall Market, University of Agriculture, Faisalabad.	1998	
10	Younas, M.				A Dictionary of Animal Production.		National Book Foundation (NBF), Islamabad.	1999	Under Publication
11	Khan, B.B.	A. Iqbal	M.I. Mustafa		Sheep and Goat Production.		Dept. of Livestock Management, University of Agriculture, Faisalabad.	2003	
12	Khan, B.B.	A. Iqbal	M. Riaz		Production and Management of Camel.		Dept. of Livestock Management, University of Agriculture, Faisalabad.	2003	
13	Bilal, M.Q.	A. Ahmad			Dairy Hygiene and Disease Prevention, A textbook of Dept. of Livestock Management.		Usman and Bilal Publishers, Faisalabad.	2004	
14	Bilal, M.Q.				Dairy Farming. A textbook of Dept. of Livestock Management.		Zari Digest publication, University of Agriculture, Faisalabad.	2004	Urdu
15	B.B. Khan	M. Yaqoob	A. Iqbal	M. Riaz	Husbandry and Health of Horses	1st	University of Agriculture, Faisalabad	2005	Compiled
INSTITUTE OF ANIMAL NUTRITION & FEED TECHNOLOGY									
1	Sarwar, M.	C.S. Ali.			The Rumen: Digestive Physiology and Feeding management.		Friends Science Publishers, 399-B, Peoples Colony No.1, Faisalabad.	2000	Printed at University of Agriculture Press.

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
2	Sarwar, M.	Z.U. Hassan.			Nutrient Metabolism in Ruminants.		Friends Science Publishers, 399-B, Peoples Colony No.1, Faisalabad.	2000	Printed at University of Agriculture Press.
3	Khan, M.L.				Poultry feeds and nutrition.		AD club, Raheem Centre, Aminpur Bazar, Faisalabad.	2000	
4	Khan, M.L.				Fundamentals animal nutrition.		AD club, Raheem Centre, Aminpur Bazar, Faisalabad.	2000	
5	Sarwar, M.	M. Nisa.	M.A. Khan.		Analytical Techniques in Nutrition		Friends Science Publishers, 399-B, Peoples Colony No.1, Faisalabad.	2004	In press
DIVISION OF EDUCATION & EXTENSION									
DEPARTMENT OF AGRI. EXTENSION									
1	Muhammad, S.				Individual Contact Methods. In: Memon, R.A. and E.Bashir (eds.) Extension Methods.		National Book Foundation, Islamabad, Pakistan.	1993	
2	Muhammad, S.				Amoor-e-Baghbani		Kitab Markaz, Faisalabad, Pakistan.	1996	URDU
3	Muhammad, S.				"Phalon Ki Kasht"		Division of Education & Extension, University of Agriculture, Faisalabad.	1999	URDU, Special number of Zarri Digest.
4	Muhammad, S.				Agricultural Extension.		Strategies and Skills, Unitech Communications, Faisalabad, Pakistan.	2001	
5	Muhammad, S.				Extension Systems.		Allama Iqbal Open University, Islamabad, Pakistan.	2004	
6	Ahmad, M.	T. Ali			The Extension Programme Development.		Allama Iqbal Open University, Islamabad, Pakistan.	2002	
7	Davidson, A.P.	M. Ahmad			Privatization and the Crisis of Agricultural Extension: The case of Pakistan.		Ashgate Publishing Ltd., UK.	2003	
8	Sher Muhammad				Agricultural Extension: Strategies and Slikks		United Communications, Faisalabad, Pakistan	2005	
DEPARTMENT OF AGRI. EDUCATION									
9	Lodhi, T.A.	S.Muhammad			Agricultural and Gardening for 6th class.		Punjab Text Book Board, Lahore, Pakistan.	1980	
10	Lodhi, T.A.	S. Muhammad			Agricultural and Gardening for 7th class.		Punjab Text Book Board, Lahore, Pakistan.	1980	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
11	Lodhi, T.A.	S. Muhammad			Agricultural and Gardening for 8th class.		Punjab Text Book Board, Lahore, Pakistan.	1980	
12	Lodhi, T.A.	S.Muhammad			Zarri Taleem for 6th class		Punjab Text Book Board, Lahore, Pakistan.	1985	
13	Lodhi, T.A.	N.H. Malik			Zarri Taleem for 7th class		Punjab Text Book Board, Lahore, Pakistan.	1985	
14	Lodhi, T.A.	N.H. Malik	S.Muhammad		Zarri Taleem for 8th class		Punjab Text Book Board, Lahore, Pakistan.	1985	
15	Toor, M.A.				Zarri Taleem and Toseeh		Dept. of Agri. Education, University of Agriculture, Faisalabad.	1985	
16	Malik, N.H.	S.A. Khan			Extension Methods		National Book Foundations, Islamabad, Pakistan.	93-94	Three chapters in this book
DEPARTMENT OF RURAL HOME ECONOMICS									
17	M. Laiq Khan	Nighat Bhatty	Khuram Khan		Poultry Feeds & Nutrition		Kitabistan Publishing Co., Urdu Bazar, Lahore, Pakistan.	2001	
18	M. Laiq Khan	Nighat Bhatty	Abrar Hussain Gillani		Fundamentals of Animal Nutrition.		Dept. of Animal Nutrition, University of Agriculture, Faisalabad, Pakistan.	2001	
DEPARTMENT OF CONTINUING EDUCATION									
19	Mr. Muhammad Usman Ghazanfar				Basics of Agriculture.		Quiz Club Publications, University of Agriculture, Faisalabad, Pakistan.		
FACULTY OF AGRI. ECONOMICS & RURAL SOCIOLOGY									
DEPARTMENT OF ENVIRONMENTAL AND RESOURCE ECONOMICS									
1	M. Aslam Chaudhry	Bashir Ahmad	Muhammad Sharif		Researchers hand book for economic analysis of experimental data	Ist	University of Agriculture, Faisalabad.	1993	
2	Bashir Ahmad	Munir Ahmad	M. Aslam Chaudhry		Economics of Livestock production and Management	Ist	University of Agriculture, Faisalabad.	1996	
3	Bashir Ahmad	Zakir Hussain	Jamalongmir		Farm Management Handbook	1st	University of Agriculture, Faisalabad	1993	
4	Bashir Ahmad	M.B. Kausar	Qamar Moh-Din	M. Asghar Cheema	Economics Revival of Small Farmers	1st	University of Agriculture, Faisalabad		
5	Abedullah	Srun Sakham	Umer Farooq		The Vegetable sector in Indochina Countries: Farm and Household perspective on poverty Alleviation		Asian Vegetable Res. & Dev. Centre (AVRDC) Taiwan	2002	Contributed Chapter No.2
6	Vu Thi Bich Hau	Chu Van Chuong	Abedullah		The Vegetable sector in Indochina Countries: Farm and Household perspective on poverty Alleviation		Asian Regional Centre (ARC) Thailand.	2002	Contributed Chapter No.4

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
7	Suresh Pal.	S. Pandey	Abedullah		Growth and variablity in Agri. Revisited: District Level Evidence of Rice Production in Eastern India		(IRRI) Philippines	2000	Pages 97-114 contributed
DEPARTMENT OF DEVELOPMENT ECONOMICS									
8	Khan, M.A.				Cooperatives Dilemma		West Pakistan Agricultural University Press	1972	
9	Khan, M.A.				Cooperative Dynamics		West Pakistan Agricultural University Press	1972	
10	Khan, D.A.				Price Fixation by Coopeative Association-An Economic Fallacy.		University of Agriculture, Faisalabad.	1973	
DEPARTMENT OF RURAL SOCIOLOGY									
11					Population: Social and Programme Issues.		Friends Science Publishers, Faisalabad.	2000	
FACULTY OF SCIENCES									
DEPARTMENT OF CHEMISTRY									
1	Khalil-ur-Rehman	Zahoor-u-Hassan			Clinical Biochemistry		Career Books Publications, Lahore, Pakistan.	2002	
2	Bhatti, H.N.				Test your Chemistry		Carwan Book House, Lahore, Pakistan.	2003	
3	Khalil-ur-Rehman	M.A. Sheikh			Basic Concepts in Biochemistry		Al-Umar Publisher, Press Market, Faisalabad, Pakistan.	2004	
4	Bhatti, H.N.	K. Hussain			Principles of Physical Chemistry		Carwan Book House, Lahore, Pakistan.	2004	
5	Bhatti, H.N.	B.A. Nasir			Modern Inorganic Chemistry		Carwan Book House, Lahore, Pakistan.	2004	
DEPARTMENT OF COMPUTER SCIENCE									
6	Tariq M.	T. Mustafa	I. Saeed	A.R. Sattar	Visual programming using Visual Basic		IT Publishers Faisalabad, Pakistan.	2003	
7	Imran. S.	T. Mustafa	T. Mahmood	A.R. Sattar	A fundamental study of database management systems.		IT Publishers Faisalabad, Pakistan.	2003	
8	Tasleem M,	T. Mahmood	I. Saeed		Computer applications in Business.		IT Publishers Faisalabad, Pakistan.	2003	
9	Tasleem M,	A.R. Sattar	W. Ahmad		Computer Studies		IT Publishers Faisalabad, Pakistan.	2004	
10	Tasleem M,	I. Saeed	Tariq Mahmood		Computer Studies (Objectives)		IT Publishers Faisalabad, Pakistan.	2004	
11	Tasleem M,	T. Mahmood	Imran Saeed		Programming Basics using C		IT Publishers Faisalabad, Pakistan.	2004	
12	Tasleem M,	T. Mahmood	Imran Saeed		Objective type book of CPACCES		IT Publishers Faisalabad, Pakistan.	2004	
DEPARTMENT OF BOTANY									

