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(NASRI)

Khumaltar. Lalitpur, Nepal

PROCEEDINGS

9th National Workshop on Livestock and Fisheries Research In Nepal

30-31 May 2013 (16-17 Jestha 2070)

Chief Editor
Dr. Tek Bahadur Gurung

Editors
Dr. Megh Raj Tiwari
Dr. Upendra Man Singh
Mr. Suresh Kumar Wagle
Mr. Tulsi Prasad Paudel
Mr. Kishor Kumar Shrestha
Mr. Netra Prasad Osti
Mr. Saroj Sapkota

Nepal Agricultural Research Council
National Animal Science Research Institute (NASRI)
Khumaltar, Lalitpur, Nepal

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Nepal Agricultural Research Council (NARC)
National Animal Science Research Institute (NASRI)
Khumaltar, Lalitpur, Nepal
Tel: 977-01-5524040 / 5549300
Fax: 977-01-4262500
E-mail: nasri@narc.gov.np
Web site: http / / www.narc.gov.np

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Foreword

Livestock and Fisheries play an important role in livelihood of Nepalese farmers. Both of these sub sectors in Nepal need more attention for improving productivity comparing to neighboring countries. At present production systems in livestock and fisheries are more traditional type. However, substantial changes in farming technology, marketing approach, value addition and several aspects are desirable to enhance the productivity. These reflect that robust technological backup system is desirable to support farming communities to improve production. For the purpose, Nepal Agricultural Research Council has been mandated to conduct research especially on the problems facing by farmers, DLS, entrepreneurs and consumers.

In the present proceedings of the 9th National Workshop on Livestock and Fisheries Research in Nepal, results of various research studies conducted on fields of livestock and fisheries have been compiled. It is expected that this proceedings will serve the purpose of improvement on extisting technologies to solve the farmers' problems. This proceeding would also be useful to many stakeholders.

I hope to great extent of NARC stations have been successful to solve some of farmers problems associated with livestock and fisheries. Since, there are limited research stations under the NARC, therefore, all issues and problems faced by farmers may not be addressed. However, the NARC scientists and all staffs associated with livestock and fisheries research have attempted sincerely to the extent they could do. Hope, NARC would be able to address most of the issues of livestock and fisheries subsectors in days ahead for increasing profitability to farmers and all stakeholders. Moreover, I also hope that the current proceedings would be useful to many stakeholders as reference material.

I am grateful to National Planning commission, Ministry of Finance, Ministry of Agriculture Development and many others for their support to allocate fund to Nepal Agricultural Research Council. I would like to express thanks to Dr. Tek Bahadur Gurung, Director, Livestock and Fisheries Research, NARC and his team for successful organization of this workshop. I am also thankful to all authors and editors who contributed to publish this proceeding.

Dr. Dil Bahadur Gurung
Executive Director
Nepal Agricultural Research Council

Foreword

This proceeding presents compilation of research papers presented in 9th National Workshop on Livestock and Fisheries Research in Nepal organized by National Animal Science Research Institute (NARSI). In this proceeding research works conducted in various research stations of Nepal Agricultural Research Council (NARC) have been compiled. The nature of the research undertaken by NARC is mostly problem solving type facing by rural farmers.

Technologies published in this volume are likely to be adopTable - in Nepalese context. Many issues on livestock and fisheries sub sectors might have not been covered in present volume due to limited financial and human resources and other constraints. Many of the farmers' problems might have not been touched due to inadequate research farms and stations in specific locations. Hopefully, these problems could be attempted by our scientists on priority basis in days ahead.

Currently the livestock and fisheries sub sector is known for facing insufficient production due to shortage of labor force in villages, migration of youth, extreme climate change pattern, inadequate feeds and fodder, low investment, small holding size, diseases problems etc. Hope, some of the problems associated with livestock and fisheries sub sector would be addressed by research undertaken by Nepal Agricultural Research Council in days ahead.

Many of the research initiatives on livestock and fisheries are gender friendly and supportive to women work force involved in animal husbandry and fisheries. Initiatives on climate change vulnerability and adaptation in livestock and fisheries sub sector have been started. Hope such new technologies and information would be supportive to enhance the livelihood of Nepalese farmers and other stakeholders.

I am grateful to Dr. Dil Bahadur Gurung, Executive Director, NARC; Director General, Department of Livestock Services; Program Director, Directorate of Fisheries Development, Department of Agriculture; all concerning Directors of NARC; Department of Agriculture, Institute of Agriculture and Animal Science, Tribhuwan University and Agriculture and Forestry University for their support to livestock and fisheries research. To perform the research works on livestock and fisheries sub sectors addressing the problems of farmers are tedious and labor intensive. Despite of that, I am thankful to all of my colleagues who have been able to document the information in the present proceedings. I also express my appreciation to all of livestock and fisheries Scientists, Technical and Supportive staffs for their work in far remote places in farmers filed. It is anticipated that NARC research on livestock and fisheries sub sectors would be more robust and be able to address the problems facing by farmers.