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
13	Chaudhary, S.A.				Flora in Lyallpur and the Adjacent Canal Colony District.		University of Agriculture, Faisalabad.	1971	
14	Rao, A.R.	M. Arshad	M. Shafiq		Perennial Grass Germplasm Cholistan Desert and its Phytosociology.		Cholistan Institute of Desert Studies, Islamia University Bahawalpur.	1989	
15	Jamil A.	Naim, S.	Ahmad, S.	Ashraf, M.	The production of industrially important enzymes using molecular approaches with special reference to xylanase and cellulases		Regency Publications, New Delhi, India	2004	Book Chapter
16	Ashraf, M.Y.	Ashraf, M.	Sarwar, G.		Response of Okra (Hibiscus esculentus) to drought and salinity stresses. (Book Chapter) In: Vegetables		Ramdane Dris. World Food Ltd. Helsinki, Finland	2005	Book Chapter
17	Jamil A.	Anwar, F.	Ashraf, M.		Plant Tolerane to Biotic and Biotic Stresses through Modern Genetic Engineering Techniques		Ramdane Dris. World Food Ltd. Helsinki, Finland	2005	Book Chapter
18	Ashraf, M.Y.	Ashraf, M.	Sarwar, G.		Physiological approaches to improving plant salt tolerance In: CROPS		Ramdane Dris. World Food Ltd. Helsinki, Finland	2005	Book Chapter
19	Rehman, S	Haris, PJC	Ashraf, M.		Stress environments and their impact on crop production In: Abiotic Stresses		Haworth Press, New York	2005	Book Chapter
20	Ashraf, M.Y.	P.I.C Harris			Plant resistane through breeding and molecular approaches In: Abiotic Stresses		Haworth Press New York	2005	Book Chapter
21	Athar, H.R.	Ashraf, M.			Photosynthesis under Drought Stress	2nd Ed.	M. Pessarakli, Marcel and Dekker (Eds.), Inc., New York, U.S.A.	2005	Book Chapter
22	Wahid A.	M.A. Khan			Various Bacteria and Thalloid Organisms	1st	Higher Education Commission, Islamabad, Pakistan.	2005	Under Review
INSTITUTE OF FOOD SCIENCE AND TECHNOLOGY									
1	Awan J.A.				Elements of Food Science and Technology				
2	Awan J.A.				Food Processing and Preservation				
3	Awan J.A.				Elements of Food and Nutrition				
4	Awan J.A.				Scientific Presentations				
DIRECTORATE OF RESEARCH									
1	Ghafoor, A.,	M. Qadir.	G. Murtaza		Saline-sodic soils: principles of management.	1st	Allied Book Centre, Urdu Bazar, Lahore, Pakistan	2004	
2	Ghafoor, A.,				Manual for Synopsis and Thesis Preparation	1st	University of Agriculture, Faisalabad	2005	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
3	Ijaz Pervez	A. Rashid	M. Zafar Amir	A. Rasool	Training Guide for Pesticide Dealers	1st	Directorate of Pest Warning and Quality Control of Pesticides, Punjab, Lahore	2005	
4	Ghafoor A.	A. Naveed	A. Rashid		Farmers Firently Technologies (1961-2005)	1st	University of Agriculture, Faisalabad	2006	Compiled
5	Ghafoor A.	A. Naveed	A. Rashid		Postgraduate Research (Glympses) (2961-2005)	1st	University of Agriculture, Faisalabad	2006	Compiled
6	Ghafoor A.	A. Rashid	A. Naveed		Proceedings of World Food Day October 16, 2004	1st	University of Agriculture, Faisalabad	2006	Compiled
7	Ghafoor A.	A. Rashid	A. Naveed		Priority Areas of Research (2005-2006)	1st	University of Agriculture, Faisalabad	2006	Compiled
8	Ghafoor A.	A. Rashid	A. Naveed		100 Years of excellence in Education & Research Punjab Agricultural College and Research Institute, Lyallpur (1906-1960) Vol.1	1st	University of Agriculture, Faisalabad	2006	Compiled
9	Ghafoor A.	A. Rashid	A. Naveed		100 Years of excellence in Education & Research University of Agriculture, Faisalabad (1961-2005) Vol.2	1st	University of Agriculture, Faisalabad	2006	Compiled
10	Ghafoor A.	A. Rashid	A. Naveed		Bibliography of Scientific Publications (1961-2005)	1st	University of Agriculture, Faisalabad	2006	Compiled
DEPARTMENT OF ISLAMIC STUDIES									

کل نمبر شمار	نمبر شمار	نام مصنف	نام کتاب/ تحقیقی مقالہ	صفحات	تاریخ/سالِ	طباعتی ادارہ	کیفیت
151	15	مولانا غلام احمد حریری	حیاتِ حضرت امام ابوحنیفہؒ	708	1980ء	المکتبہ السلفیۃ لاہور	
152	16	مولانا غلام احمد حریری	حیات امام ابن قیمؒ	728	1965ء	شیخ غلام علی اینڈ سنز لاہور	
153	17	مولانا غلام احمد حریری	حیات امام ابن حزمؒ	700	1964ء	شیخ غلام علی اینڈ سنز لاہور	
154	18	مولانا غلام احمد حریری	حدیثِ رسولؐ کا تشریعی مقام	640	1971ء	ملک سنز کارخانہ بازار فیصل آباد	
155	19	مولانا غلام احمد حریری	علوم القرآن	484	1978ء	ملک سنز کارخانہ بازار فیصل آباد	
156	20	مولانا غلام احمد حریری	علوم الحدیث	473	1978ء	ملک سنز کارخانہ بازار فیصل آباد	
157	21	مولانا غلام احمد حریری	اسلامی مذاہب	391	1979ء	ملک سنز کارخانہ بازار فیصل آباد	
158	22	مولانا غلام احمد حریری	تاریخِ تفسیر ومفسرین	281	1979ء	ملک سنز کارخانہ بازار فیصل آباد	
159	23	مولانا غلام احمد حریری	تاریخِ حدیث ومحدثین	656	1979ء	ملک سنز کارخانہ بازار فیصل آباد	
160	24	مولانا غلام احمد حریری	المنتقی	419	1980ء	مولانا خالد گرجاکھی گوجرانوالہ	
161	25	مولانا غلام احمد حریری	حضرت ابوہریرہؓ	352	1980ء	ناشرانِ قرآن لاہور	
162	26	مولانا غلام احمد حریری	قرآن مجید کے فنی محاسن	382	1980ء	طارق اکیڈمی فیصل آباد	
163	27	مولانا غلام احمد حریری	عربی اردو بول چال مع کلید	213	1980ء	مکتبہ القریش لاہور	
164	28	مولانا غلام احمد حریری	اساسِ اسلام	271	1981ء	علمی کتاب خانہ لاہور	
165	29	مولانا غلام احمد حریری	فہم اسلام	289	1981ء	علمی کتاب خانہ لاہور	
166	30	مولانا غلام احمد حریری	شرح الحدیث والفقہ	301	1981ء	پولیمر پبلی کیشنز لاہور	
167	31	مولانا غلام احمد حریری	مخزنِ اسلام	381	1981ء	پولیمر پبلی کیشنز لاہور	
168	32	مولانا غلام احمد حریری	اعجاز القرآن	14	1978ء	اردو دائرہ معارف اسلامیہ پنجاب یونیورسٹی لاہور	
169	33	مولانا غلام احمد حریری	علوم القرآن	10	1978ء	پنجاب یونیورسٹی لاہور	
170	34	مولانا غلام احمد حریری	قرآن کریم کے اثرات وبرکات	40	1978ء	پنجاب یونیورسٹی لاہور	
171	35	مولانا غلام احمد حریری	علم الصرف	5	1978ء	پنجاب یونیورسٹی لاہور	
172	36	مولانا غلام احمد حریری	علم الشتقاق	4	1978ء	پنجاب یونیورسٹی لاہور	
173	37	مولانا غلام احمد حریری	سیرت نگاری	9	1978ء	پنجاب یونیورسٹی لاہور	
174	38	مولانا غلام احمد حریری	عربی نعت نگاری	12	1978ء	پنجاب یونیورسٹی لاہور	

175	39	مولانا غلام احمد حریری	کعبہ	15	1978ء	پنجاب یونیورسٹی لاہور		
176	40	مولانا غلام احمد حریری	منبر	3	1978ء	پنجاب یونیورسٹی لاہور		
177	41	قاری محمد اقبال	اخوت کا بیاں ہو جا	8	1987ء	تبلیغ الاسلام ایجوکیشنل سنٹر فیصل آباد		
178	42	قاری محمد اقبال	اسلام کا نظام عدل واحسان اور برائیوں کا انسداد	12	1988ء	وزارت مذہبی امور حکومت پاکستان اسلام آباد		
179	43	قاری محمد اقبال	تخلیق انسانی کے انفرادی پہلو	5	1992ء	ماہنامہ ''دلیل راہ'' لاہور جلد شمارہ 8		
180	44	قاری محمد اقبال	انسانی حقوق اور تعلیماتِ نبوی (قسط اول)	3	1992ء	ماہنامہ ''منہاج القرآن'' لاہور جلد 6 شمارہ 4		
181	45	قاری محمد اقبال	انسانی حقوق اور تعلیماتِ نبوی (قسط دوم)	4	1992ء	ماہنامہ ''منہاج القرآن'' لاہور جلد 6 شمارہ 5		
182	46	قاری محمد اقبال	تخلیقِ انسانی کے انفرادی پہلو (قسط اول)	3	1994ء	ماہنامہ ''منہاج القرآن'' لاہور جلد 8 شمارہ 2		
183	47	قاری محمد اقبال	تخلیقِ انسانی کے انفرادی پہلو (قسط دوم)	4	1994ء	ماہنامہ ''منہاج القرآن'' لاہور جلد 8 شمارہ 6		
184	48	قاری محمد اقبال	مسلکِ امام ربانی مطبوعہ مقالہ جو الحمراء ہال لاہور میں پڑھا گیا	20	1996ء	سلطانیہ پبلی کیشنز: جہلم		
185	49	قاری محمد اقبال	مصطفائی معاشرے کی تشکیلی بنیاد: اخوت	13	2004ء	مرکزِ تحقیق فیصل آباد		
186	50	قاری محمد اقبال	اسلام کا تجارتی ضابطۂ اخلاق	15	2004ء	مرکزِ تحقیق فیصل آباد		
187	51	خلیل احمد علیم وغلام احمد حریری	مخزن اسلام			پولیمر پبلی کیشنز اردو بازار لاہور		
188	52	خلیل احمد علیم	رہنمائے عمرہ			شعبہ تبلیغ جامعہ مسجد زکریا راجہ کالونی فیصل آباد		
189	53	خلیل احمد علیم	پیغمبر اکرم ﷺ اور اصلاح معاشرہ			مرکزی وزارت مذہبی امور اسلام آباد پاکستان		
190	54	خلیل احمد علیم	اسلام کا نظام عدل واحسان اور برائیوں کا انسداد			مرکزی وزارت مذہبی امور اسلام آباد پاکستان		
191	55	خلیل احمد علیم	لسانی وگروہی اختلافات کا خاتمہ تعلیمات نبوی کی روشنی میں			مرکزی وزارت مذہبی امور اسلام آباد پاکستان		
192	56	خلیل احمد علیم	تعمیر شخصیت وفلاح انسانیت سیرت طیبہ کی روشنی میں			مرکزی وزارت مذہبی امور اسلام آباد پاکستان		
193	57	خلیل احمد علیم	استحکام پاکستان اور سیرت طیبہ			مرکزی وزارت مذہبی امور اسلام آباد پاکستان		
194	58	خلیل احمد علیم	عدم برداشت کا قومی وبین الاقوامی رجحان اور تعلیمات نبوی ﷺ			مرکزی وزارت مذہبی امور اسلام آباد پاکستان		
195	59	خلیل احمد علیم	اسلامی نظم معیشت اور کفالت عامہ میں زکوۃ کی اہمیت			مرکزی وزارت مذہبی امور اسلام آباد پاکستان		
196	60	خلیل احمد علیم	تعلیمات پیغمبر ﷺ کی روشنی میں			مرکزی وزارت مذہبی امور اسلام آباد پاکستان		
197	61	خلیل احمد علیم	اسلامی معاشرہ اور رمضان المبارک			شعبہ تبلیغ جامعہ مسجد زکریا راجہ کالونی فیصل آباد		
198	62	خلیل احمد علیم	صراط الادب (عربی گرائمر)			مکتبہ فاران خالد آباد فیصل آباد		
199	63	خلیل احمد علیم	کلید ادب (اردو گرائمر)			فاران اکیڈمی خالد آباد فیصل آباد		
200	64	خلیل احمد علیم	پیغمبرِ اسلام اور اصلاحِ معاشرہ		نومبر 1987ء	مقالات سیرت (مرکزی وزارت مذہبی امور)		
201	65	خلیل احمد علیم	تعلیمات پیغمبر اور سیرت طیبہ		اکتوبر 1988ء	مقالات سیرت (مرکزی وزارت مذہبی امور)		

202	66	خلیل احمد علیم	لسانی اور گروہی اختلافات کا خاتمہ سیرت کی روشنی میں		ستمبر 1990ء	مقالات سیرت (مرکزی وزارت مذہبی امور)	
203	67	خلیل احمد علیم	اسلام کی عالمگیریت		29.01.1988	روزنامہ نوائے وقت لاہور	
204	68	خلیل احمد علیم	اسلامی معاشرہ میں حکمرانوں کا کردار		31.12.1996	روزنامہ نوائے وقت لاہور	
205	69	خلیل احمد علیم	اسلام کا نظام معیشت		27.04.1981	روزنامہ امروز لاہور	
206	70	خلیل احمد علیم	اسلام کا عادلانہ معاشی نظام		09.05.1981	روزنامہ جسارت کراچی	
207	71	خلیل احمد علیم	اسلام میں انسداد فواحش		17.01.1985	روزنامہ ڈیلی بزنس فیصل آباد	
208	72	خلیل احمد علیم	ازدواجی زندگی کے اخلاقی تقاضے		25.01.1985	روزنامہ ڈیلی بزنس فیصل آباد	
209	73	خلیل احمد علیم	گداگری اور اسلام		08.02.1985	روزنامہ ڈیلی بزنس فیصل آباد	
210	74	خلیل احمد علیم	اسلام کا نظام اخلاق اور آخرت		13.03.1985	روزنامہ ڈیلی بزنس فیصل آباد	
211	75	خلیل احمد علیم	اسلام دین وحدت		09.05.1985	روزنامہ ڈیلی بزنس فیصل آباد	
212	76	خلیل احمد علیم	رمضان اور سماجی برائیاں		03.02.1985	روزنامہ ڈیلی بزنس فیصل آباد	
213	77	خلیل احمد علیم	حرام خوری اور ناجائز آمدن		04.10.1985	روزنامہ ڈیلی بزنس فیصل آباد	
214	78	خلیل احمد علیم	قران کے تراجم وتفاسیر		04.10.1985	روزنامہ ڈیلی بزنس فیصل آباد	
215	79	خلیل احمد علیم	اسلام دین اخلاق		07.10.1987	روزنامہ ڈیلی بزنس فیصل آباد	
216	80	خلیل احمد علیم	دعا خلیل ونوید مسیحا		01.01.1989	ماھنامہ الجامعہ جھنگ	
217	81	خلیل احمد علیم	آداب زکوۃ		اپریل 1988	ماھنامہ الجامعہ جھنگ	
218	82	خلیل احمد علیم	سیدنا عثمان ذی النورین		اگست 1988	ماھنامہ الجامعہ جھنگ	
219	83	خلیل احمد علیم	زکوۃ کی اہمیت		اپریل 1988	ہفت روزہ خدام الدین لاہور	
220	84	خلیل احمد علیم	آداب زکوۃ		اپریل 1988	ماھنامہ الجامعہ جھنگ	
221	85	خلیل احمد علیم	مقاصد زکوۃ		مئی 1988	ماھنامہ الجامعہ جھنگ	
222	86	خلیل احمد علیم	یتیموں اور غریبوں کے حقوق		26.09.1994	روزنامہ النقیب فیصل آباد	
223	87	خلیل احمد علیم	بیمار پرسی کے آداب		30.12.1994	ہفت روزہ محافظ وطن فیصل آباد	
224	88	خلیل احمد علیم	خدمت خلق		12.09.1995	ہفت روزہ ترجمانِ پاکستان	
225	89	خلیل احمد علیم	عفوودرگزر		04.10.1995	ہفت روزہ ترجمانِ پاکستان	
226	90	خلیل احمد علیم	آداب میزبانی		14.11.1995	ہفت روزہ ترجمانِ پاکستان	
227	91	خلیل احمد علیم	غصہ سے اجتناب		07.11.1995	ہفت روزہ ترجمانِ پاکستان	
228	92	خلیل احمد علیم	سید ولد آدم		05.12.1995	ہفت روزہ ترجمانِ پاکستان	

229	93	خلیل احمد علیم	ورفعنا لك ذكرك		12.12.1995	ہفت روزہ ترجمانِ پاکستان		
230	94	خلیل احمد علیم	اسلامی نظریہ حیات		11.02.1996	ہفت روزہ ترجمانِ پاکستان		
231	95	خلیل احمد علیم	روزہ اور تحمل		14.02.1996	ہفت روزہ ترجمانِ پاکستان		
232	96	خلیل احمد علیم	روزہ اور تزکیۂ نفس		15.02.1996	روزنامہ عوام فیصل آباد		
233	97	خلیل احمد علیم	تزکیۂ نفس کیسے؟		27.02.1996	روزنامہ عوام فیصل آباد		
234	99	خلیل احمد علیم	بابُ العلم حضرت علی		27.03.1996	روزنامہ عوام فیصل آباد		
235	100	خلیل احمد علیم	غزوہ احد ورلڈ کپ اور ثقافتی شو		09.07.1996	روزنامہ عوام فیصل آباد		
236	101	خلیل احمد علیم	مرکزی وزارت مذہبی امور سیرت کانفرنس نہیں ہے داد کا طالب		26.07.1996	روزنامہ یارن فیصل آباد		
237	102	خلیل احمد علیم	مولانا حکیم عبدالرحیم اشرف پر تحقیقی مضمون		24.04.1967	روزنامہ یارن فیصل آباد		
238	103	خلیل احمد علیم	طلبہ اور نصاب		28.04.1967	روزنامہ عوام فیصل آباد		
239	104	خلیل احمد علیم	اعلاً کلمة الله		16.06.1967	روزنامہ عوام فیصل آباد		
240	105	خلیل احمد علیم	میں بھی حاضر تھا وہاں		28.12.1968	روزنامہ عوام فیصل آباد		
241	106	خلیل احمد علیم	روزہ اطباء یورپ کی نظر میں		11.10.1971	روزنامہ عوام فیصل آباد		
242	107	خلیل احمد علیم	جہاد اسلامی معاشرے کا روشن باب		11.10.1971	ہفت روزہ اخبار پنجاب فیصل آباد		
243	108	خلیل احمد علیم	منشیات سے اجتناب		17.11.1996	روزنامہ عوام فیصل آباد		
244	109	خلیل احمد علیم	کلیدی عہدوں کا احتساب کا استثناء کیوں؟		05.12.1996	ڈیلی یارن فیصل آباد		
245	110	حافظ احمد تبسم	قراء کرام سے ایک استفسار	3	فروری 1997ء	ماہنامہ بینات کراچی جلد 59 شمارہ 9		
246	111	حافظ احمد تبسم	حرمتِ محاورہ اہم ہے کہ تعظیمِ شعائر اللہ؟ قسط اول	3	اپریل 1997ء	ماہنامہ بینات کراچی جلد 59 شمارہ 11		
247	112	حافظ احمد تبسم	حرمتِ محاورہ اہم ہے کہ تعظیمِ شعائر اللہ؟ قسط دوم	4	مئی 1997ء	ماہنامہ بینات کراچی جلد 59 شمارہ 12		
248	113	حافظ احمد تبسم	حرمتِ محاورہ اہم ہے کہ تعظیمِ شعائر اللہ؟ قسط سوم	3	جون 1997ء	ماہنامہ بینات کراچی جلد 60 شمارہ 1		
249	114	حافظ احمد تبسم	حرمتِ محاورہ اہم ہے کہ تعظیمِ شعائر اللہ؟ قسط چہارم	3	جولائی 1997ء	ماہنامہ بینات کراچی جلد 60 شمارہ 2		
250	115	حافظ احمد تبسم	حرمتِ محاورہ اہم ہے کہ تعظیمِ شعائر اللہ؟ قسط پنجم	5	اگست 1997ء	ماہنامہ بینات کراچی جلد 60 شمارہ 3		
251	116	حافظ احمد تبسم	تعمیر شخصیت وفلاح انسانیت سیرت طیبہ کی روشنی میں	7	ستمبر 2000ء	مقالات سیرت وزارت مذہبی امور پاکستان		