Dr. Tek Bahadur Gurung
Director, Livestock and Fisheries Research
Nepal Agricultural Research Council

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16-17 Jestha, 2070 (30-31 May, 2013)

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Master of ceremony: Mrs. Sunita Sanjyal

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Convener: Mr. Kishor K Shrestha
Chairperson: Mr. Dinesh Pariyar
Rapporteur: Mr. Devi Prasad Adhikari

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Venue: NARI Hall, Khumaltar, Lalitpur

Master of ceremony: Mrs. Sunita Sanjyal

Time	**Activities**	
16:15- 16:30	Chairperson: Dr. T. B. Gurung, Director, NARC Chief guests: Mr. V. K. Mallik, Joint Secretary, MoAD Guest: Dr. M. N. Paudel, Director, NARC Guest: Dr. N. P. Adhikari, Director, NASRI	
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17:10-17:20	Few words	Dr. N.P. Adhikari, Director, NASRI
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17:30- 17:40	Few words	Mr. V. K. Mallik, Joint Secretary, MoAD
17:40 -17:50	Vote of thanks	Dr. C. R. Upreti, Coordinator, NCRP
17:50-18:00	Closing remarks by Chairperson	Dr. T. B. Gurung, Director, NARC

Fisheries

HARNESSING FISHERIES INNOVATION FOR TRANSFORMATIONAL ECONOMIC IMPACT

Tek Bahadur Gurung
Nepal Agricultural Research Council, Singha Durbar Plaza
Email: tek_fisheries@hotmail.com

ABSTRACT

Per capita fish production in Nepal is probably the least in the world. At least to be at par for fish consumption the present fish production in Nepal should be increased at least 4-5 times or more within a short spell of 10 years facing increasing risk of climate change impact and not to be the cost of environment. It is proposed that technological innovation of Pangasius hypopthalamus, tilapia, carp and aquaculture in integration with pico-, micro-, mega- hydropower for utilizing natural 'gift' of vertical gradient of Himalayan landscape for establishing food-energy-water nexus could additional options for transformative impact.

Key words: innovation, hydropower, aquaculture integration, food-energy-water nexus

INTRODUCTION

Aquaculture innovation is the development of new customer's value through solutions that meet new needs, inarticulate needs, or old customer and market needs in new ways for fisheries (modified version, accomplished through effective products, processes, services, technologies, that are readily available to markets, governments, and society (please see Wikipedia 2013) for transformative impacts.

Fish are a source of high-protein and nutrient rich aqua based quality food, in general. For balanced food and nutritional security to ever increasing population producing only conventional staple grains cannot be adequate (WFC, 2008; IFPRI, 2008 and NARC, 2011). Besides, that aquatic agriculture such as fisheries and aquaculture had been shown to contribute in supplying nutrient rich food to foster humanity since immortal (Gurung, 2003**).** The fish are the source of minerals, vitamin A and vitamin B indispensable to all age groups for good health as basic food items (WFC, 2008).

Nepal represents a country where per capita fish consumption is probably lowest (about 2.0 kg per year) in Asian continents (DoFD, 2013). The policy documents such as Agricultural Perspective Plans agreed fisheries and aquaculture sector to be one of the dynamic sectors (APP, 1995). Fisheries productivity in Nepal has been inhibited by inadequate appropriate technological knowledge, education, research, extension systems and landscape. Nepal has a small strip of tropical flat areas called terai in northern part, mostly the country is predominated by fascinating tallest cascading highest mountains of the world, implying that such agro-ecological zone, fisheries research should be pioneering and inventive (Gurung, 2011).

Considering the unique ecological features due to marked altitudinal gradients, fisheries and aquculture development deserve innovation for transformative impacts. There are several advantages of the country being so diverse within a small and narrow range. Fisheries of highland moutains have several comparative advantages, as products are easily branded for marketing, especially those origniated from Himalaya pristine waters such as fish products.

Aquaculture is one of the fastest growing food industry in the world (NACA, 2010) including Nepal. Recently it has been shown that the annual growth rate of fisheries is about 9% in Nepal (Gurung *et al*., in press). Fisheries play very important role in the livelihood of many ethnic communities since tradition in the country. Aquatic agriculture based livelihood is considered to be one of the oldest systems in the country. It has been estimated that there are about 12 different ethnic communities representing about 18% of total population of the country involved directly or indirectly in fisheries (Gurung *et al.*, 2005). These communities not only dependent for their livelihood and income but also have got their social recognition for fishing in natural common waters. To support such communities and other farmer's fisheries research was initiated by the Government of Nepal. Being Nepal located in the Himalayan terrain modest innovative ideas and practices that could be successfully adopted to turn into economic gain would be desirable (Gurung, 2011**).**

Nepal has divers' agro ecological zone sui Table - for warm to cold water fisheries. Southern plain of terai is one of the most suiTable - locations for warm water inland aquaculture. Lakes, streams, rivers and reservoirs comprises of approximately 5% of total country. These inland water resources including that of mid and high mountains areas are the home of wide varieties of fish and fisheries resources (Petr, 2002) including a total of 229 freshwater fishes (Rajbanshi, 2013). These fish resources could be key sources of food and nutritional security and income to mountain communities. Animal food proteins are inadequate in hills. Generally the hill people suffer malnutrition, protein deficiency and problems like that of goiter due to inadequate iodine in the diet.