LIST OF LABORATORY MANUALS PUBLISHED BY THE TEACHERS AT NATIONAL/ INTERNATIONAL LEVEL

UNIVERSITY OF AGRICULTURE, FAISALABAD

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
FACULTY OF AGRICULTURE									
DEPARTMENT OF PLANT BREEDING & GENETICS									
1	Aslam, M.	M.M. Gilani	M. Asif		Laboratory guide to elements of cytogenetics and crop improvement.		Department of Plant Breeding & Genetics, West Pakistan Agriculture University, Lyallpur.		
2	Rehman, A.	M.M. Gilani			Guide to Practicals Introductory Genetics and Plant Breeding		West Pakistan Agri. University, Lyallpur.		
3	Dr. Iftikhar Ahmad Khan				Course Manual - Integration of Biotechnological and Conventional Techniques in Crop Improvement.		Dept. of Plant Breeding & Genetics, University of Agriculture, Faisalabad.		
DEPARTMENT OF AGRI. ENTOMOLOGY									
4	Yousaf, M.				A Manual of Introductory Entomology.		Department of Agri. Entomology, University of Agriculture, Faisalabad.	1989	
5	Suhail, A.				A notebook of Classification of Adult Insects.		Department of Agri. Entomology, University of Agriculture, Faisalabad.	2002	
6	A. Sohail	R.R. Khan	M.A. Khan		Laboratory Manual of Natural History and Behaviour of Insects.		Department of Agri. Entomology, University of Agriculture, Faisalabad.	2003	
DEPARTMENT OF FORESTRY, RANGE MANAGEMENT AND WILDLIFE									
7	Quraishi, Masood A.A.	M. Tahir Siddiqui			Practical Manual of Agro-Forestry		University of Agriculture, Faisalabad.	1993	
8	Quraishi, Masood A.A.	M. Ishaque			Practical Manual for Range Management.		A-One Publisher, Urdu Bazar, Lahore, Pakistan.	1998	
9	Quraishi, Masood A.A.	M. Tahir Siddiqui			Practical Manual of Watershed Management.		University of Agriculture, Faisalabad.	2002	
DEPARTMENT OF PLANT PATHOLOGY									
10	Bhatti, M.A.R.	M.A. Randhawa	S.M. Khan		Laboratory Manual: Introduction to Plant Disease Control.		Department of Plant Pathology, University of Agriculture, Fiasalabad.	1978	
11	Mirza, J.H.	S.M. Khan	M.A. Khan		Laboratory Manual: Introductory Mycology		Department of Plant Pathology, University of Agriculture, Fiasalabad.	1992	
12	Mirza, J.H.	S.M. Khan	M.A. Khan	S.T. Sahi	Plant Pathology Laboratory Manual		Pak. Phytopathol. Society.	1992	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
13	Ahmad, R.	M.A. Khan			Laboratry Manual for Plant Nematology		Department of Plant Pathology, University of Agriculture, Fiasalabad.	1999	
14	Mirza, J.H.	S.M. Khan	M.A. Khan		Mycology Laboratory Manual		Department of Plant Pathology, University of Agriculture, Fiasalabad.	1990	
15	Mirza, J.H.	R.A. Chohan	M.A. Khan	S.T. Sahi	Laboratrory manual for Plant Pathology. Pak Phytopath Society		Department of Plant Pathology, University of Agriculture, Fiasalabad.	1995	
16	Ahmad, R.	M.A. Khan	N. Javed		Laboatory Manual for Plant Nematology		Department of Plant Pathology, University of Agriculture, Fiasalabad.	1999	
17	Khan, S.M.	R.A. Chohan	M.A. Khan	S.T. Sahi	Laboratory Manual for Plant Pathogens		Department of Plant Pathology, University of Agriculture, Fiasalabad.	1999	Revised
18	Khan, M.A.	R. Ahmad			Laboratory Manual for Bacterial Plant Pathology		Department of Plant Pathology, University of Agriculture, Fiasalabad.	1999	
19	Khan, S.M.	R. Ahmad	M.A. Khan		Laboratory Manual for Plant Pathogens, Pak Phytopath Soc.		Department of Plant Pathology, University of Agriculture, Fiasalabad.	1999	
INSTITUTE OF HORTICULTURAL SCIENCES									
1	Ali, N.,	M.N. Malik	A.H. Gillani		Practical Manual of fruit culture. Department of Horticulture		University of Agriculture, Faisalabad.	1979	
2	Ali, N.,				Field and Laboratory Manual for advanced courses in horticulture. Department of Horticulture,		University of Agriculture, Faisalabad.	1985	
FACULTY OF VETERINARY SCIENCES									
DEPARTMENT OF CLINICAL MEDICINE & SURGERY									
1	Athar, M.				Practical Manual for Large Animal Surgery.	1st	World wide Publishers, Faisalabad.	1995	
2	Athar, M.				Practical Manual for small Animal Surgery	1st	World wide Publishers, Faisalabad.	1995	
3	Athar, M.	M. Tauseef Ahmad			Vet's Guide - A Manual of Veterinary Products.	1st	Agri.-Livestock Bureau Pakistan, Faisalabad, Pakistan.	1990	
4	Athar, M.	M. Tauseef Ahmad			Vet's Guide - A Manual of Veterinary Products.	2nd	World-wide Pubishers, Faisalabad, Pakistan.	1996	
DEPARTMENT OF VETERINARY PARASIOTOLOGY									
5	Khan, M.N.	Z.D. Sandhu	A. Jabbar		Manual of Veterinary Entomology.		Friends Science Publishers, Peoples Colony, Faisalabad, Pakistan.	2003	

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6	Iqbal, Z.	Z.D. Sandhu	A. Jabbar		Manual of Veterinary Helminthology.		Friends Science Publishers, Peoples Colony, Faisalabad, Pakistan.	2004	
7	Iqbal, Z.	M.S. Sajid	R.Z. Abbas	M.N. Khan	Manual of General Parasitology and Protozoology.		Friends Science Publishers, Peoples Colony, Faisalabad, Pakistan.	2003	
8	Khan, M.N.	R.Z. Abbas	M.S. Sajjid		Manual of Meat Hygiene and Inspection.		Friends Science Publishers, Peoples Colony, Faisalabad, Pakistan.	2003	
DEPARTMENT OF VETERINARY MICROBIOLOGY									
9	Arshad, M.	H. Afzal			Laboratory Manual of Milk Hygiene		Department of Veterinary Microbiology, University of Agriculture, Faisalabad.	1996	
DEPARTMENT OF VETERINARY PATHOLOGY									
10	Anjum, A.D.				Laboratory Manual for "General Pathology"		Alpha Printing Press, Faisalabad, Pakistan.	1980	
DEPARTMENT OF VETERINARY ANATOMY									
11	Chaudhry, M.N.	A.S. Qureshi			Illustrated Veterinary Histology		Mas Publishers, Faisalabad.	1997	
DEPARTMENT OF ANIMAL REPRODUCTION									
12	Lodhi, L.A.	H.A. Samad	I. Ahmad		“Guidelines and recommendations for improving artificial breeding of cattle and buffalo in Asia” by N. Schutte, O. Perera and D. Galloway (Eds)		In IAEA Pbulication, Vienna, Austria.	2004	
DEPARTMENT OF PHYSIOLOGY AND PHARMACOLOGY									
13	Zia-ur-Rahman	J.A. Khan	Tanveer Khaliq		Physiology-I		University of Agriculture, Faisalabad.	2004	
14	Zia-ur-Rahman	J.A. Khan	Tanveer Khaliq		Physiology-II		University of Agriculture, Faisalabad.	2004	
15	Zia-ur-Rahman	J.A. Khan	Tanveer Khaliq		Manual of Physiology-I		Pak. T.M. Printers, Faisalabad, Pakistan	2004	
16	Zia-ur-Rahman	J.A. Khan	Tanveer Khaliq		Manual of Physiology-II		Mass Computers Faisalabad, Pakistan	2005	
FACULTY OF ANIMAL HUSBANDRY									
DEPARTMENT OF POULTRY HUSBANDRY									
1	Mahmood, S.	M. sarwar			Safety code for laboratory practice.		University of Agriculture, Faisalabad.	1997	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
DEPARTMENT OF LIVESTOCK MANAGEMENT									
2	Khan, B.B.	M.A. Assad	M. Tufail	M. Younas and A.S. Chaudhry	Practical Manual for Introductory Livestock Management Course for Agri. Students.		Mashhoor Printing Press, Faisalabad, Pakistan.	1982	
3	Khan, B.B.	M.A. Assad	M. Tufail	A.S. Chaudhry and M. Younas	Practical Manual for Introductory Livestock Management Courses.		Mashhoor Printing Press, Faisalabad, Pakistan.	1983	
4	Younas, M.				A Training Manual containing curricula developed for Village Specialists in Animal Production and Health for Quetta based Balochistan Rural Support Program (BRSP).		Dept. of Livestock Management, University of Agriculture, Fiasalabad, Pakistan.	1993	
5	Younas, M.				Compendium on Range Livestock Production. A manual for under and post-graduate classes		Dept. of Livestock Management, University of Agriculture, Fiasalabad, Pakistan.	1998	
6	Khan, B.B.	M. Yaqoob	M. Riaz	M. Younas and A. Iqbal	Livestock Management Manual for Introductory Courses.		Dept. of Livestock Management, University of Agriculture, Fiasalabad, Pakistan.	2004	
INSTITUTE OF FOOD SCIENCE & TECHNOLOGY									
1	Awan, J.A.	S. Rehman			Food Analysis Manual	1st	VetAg Publishers, Chiniot Bazar, Faisalabad, Pakistan.	1997	
2	Awan, J.A.	S. Rehman			Food Preservation Manual	1st	VetAg Publishers, Chiniot Bazar, Faisalabad, Pakistan.	1997	
3	Awan, J.A.	S. Rehman			Food Analysis Manual	2nd	World Wide Publishers, Press Market, Faisalabad, Pakistan.	1999	
4	Awan, J.A.	S. Rehman			Food Preservation Manual	2nd	Uni. Tech. Publishers, Peoples Colony No.1, Faisalabad, Pakistan.	1999	
5	Awan, J.A.	S. Rehman			Food Analysis Manual	3rd	Uni. Tech. Publishers, Peoples Colony No.1, Faisalabad, Pakistan.	2000	
6	Awan, J.A.	S. Rehman			Food Preservation Manual	3rd	Uni. Tech. Publishers, Peoples Colony No.1, Faisalabad, Pakistan.	1999	
7	Awan, J.A.	S. Rehman			Microbiology Manual				

LIST OF TECHNICAL REPORTS PUBLISHED BY THE TEACHERS AT NATIONAL/ INTERNATIONAL LEVEL

UNIVERSITY OF AGRICULTURE, FAISALABAD

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
FACULTY OF AGRICULTURE									
DEPARTMENT OF PLANT PATHOLOGY									
1	Khan, M.A.				Forecasting epidemics of leaf rest of wheat and their control.		UGC funded project.	1997	
2	Khan, M.A.				Characterization of epidemiological factors conducive for bacterial blight of cotton and its management		UGC funded project.	1999	
3	Khan, M.A.				Identification of resistant sources against major potato viruses and their vectors and their diagnosis band on serological tests.		PSF funded project.	2003	
4	Riaz A. Chohan				Biological control of Root knot nematodes with bacterium *pasteuria penetrans* and fungus *verticillium chlamydosporium*		ODA (Oversees Development Agency) UK		
5	Riaz A. Chohan				Use of Plant growth promoting Rhizobacteria for the biotogical control of chickpea wilt.			2000	
6	Riaz A. Chohan				Survey, biology and management of citrus slow decline cause by *Tylenchus semipenetrans* .		Higher Education Commission, Islamabad.	2004	
7					Citrus canker, loss assessment and its chemical control			2003	
8	Khan, S.M.	R. Ahmad	M.A. Khan		Plant diseases of Economic Importance and their management.		Proceeding of the Second National conference of Plant Pathology.	1999	
INSTITUTE OF HORTICULTURAL SCIENCE									
1	Ibrahim, M.I.				Proceeding of International Conference on Citriculture		University of Agriculture, Faisalabad.	2004	
INSTITUTE OF SOIL AND ENVIRONMENTAL SCIENCES									
1	Gill, A.M.	N. Ahmad			Nutritional and Physiological aspects of Cotton Leaf Curl Virus		University of Agriculture, Faisalabad	1999	
2	Gill, A.M.	Rahmatullah	T. Aziz		Evaluation of soil properties for their possible role in Shisham dieback under umbrella project: Survey Research and Control of Shisham Dieback in Punjab		Annual Research Report, University of Agriculture, Faisalabad.	2003-04	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
3	Arshad, M.,	Z.A. Zahir	S.A. Abbas		Improving maize yield through substratedependent. Microbially derived plant hormones		Annual Report PSF Project University of Agriculture, Faisalabad	1997	
4	Arshad, M.,	Z.A. Zahir	A. Khaliq		Study of hormonal imbalance in Cotton in relation to cotton leaf curl virus.		Progress Report5 CLCV Sub-Project-2, Ministry of Food and Agriculture Livestock. University of Agriculture, Faisalabad	1998	
5	Zahir, Z.A.,	A.R. Malik	M. Khalid	M.Arshad	Phosphorus releasing potential of Pakistani soils.		Ist Annual Report of UGC funded Project	2000	
6	Arshad, M.,	Z.A. Zahir	S.A. Abbas	A. Khalid and M. Khalid	Improving maize yield through substrate-dependent microbially-derived plant hormones.		Final Report PSF Project No. University of Agriculture, Faisalabad	2000	
7	Zahir, Z.A.	M. Khalid	M. Arshad		Phosphatase activity in soils. Assessment of phosphorus releasing potential of Pakistani soils.		Final Report of UGC funded project	2001	
8	Arshad, M.,	Z.A. Zahir	M. Rizwan		Recycling of organic waters for sustainable crop production		Annual Report of ALP Project		
9	Arshad, M.,	Z.A. Zahir	B. Shaharoona		Microbial ACC-deaminase biotechnology for sustainable production of cereals.		Annual Report of the Project funded by Ministry of Science and Technology	2003	
10	Arshad, M.,	Z.A. Zahir	M.H. Mahmood		Recycling of organic wastes for sustainable crop production		Annual Report of ALP Project		
11	Arshad, M.,	Z.A. Zahir	B. Shaharoona		Microbial ACC-deaminase biotechnology for sustainable production of cereals.		Annual Report of the Project funded by HEC/MOST	2004	
12	Qureshi, R.H.	S.Muhammad	M. Aslam		Proceedings of Seminar/Workshop on Membrane Biophysics and Development Salt Tolerance in lants		University of Agriculture, Faisalabad.	1978	
13	Sandhu, G.R.	R.H. Qureshi			Possibility of raising green fodder in parts of Cholistan desert.		NIAB-Micro/II, Nuclear Institute for Agriculture and Biology, Faisalabad, Pakistan,	1975	
14	Sandhu, G.R.	R.H. Qureshi			Feasibility of growing green fodder in saline soils of Indus West Bank		Nuclear Institute for Agriculture and Biology, Faisalabad, Pakistan.	1975	
15	Qureshi, R.H.	N. Ahmad	R. Jabeen		Cooricinated Research Programme on Saline Agriculture		Ist Annual Report University of Agriculture, Faisalabad, Pakistan	1982	
16	Qureshi, R.H.	N. Ahmad	R. Jabeen		Coordinated Research Programme on Saline Agriculture		IInd Annual Report, University of Agriculture, Faisalabad, Pakistan	1983	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
17	Qureshi, R.H.	N. Ahmad	R. Jabeen		Coorinated Research Programme on Saline Agriculture		IIInd Annual Report, University of Agriculture, Faisalabad, Pakistan	1984	
18	Qureshi, R.H.	N. Ahmad	S. Nawaz		Cooridianted Research Programme on Saline Agriculture		Ivth Annual Report, University of Agriculture, Faisalabad, Pakistan	1985	
19	Qureshi, R.H.	N. Ahmad	S. Nawaz		Cooridianted Research Programme on Saline Agriculture		Vth Annual Report, University of Agriculture, Faisalabad, Pakistan	1986	
20	Qureshi, R.H.	N. Ahmad	S. Nawaz		Editorial Committee. 25 year's of Education and Research		University of Agriculture, Faisalabad, Pakistan	1961-86	
21	Qureshi, R.H.	M. Aslam			Principal Investigator, Research on Utilization of Degraded Lands Sadhoke		1th Annual Report, University of Agriculture, Faisalabad, Pakistan	1987-88	
22	Qureshi, R.H.	M. Aslam			Principal Investigator, Research on Utilization of Degraded Lands Sadhoke		2th Annual Report, University of Agriculture, Faisalabad, Pakistan	1988-89	
23	Ahmad, N.	R.H. Qureshi	M. Qadir		Irrigation systems management/ research (biotic and chemical reclamation of sodic soil)		2th Annual Report, Dept of Crop Physiology, University of Agriculture, Faisalabad, Pakistan	1988	
24	Qureshi, R.H.	T.Hussain	S.H.Shah	M.Ibrahim and M. Ahmad	Proceedings National Seminar on the Role of Plant Health and Care in Agricultural Production		University of Agriculture, Faisalabad, Pakistan	1988	
25	Ahmad, N.	R.H. Qureshi	M.Qadir		Irrigation systems management/ research (biotic and chemical reclamation of sodic soil)		3th Annual Report, Dept of Crop Physiology, University of Agriculture, Faisalabad, Pakistan	1989	
26	Ahmad, N.	R.H. Qureshi	M.Qadir		Irrigation systems management/ research (biotic and chemical reclamation of sodic soil)		4th Annual Report, Dept of Crop Physiology, University of Agriculture, Faisalabad, Pakistan	1990	
27	Ahmad, N.	R.H. Qureshi	M.Qadir	M. Javaid	Irrigation systems management/ research (biotic and chemical reclamation of sodic soil)		5th Annual Report, Dept of Crop Physiology, University of Agriculture, Faisalabad, Pakistan	1991	
28	Aslam, M.	R.H. Qureshi	I.A.Mahmood		Salt Tolerance Studies on Rice		11th Annual Report, Dept of Soil Science, University of Agriculture, Faisalabad, Pakistan	1992	
29	Aslam, M.	R.H. Qureshi	I.A.Mahmood		Salt Tolerance Studies on Rice		1th Annual Report, Dept of Soil Science, University of Agriculture, Faisalabad, Pakistan	1993	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
30	Qureshi, R.H.	M.Aslam	S.H.Hanjra	Raza Ali Gill	Forage shrub production from saline and/or sodic soils in Pakistan,		ACIAR Project 8619. Final Report Dept. of Soil Science, University of Agriculture, Faisalabad, Pakistan	1990-93	
31	Qadir, M.	R.H. Qureshi			Reclamation of slat-affected soils: review of the research work conducted by the University of Agriculture, Faisalabad		Soil Science, University of Agriculture, Faisalabad, Pakistan	1994	
32	Qureshi, R.H.	E.G.Barrett-Lennard			Saline Agriculture for Irrigated Land in Pakistan: A handbook		Australian Centre for International Agricultural Research Canberra, Australia. Better Printing Queanbeyan, Australia	1998	
33	Qureshi, R.H.				Impact of Agricultural Practices on Environmental Sustainability in Asia		Report of an Asian Productivity Organization, Tokyo, Japan from	2000	
34	Mian M.A.	J. Akhtar			Cooperative Research Programme on Rice		6th and 7th Annual Reports Dept. of Soil Science, University of Agriculture, Faisalabad	1988	
35	Akhtar, J.	M. Aslam			Screening of trees and grasses salinity for the utilization of salt-affected wastelands.		Six month progress report. Dept. of Soil Science, University of Agriculture, Faisalabad	1996	
36	Akhtar, J.	K. Mahmood			Use of brackish drainage effluent for Agriculture and forestry.		Annual Progress Report (Sept. 1998 to May 1999). Saline Agriculture Research Cell, University of Agriculture, Faisalabad	1999	
37	Akhtar, J.	M.S. Iqbal	K. Mahmood		Use of brackish drainage effluent for Agriculture and forestry.		Annual Progress Report (May, 1999 toMay 2000). Saline Agriculture Research Cell, University of Agriculture, Faisalabad	2000	
38	Akhtar, J.	K. Mahmood			Use of brackish drainage effluent for Agriculture and forestry.		Interim Report. Saline Agriculture Research Cell, University of Agriculture, Faisalabad	2000	
39	Akhtar, J.	K. Mahmood	T. Haq		Use of brackish drainage effluent for Agriculture and forestry.		Annual Progress Report (May, 2000 to May 2001) Saline Agriculture Research Cell, University of Agriculture, Faisalabad	2001	

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40	Akhtar, J.	M.A. Haq	T. Haq		Soil Survey Report (Shorkot Site). Saline Agriculture Farmers Participatory Development Project		Saline Agriculture Research Centre, University of Agriculture, Faisalabad	2002	
41	Akhtar, J.	K. Mahmood	T. Haq	M.A. Haq	Use of brackish drainage effluent for Agriculture and forestry.		Annual Progress Report (May, 2001to May 2002). Saline Agriculture Research Centre, University of Agriculture, Faisalabad	2002	
42	Akhtar, J.	M.A. Haq	K. Mahmood	T. Haq	Use of brackish drainage effluent for Agriculture and forestry.		Final Report (1998-2002). Saline Agriculture Research Centre, University of Agriculture, Faisalabad	2003	
43	Akhtar, J.	M.A. Haq			PARC-ALP Project, National Coordinated Project on Management of Salt Affected Soil and Brackish Waters in Pakistan (Component III, UAF)		Annual Report 2003-04. Saline Agriculture Research Centre, University of Agriculture, Faisalabad	2004	
44	Ghafoor, A.	B. Ahmad	A.A. Maan	G. Murtaza	Farmer Participaion in Technology Development and Transfer for Using Agricultural Drain Water for Growing Grain Crops During Reclamation of Saline-Sodic Soils.		Technical Report 1 (July 2000-December 2001). University of Agriculture, Faisalabad	2001	
45	Murtaza, G.				Management of brackish water for cotton-wheat crops production.		Progress Report (April 2001 to July 2002). University of Agriculture, Faisalabad	2002	
46	Ghafoor, A.	B. Ahmad	A.A. Maan	G. Murtaza	Farmer Participaion in Technology Development and Transfer for Using Agricultural Drain Water for Growing Grain Crops During Reclamation of Saline-Sodic Soils.		Technical Report 2 (July 2001-December 2002). University of Agriculture, Faisalabad	2002	
47	Murtaza, G.				Management of brackish water for cotton-wheat crops production.		Progress Report (July 2002 to July 2003). University of Agriculture, Faisalabad, Pakistan	2003	

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48	Ghafoor, A.	B. Ahmad	A.A. Maan	G. Murtaza	Farmer Participaion in Technology Development and Transfer for Using Agricultural Drain Water for Growing Grain Crops During Reclamation of Saline-Sodic Soils.		Technical Report 3 (June 2002-December 2003). University of Agriculture, Faisalabad	2003	
49	Ghafoor, A.	B. Ahmad	A.A. Maan	G. Murtaza	Farmer Participaion in Technology Development and Transfer for Using Agricultural Drain Water for Growing Grain Crops During Reclamation of Saline-Sodic Soils.		Draft Technical Final Report (June 2001-February 2004). University of Agriculture, Faisalabad, Pakistan	2004	
50	Murtaza, G.				Management of brackish water for cotton-wheat crops production.		Final Technical Report University of Agriculture, Faisalabad	2004	
FACULTY OF AGRI. ECONOMICS & RURAL SOCIOLOGY									
DEPARTMENT OF AGRI. ECONOMICS									
1	Ahmad Saeed Kahn	M. Aslam Chaudhry			A study of cropping pattern in rice zone of the Punjab		University of Agricutlure, Faisalabad		
2	M. Aslam Chaudhry	M. Aslam Chaudhry			Economics of crop insurance		University of Agricutlure, Faisalabad		
3	Bashir Ahmad	M. Aslam Chaudhry	Sarfraz Hassan		Cost of producing major crops in the Punjab		University of Agricutlure, Faisalabad		
4	Bashir Ahmad	Khuda Bakhsh	Sarfraz Hassan	Shahid Bashir Khokar	Economics of growing tinda gourd		Deptt. of Farm Management, Univ. of Agri., Faisalabad	2003	
5	Bashir Ahmad	Khuda Bakhsh	Sarfraz Hassan	Shahid Bashir Khokar	Economics of growing bitter gourd		Deptt. of Farm Management, Univ. of Agri., Faisalabad	2003	
6	Bashir Ahmad	Khuda Bakhsh	Sarfraz Hassan	Shahid Bashir Khokar	Economics of growing Muskmelon		Deptt. of Farm Management, Univ. of Agri., Faisalabad	2003	
7	Ali Muhammad Chaudhry	Bashir Ahmad	M. Aslam Chaudhry		Cost of Producing major crops in Pakistan		Deptt. of Farm Management, Univ. of Agri., Faisalabad		
8	Bashir Ahmad	M. Aslam Chaudhry			Productivity Differential between Pakistan and Indian Punjabs: An analysis		Deptt. of Farm Management, Univ. of Agri., Faisalabad	1996	
9	Bashir Ahmad	M. Aslam Chaudhry	Munir Ahmad		Factors Contributing towards Aversion of Virus attack on Cotton Crop in the Punjab		Deptt. of Farm Management, Univ. of Agri., Faisalabad	1996	

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
10	M. Asghar Cheema	Bashir Ahmad	M. Aslam Chaudhry	Mukhtar Ahmad Wahla	Baseline Socio-Economic Survey of Selected Model Villages in Rural Development Project (Faisalabad - Pakistan)		Deptt. of Farm Management, Univ. of Agri., Faisalabad	1992	
11	Bashir Ahmad	M. Aslam Chaudhry	Munir Ahmad		Farm Management Analysis of Rice Production in the Rice Based Farming system of Punjab.		Deptt. of Farm Management, Univ. of Agri., Faisalabad	1996	
12	Jack A. Sinden	Bashir Ahmad	M. Aslam Chaudhry		An Economic Comparison of Rural Welfare in Various Crop Ecological Regions of the Punjab.		Deptt. of Farm Management, Univ. of Agri., Faisalabad	1997	
DEPARTMENT OF DEVELOPMENT ECONOMICS									
13	Chaudhry, M.A.	B.M. Kausar	Zahir Hussain		Agricultural Development and Labour Migration in Sargodha Region (A Research Report for Housing and Physical Planning Department, Punjab)			1977	
14	Kausar, M.B.	Ashfaq Hussain Mirza	M. Afzaal	Abbas Khan	Structural Pre-requisites for the Functioning of Water User's Associations, under Cooperative Law.		University of Agriculture, Faisalabad.	1982	
15	Bajwa, M.A.				Determination of Economics of the existing Farm Enterprises.		University of Agriculture, Faisalabad.	1982	
16	Bajwa, M.A.	M.B. Kausar			The Pattern of Rural Savings in Selected Villages of Faisalabad District.		University of Agriculture, Faisalabad.	1989	
17	Kausar, M.B.	Afzaal Khan			Maintenance of Improved Watercourses and Organizational Perspective.		University of Agriculture, Faisalabad.	1984	
18	Gill, Z.A.	Qamar Mohy-ud-Din			The Wheat Marketing Activity in the Punjab Province.		University of Agriculture, Faisalabad.	2002	
DEPARTMENT OF ENVIRONMENTAL AND RESOURCE ECONOMICS									
19	Abedullah	Hans Koegl.			Economic Feasibility and potential acceptance of "Oval Saw" New technology to remove the spinal cord in cattle and sheep carcasses.				submitted to European Union Commission
20	Abedullah	Hans Koegl.			Risk, Information, and Fertilizer use in Rainfed Lowland Rice Areas of Tarlac, Philippines		Faculty of Graduate School University of the Philippines at Los Banos	1998	International
21	Abedullah	Hans Koegl.			The Role and nature of Risk in Alternative Cropping Patterns in Claveria, Northern Mindanao, Philippines		Faculty of Graduate School University of the Philippines at Los Banos	1993	International

S.#	Author_1	Author_2	Author_3	Author_4	Title	Edition	Published by	Year	Remarks
22	Dr. Ali M. Ch.	Dr. Bashir Ahmad		Manzoor Ahmad	A Study into Economic Comparison of Bullock Farming Versus Tractor Farming in Lyallpur District.		Research Studies, West Pakistan Agricultural University Lyallpur.	1970	
23	Dr. Ali M. Ch.	Dr. Bashir Ahmad		Manzoor Ahmad	Economics of Irrigation.		Department of Economics, Colorado State University Fort Collins.	1974	
24	Dr. Ali M. Ch.	Dr. Bashir Ahmad		Manzoor Ahmad	Economics of Land Leveling		Department of Economics, Colorado State University Fort Collins.	1974	
25	Dr. Ali M. Ch.	Dr. Bashir Ahmad		Manzoor Ahmad	A Model for Simulating the Impacts of Crop Production Management Practices.		Department of Agricultural Economics, University of Manitoba Winnipeg.	1976	
26	Dr. Ali M. Ch.	Dr. Bashir Ahmad		Manzoor Ahmad	Farm Business Decision.		Presented on a Seminar "Economy of Military Farms" at Military Farm Instructional Centre, Okara.	1980	
27	Dr. Ali M. Ch.	Dr. Bashir Ahmad		Manzoor Ahmad	Base-Line Socio-Economic Survey of Chashma Right Bank Canal Project in Taunsa Tehsil.		Faculty of Agricultural Economics and Rural Sociology, University of Agriculture, Faisalabad and Social Sciences Research Center, University of Punjab Lahore.	1980	
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112	Dr. Bashir Ahmad				Economics of Growing Muskmelon		Department of Farm Management, Faculty of Agricultural Economics and Rural Sociology, University of Agriculture, Faisalabad.	2003	
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1	Muhammad, G.	M. Athar	M.Z. Khan	S. Rehman	A Producer Participatory Rural Out-Reach Mastitis Control Program Focusing on Early Detection and Improved Management.		A Project, funded by University of Agriculture, Faisalabad.	1995	
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2	Iqbal, Z.				Characterization of different antigens of Haemonchus contortus of sheep and their immunogenic potential as vaccine		University Grants Commission, Pakistan.	1996	

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4	Hayat, C.S.	M. Akhtar			Production of tick cell culture vaccine		University Grants Commission Islamabad	1996	
5	Hayat, C.S.	M. Akhtar			Free living nematode Rhabditis as helminth vaccine against Toxocara vitulorum		PSF, Pakistan.	1998	
6	Iqbal, Z.				Partially completed research project on "Haemonchosis in sheep: research based control strategies and economic returns"		Competitive Grants System	1999	
7	Iqbal, Z.				Trichostrongylid nematodes of sheep: Some Epidemiological aspects and evaluation of anthelmintic activity of some indigenous plants		University Grants Commission Islamabad	2002	
8	Akhtar, M.	C.S. Hayat	M. Ashfaque		Immunoprophylaxis against coccidiosis in Poultry		University Grants Commission Islamabad	2002	
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10	Iqbal, Z.				Characterization of tannins in feeds and forages of Pakistan and their evaluation for anthelmintic activity		ALP program by PARC	2004	
11	Khan, M.N.	C.S. Hayat			Mite infestation in animals: Chemotherapeutic and immunological control.		University Grants Commission Islamabad		
12	Khan, M.N.				Studies on epidemiology, Economic significance and chemotherapy of hypodermosis in cattle and buffaloes		University Grants Commission Islamabad		
13	Iqbal, Z.	Farah Deeba			Screening of Nematode Populations of Beetal Goats for Development of Resistance against commonly used Anthelmintics at Livestock Farms of Punjab		Pakistan Science Foundation	2005	
14	Iqbal, Z.				Studies on the Prevalence, Biology, Control and Economic Significance of *Hypoderma* Species in Some Semi-hilly Districts of Punjab	2nd	Pakistan Science Foundation	2005	

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15	Khan, A.	M.Z. Khan			Effects of formalin (37% formaldehyde) feeding on haematological and serum bio-chemical values in White Leghorn cockerels.		Final Project report funded by UAF/HEC, Islamabad.	2001	
16	Javed M.T.				Epidemiological and Pathological study on tuberculosis in food animals and its association with human infection		PSF funded Project	2004	
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17	Nawaz, M.				Proceedings of the European Union International Workshop on the Rational Application of Veterinary Pharmaceuticals and Biologicals.		Livestock & Dairy Development Department, Spinny Road, Quetta.	1996	
18	Nawaz, M.	A.D. Anjum			Proceedings of the 3rd International Congress of the Pakistan Veterinary Medical Association.		University of Agriculture, Faisalabad	1990	
19	Nawaz, M.	F.H. Khan			Pharmacokinetics of Antibiotics in Domestic Animals.		Punjab Agricultural Research Coordination Board, University of Agriculture, Faisalabad.	1985	
20	Nazir Ahmad	Tassawar Hussain Shah	Zia ur Rahman	Muhammad Akram	Improvement of egg production potential of spent layers in Pakistan.		University of Agriculture, Faisalabad.	2002	
21	Muhammad Akram	Nazir Ahmad	Zia ur Rahman		Studies of improve the potentialities of spent broiler breeder parents through forced moulting programme under Pakistan conditions.	Phase-I	University of Agriculture, Faisalabad.	2002	
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27	Muhammad Shoaib Akhtar				Pharmacological screening of indigenous medicinal plants for antidiabetic activity.		Punjab Agricultural Research Coordination Board, Faisalabad.	1982-84	
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29	Muhammad Shoaib Akhtar				Study of some pharmacological effects of *paederia foetida* Linn.		Government of Punjab, Lahore.	1986	
30	Muhammad Shoaib Akhtar				Trials of some indigenous medicinal plants in volunteer diabetics.			1995	
31	Muhammad Shoaib Akhtar				Antidiabetic evaluation of *Alstonia scholaris* (Satona) leaves in diabetic patients.		University of Agriculture, Faisalabad.	2001	
32	Muhammad Shoaib Akhtar				Hypoglycemic effect of *Butea monosperma* leaves (Dhak) and *Emblica officinalis* seeds (Amla) in non-unsulin dependent diabetic patients.		University of Agriculture, Faisalabad.	2004	In progress
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2	Gilani, A.H.	M.A. Sial	M. Younas		Proc. of the Seminar on Research and Development for Livestock Production in 21st Century.		PARB and University of Agriculture, Faisalabad.	1994	
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1	Lodhi, T.A.	S.A. Khan			Bench Mark Survey of Punjab Extension and Agricultural Development Project		University of Agriculture, Faisalabad	1984	
2	Lodhi, T.A.	S.A. Khan			Linkage Between Agricultural Research and Extension in the Punjab.		University of Agriculture, Faisalabad	1988	
WATER MANAGEMENT RESEARCH CENTRE									
1	Q.A. Awan				Water Management Training Programme		University of Agriculture, Faisalabad.	1979	
2	Arshad Ali	F.M. Chaudhry	Q.A. Awan		Improved Agronomic and Water Management practices for Sugarcane Production		University of Agriculture, Faisalabad.	1979	
3	A.H. Mirza	M.A. Khan			Involvement of the Rural Poor in Development through Rural People Organizations in Pakistan Interim Report.		University of Agriculture, Faisalabad.	1980	
4	M.A. Chaudhry	M.A. Bajwa	G.A. Khan	B. Akhtar	Farmers Guide Book "Rahnuma-e-Kissan"		University of Agriculture, Faisalabad.	1980	In Urdu
5	M.A. Chaudhry	G.A. Khan	B. Akhtar		Inventory of resources of rural households in the Shahkot.		University of Agriculture, Faisalabad.	1980	

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7	A.H. Mirza	M.A. Khan			Structural Pre-requisites for the functioning of Water User's Associations under cooperative Law.		University of Agriculture, Faisalabad.	1982	
8	M.A. Chaudhry	G.A. Bajwa	B. Akhtar		Khan and Economics of existing farm enterprises - Crop Production.		University of Agriculture, Faisalabad.	1982	
9	M.A. Chaudhry	M.A. Bajwa	G.A. Khan	B. Akhtar	Farm income improvement potential with improved farm plans.		University of Agriculture, Faisalabad.	1982	
10	B. Ahmad				Available P and K in Calcareous Saline-Sodic Khurrianwala Soil Series during Reclamation with Four Amendments.		University of Agriculture, Faisalabad.	1983	
11	Q.A. Awan	K.A., Qureshi			Training in Water Management at the University of Agriculture, Faisalabad, A Scenario		University of Agriculture, Faisalabad.	1984	
12	G.H. Chaudhry	M.A. Randhawa	M. Saleem		Development of Effective Extension Methods for Motivation Farmers to Adopt Improved Water Management Practices.		University of Agriculture, Faisalabad.	1984	
13	A.R. Chaudhry	B. Akhtar	A. Khan		Time standards for farm operations.		University of Agriculture, Faisalabad.	1984	
14	M. Iqbal				Evaluation of Reclamation Status of the Saline-Sodic Khurrianwala and Gandhra Soil Series after five years of Rice-Wheat cropping.		University of Agriculture, Faisalabad.	1986	
15	A.R. Chaudhry	B. Akhtar	A. Khan		Impact of improved technology on wheat production.		University of Agriculture, Faisalabad.	1987	
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17	M.Y. Bhatti	M.A. Khan			Encyclopedia of Agriculture and Allied Sciences.		University of Agriculture, Faisalabad.	1989	In Urdu
18	S. Hussain				Field Evaluation of Application Efficiency and Distribution Uniformity		University of Agriculture, Faisalabad.	1989	
19	V. Timmer				Effect of Brackish Ground Water on the Productivity of Coarse and Fine Textured Soils in Relation to Kinetics of Steady-State		University of Agriculture, Faisalabad.	1989	

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22	A.R. Chaudhry	B. Akhtar	A. Khan		Input supply services constraints to Small Farmers.		University of Agriculture, Faisalabad.	1990	
23	M. Aslam				Cyclic use of Canal and Brackish Ground Water for Cotton production.		University of Agriculture, Faisalabad.	1990	
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25	M.A. Javed				Rice-Wheat production with Brackish Ground Water through Integrated Nutrient Management System.		University of Agriculture, Faisalabad.	1991	
26	M.S. Shahid				Soil Fertilizer Management in Rice-Wheat production using Brackish Ground Water.		University of Agriculture, Faisalabad.	1991	
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29	Rai Niaz Ahmad	N. Mahmood			Water Management Research Centre		Annual Research Report, University of Agriculture, Faisalabad.	2001-02	
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35	M.A. Khan	M.A. Khan	N. Mahmood		Annual Research Report 1994-95		University of Agriculture, Faisalabad.	1995	
36	S. Ahmad	M.A. Khan	N. Mahmood		Annual Research Report 1995-96		University of Agriculture, Faisalabad.	1996	
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39	R.N. Ahmad	N. Mahmood			Annual Research Report 2001-02		University of Agriculture, Faisalabad.	2003	
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FACULTY OF SCIENCES									
DEPARTMENT OF BOTANY									
41	Mumtaz H.	A. Kafeel			Exploitation of forage legumuinois plant diversity indigenous to Sone Valley in the salt Range of the Punjab		University of Agriculture, Faisalabad.	2004	
INSTITUTE OF FOOD SCIENCE AND TECHNOLOGY									
42	Anjum F.M.	Awan J.A.			Proceedings of the Workshop on Pakistan Food Security and Safety strategy development.		Organized in collaboration with NIH, P&D and NICEF Islamabad	2001	Proceedings

LIST OF MONOGRAPHS PUBLISHED BY THE TEACHERS AT NATIONAL/ INTERNATIONAL LEVEL

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1	Anjum Suhail				IPM of Oil Seed Crops		A short course organized by Pakistan Agriculture Research Board, Govt. of the Punjab and OPC/NESPAK.	1998	
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2	Sadaqat, H.A.	I.A. Khan	T.M. Khan		Introductory Plant Breeding		SAP, University of Agriculture, Faisalabad	2000	(Urdu) booklet
3	Dr. Abdus Salam Khan				Dhan Ki Kasht		University of Agriculture, Faisalabad.		(Urdu) booklet
4	Dr. Muhammad Saleem				Dalon Ki Kasht		University of Agriculture, Faisalabad.		(Urdu) booklet
5	Dr. Iftikhar Ahmad Khan				Kapas Ki Kasht		University of Agriculture, Faisalabad.		(Urdu) booklet
DEPARTMENT OF PLANT PATHOLOGY									
6	Trevathan, L.E.	M. A. Khan	T.J. Robbins		Effect of protectant and Eradicant Fungicides on the Area under the leaf rust progress curve, yield and kernel height of Mississippi winter wheat		Mississippi Agriculture and forestry Experiment station, USA	1993	Technical Bulletin No.1004, 7pp.
7	Mirza, J. H.	S.M. Khan	S. Begum	S. Shagufta	Mucorales of Pakistan.		Plant Pathology UAF	1979	Scientific Monographs: pp.16
8	Khan, S. M.				Mushroom cultivation		Govt. of Punjab, Lahore	1983	Urdu pp.36
9	Khan, S. M.				How to grow Chinese mushroom		University of Agriculture, Faisalabad.	1983	Urdu Extension Bulletin No.1 , pp.20
10	Khan, S. M.				Cultivation of shiitake mushroom		University of Agriculture, Faisalabad.	1983	Urdu Extension Bulletin No.2
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DEPARTMENT OF FORESTRY RANGE MANAGEMENT & WILDLIFE									
1	Quraishi	Masood A.A.	Ghulam S. Khan	Shahid Yaqoob	Watershed Management in Pakistan		University of Agriculture, Faisalabad.	1991	
2	Quraishi	Masood A.A.	Ghulam S. Khan	Shahid Yaqoob	Basics of Range and Wildlife Management		University of Agriculture, Faisalabad.	1999	
3	Quraishi	Masood A.A.	Ghulam S. Khan	Shahid Yaqoob	Basics of Forestry and Allied Sciences		University of Agriculture, Faisalabad.	2004	
INSTITUTE OF HORTICULTURAL SCIENCES									
1	Khan M.A.				Flowering Bulbs		University of Agriculture, Faisalabad	2002	
INSTITUTE OF SOIL AND ENVIRONMENTAL SCIENCES									
1	Ghafoor, A.	M.R. Chaudhry	M. Qadir	G. Murtaza and H. R. Ahmad	Use of drainage water for crops on normal and salt-affected soils without disturbing biosphere equilibrium		IWASRI Publication No. 176, International Waterlogging and salinity Research Institute, Lahore, Pakistan	1997	
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DEPARTMENT OF POULTRY HUSBANDRY									
1	Haq, A.				Practical Poultry farming		Zari Digest (Special Number) Pages 1-200.	2001	Urdu
2	Mahmood, S.	T. Ahmad			Poultry Husbandry "An Overview"		University of Agriculture, Faisalabad	1997	
DEPARTMENT OF LIVESTOCK MANAGEMENT									
3	M.A. Khan	Arshad Iqbal			Animal Husbandry (Cattle & Buffalo Production)		Zari Digest (Special Edition)	1999	in Urdu
4	M.A. Khan	Arshad Iqbal			Sheep and Goat Production		Zari Digest (Special Edition)	1999	in Urdu
5	S.H. Raza	K.Z. Gondal	A.S. Ch.		Management of Dairy Animals (A Booklet for Farmers)		University of Agriculture, Faisalabad	2004	
6	S.H. Raza	K.Z. Gondal	A.S. Ch.		The common diseases, preventive measures and vaccination program (A Booklet for Farmers)		University of Agriculture, Faisalabad	2004	in Urdu
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8	Bakht Baidar Khan	M. Yaqoob	M. Riaz	M. Younas and A. Iqbal	Livestock Management Manual - For introductory Courses		University of Agriculture, Faisalabad		
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1	M. Sarwar	Mahr-un-Nisa	Ajmal Khan		Ruminant nutrition research in Pakistan		In Press	2004	

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1	Hussain, I.	M. Akhtar	C.S. Hayat		Paractical Microbiology and Immunology		Capricorn Publications, Faisalabad-Pakistan	1998	
2	Hayat, C.S.	M. Akhtar			Parasitic Diagnosis		UGC, Govt. of Pakistan	1999	
3	Iqbal, Z.	M.N. Khan	A. Qudoos		Parasitic Research on Domesticated Animals of Pakistan, ISBN 969-417-073-7.		UGC, Pakistan	2001	
4	Akhtar, M.	I.U.J. Zafar	M.A. Hafeez		Protozology Quick Facts, ISBN 969-8753-02-8.		The Elite Scientific Publications, Faisalabad, Pakistan	2003	
5	Akhtar, M.	I. Hussain	M.A. Hafeez		Practical Poultry Farming, ISBN 969-8753-01-X		The Elite Scientific Publications, Faisalabad, Pakistan	2003	
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7	Younas, M.				A Road to Turkey. A 60 pages monograph containing an overview of the International Academic Expedition to Turkey Via Iran by the Faculty and students of the UAF from Oct. 6-20, 2000		University of Agriculture, Faisalabad.	2000	
8	Younas, M.				Safar Namah-e-Iran. A 20 pages monograph with an overview of the Academic Expedition to Iran (part of the visit) and submitted to Iranian Consulate Lahore		Iranian Consulate Lahore	2001	Urdu
9	Younas, M.				Unformal Way is a Great Mean of Education. A 40 pages monograph containing an overview of Karachi tour by International Club, UAF.		University of Agriculture, Faisalabad.	2001	
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10	Zia-ur-Rahman	M. Akram			Reconditioning of old laying hens.		University of Agriculture, Faisalabad.	2005	
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1	Ali, T.	Akbar, M.J.			Summer Vegetables		University of Agriculture, Faisalabad.	1991	(Urdu) booklet
2	Akbar, M.J.	Ali, T.			Winter Vegetables		University of Agriculture, Faisalabad.	1991	(Urdu) booklet
3	Ali, T.	Malik, N.H.	Khan, A.S.		Rear honey Bees		University of Agriculture, Faisalabad.	1994	(Urdu) booklet

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4	Khan,S.A.				Agronomy,		Training Institute of Agri.Garhi Dopatta,A.J.K.	2000	
5	Khan,S.A.				Horticulture,		Training Institute of Agri.Garhi Dopatta,A.J.K.	2000	
6	Khan,S.A.				Plant Protection		Training Institute of Agri.Garhi Dopatta,A.J.K.	2000	
7	Khan,S.A.				Rural Sociology		Training Institute of Agri.Garhi Dopatta,A.J.K.	2000	
8	Khan,S.A.				Farm Management		Training Institute of Agri.Garhi Dopatta,A.J.K.	2000	
9	Khan,S.A.				Farm Machinery		Training Institute of Agri.Garhi Dopatta,A.J.K.	2000	
10	Khan,S.A.				Soil Science		Training Institute of Agri.Garhi Dopatta,A.J.K.	2000	
DEPARTMENT OF CONTINUING EDUCATION									
11	Dr. Mahmood A. Randhawa				Oil Seed Crop Production		Zarri Publications, DEE, UAF		
12	Chaudhry W.M.	M. Aslam Ch.	Ahmad Saeed Khan		Research studies on mites of Agricultural importance in Pakistan		Agri. Entomology, UAF	1992	
DEPARTMENT OF DEVELOPMENT ECONOMICS									
13	Khan, M.A.				Farm Credit Profile and Supervised Credit in Rural Pakistan.		University of Agriculture, Faisalabad.	1973	
14	Kausar, M.B.				Modern Technological Package and Credit Requirements of the Farmers.		University of Agriculture, Faisalabad.	1977	
15	Chaudhry, A.M.				Man, Water and Economy		University of Agriculture, Faisalabad.	1970	
16	Bajwa, M.A.				Income Improvement Potential with improved Cropping Patterns.		University of Agriculture, Faisalabad.	1982	
17	Bajwa, M.A.				Linear Programming and its use in Developing Cropping Patterns.		University of Agriculture, Faisalabad.	1983	
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18	Qamar Mohy-ud-Din				Marketing Problems of Cotton Growers and Ginners in Punjab.		University of Agriculture, Faisalabad.	1979	
19	Qamar Mohy-ud-Din				An Evaluation of the Farmers Decision Making for investment in Farm Machinery, with special Reference to the Tractors.		University of Agriculture, Faisalabad.	1980	

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21	Qamar Mohy-ud-Din				Casual Hired Labour in Rural Punjab.		University of Agriculture, Faisalabad.	1982	
22	Qamar Mohy-ud-Din				Poultry Feed Marketing.		University of Agriculture, Faisalabad.	1984	
23	Qamar Mohy-ud-Din				Animal Feed Marketing.		University of Agriculture, Faisalabad.	1987	
24	Qamar Mohy-ud-Din				Marketing of Sunflower in Punjab.		University of Agriculture, Faisalabad.	1989	
25	Qamar Mohy-ud-Din				Marketing of Major Fruits in Punjab.		University of Agriculture, Faisalabad.	1989	
26	Qamar Mohy-ud-Din				A study of the difference between the support price and the actual prices received by the Farmers.		University of Agriculture, Faisalabad.	1990	
27	Qamar Mohy-ud-Din				Marketing of forest products in the Punjab Privince.		University of Agriculture, Faisalabad.	1992	
28	Qamar Mohy-ud-Din				Bulk handling of Wheat by PASSCO/Food Department in Punjab - An economic Analysis.		University of Agriculture, Faisalabad.	1994	
29	Qamar Mohy-ud-Din				Marketing of Improved Seed of Wheat and Cotton in the Punjab Privince		University of Agriculture, Faisalabad.	2000	
30	Qamar Mohy-ud-Din				An appraisal of Agricultural Marketing for the Pat Feeder command Area Development Project, Balochistan Province.		University of Agriculture, Faisalabad.	2000	
31	Chaudhry, A.R.				Analysis of the Expenditure in the Rural Areas of the Punjab.		University of Agriculture, Faisalabad.	1976	
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33	Chaudhry, A.R.				Economics of Paddy Production and Marketing in Punjab.		University of Agriculture, Faisalabad.	1980	
34	Chaudhry, A.R.				Wheat Disposal of Punjab, Agricultural Prices Commission, Government of Pakistan, Islamabad.		University of Agriculture, Faisalabad.	1981	
35	Chaudhry, A.R.				A socio-Economics study of Women Labour Force Working in Industrial Homes, Women Division, Government of Pakistan, Islamabad.		University of Agriculture, Faisalabad.	1982	

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37	Chaudhry, A.R.				Pattern and Problems of Sugarcane Marketing to Sugar Mills in Pakistan. Agri. Price Commission, Islamabad.		University of Agriculture, Faisalabad.	1985	
38	Chaudhry, A.R.				Impact of Modern Technology on Wheat Production, Water Management Research & Training Project.		University of Agriculture, Faisalabad.	1987	
39	Chaudhry, A.R.				Organization and Management of Agricultural Services and Inputs for Small Farmers in Pakistan CIRDAP, Dhaka.		University of Agriculture, Faisalabad.	1991	
40	Mustafa, K.				Cooperatives and the Rural poor in Punjab: Issued and opportunities.		University of Agriculture, Faisalabad.		
41	Mustafa, K.				Agricultural Cooperatives: Ideology, Theory and Development: A review report.		University of Agriculture, Faisalabad.		
42	Mustafa, K.				Working Capital and Finance in Subsistence Agriculture: Some conceptual and analytical issues.		University of Agriculture, Faisalabad.		
43	Mustafa, K.				Wheat Marketing System and the process of development in Punjab.		University of Agriculture, Faisalabad.		
44	Mustafa, K.				Marketing of Milk in Punjab.		University of Agriculture, Faisalabad.		
45	Mustafa, K.				Marketing of Major Vegetables in the Punjab.		University of Agriculture, Faisalabad.		
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1	Sarfraz Hussain				Food Processing & Preservation		SAP University of agriculture, Faisalabad pp73	2000	
2	Sarfraz Hussain				Preservation ofFruits and vegetables		Division of Education and Extension Division University of Agriculture, Faisalabad.pp52		
3	Sarfraz Hussain				Jam, Jellies and marmalades		SAP University of agriculture, Faisalabad.	1997	
4	Rehman, S.	A. Ali	N. Perveen		Masnuu-et-Bakery		University of Agriculture, Faisalabad.	1987	Urdu

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1	Hameed, M.	M. Ashraf			Medicinal trees and shrubs of Pakistan.		Higher Education Commission, Islamabad	2005	Under Review