Freshwater fish offers much-needed source of animal protein, micronutrients and essential fatty acids. And local freshwater fisheries are particularly important in mountainous land-locked countries or remote mountain areas due to poor access to marine fishery resources.

Nepalese aquaculture has shown successful transformative innovation in past. The successful breeding of cultivable warm water carp, development of rainbow trout technology, scaling up in other geographical locations might taken as some of the innovation in fisheries and aquaculture areas. Despite of these fisheries and aquaculture is minor subsector in Nepal; and could not be a vital component of overall development plans, and a significant means of supplementing incomes and improving impoverished diets. Therefore the present paper elucidates important past achievements for suggesting ways for fisheries to bring a substantial transformation impact in Nepal.

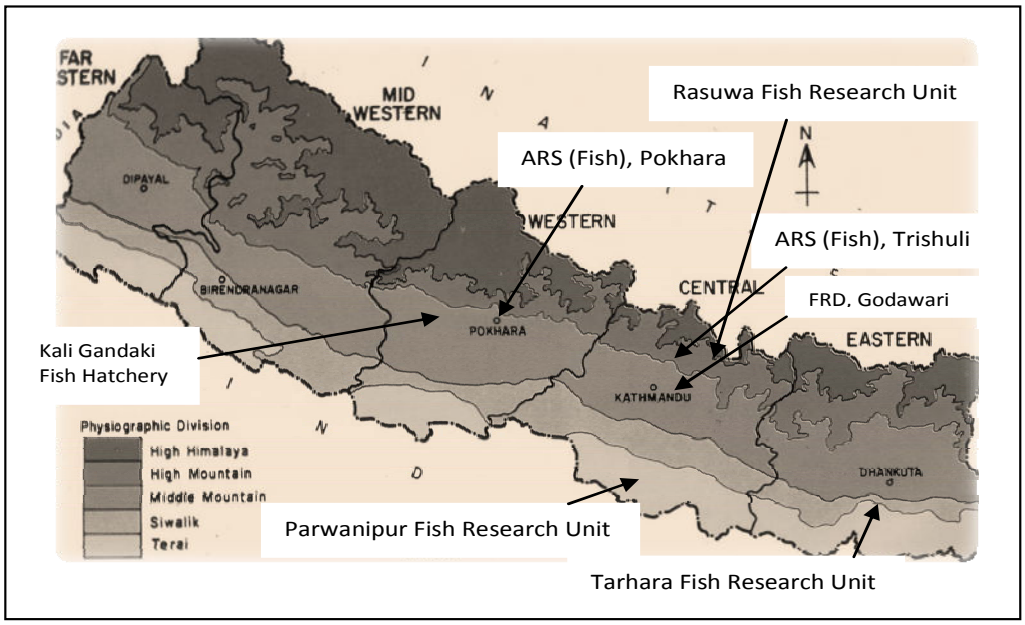


Fig. – 1: Map showing Fisheries Research Station in Nepal

MATERIALS AND METHODS

The present study is based on secondary data collected from various sources. The data on fish production, pond area, and productivity were collected from Directorate of Fisheries Development, Balaju, Ministry of Agricultural Development, Nepal Agricultural Research Council and Fisheries Research Division etc. The data on investment in fisheries sub sectors research were obtained from Nepal Agricultural Research Council as one of the representative sample. The data on fish sales in Kathmandu Valley was obtained from the Kalimati Vegetable - Market, Kathmandu. Reports, proceedings, journal articles and internet search were also consulted for compilation.

The communication, documentation and publication Division was also consulted for several information. The main research areas of fisheries and aquaculture research in the country has been fish biodiversity, taxonomy, water quality, fish culture, fish nutrition, aquaculture practices, fish breeding and fishing communities etc. In general, the research areas in fisheries and aquaculture could be divided into natural water fisheries research and aquaculture. During the analysis simple linear regression models have been used to show some of empirical relationship.

RESULTS

An estimated area that has been considered potential for fisheries and aquaculture in Nepal has been given in Table - 2. The total water surface shown is 2048353 hector in the country. Since Nepal is one of the mountainous countries, therefore the land was always a considered scare resource. At present the area coverage under fish pond are limited but, the addition by future coming reservoirs are expected to provide adequate water surface area for fisheries and aquaculture production.

Table - 1: Estimated water surface area (ha) in Nepal (DoFD, 2013)	
Water Resource	**Estimated area (ha)**
Natural water	401500
Rivers	395000
Lakes	5000
Reservoirs	1500
Village ponds	6900
Seasonal water	
Marginal swamps	11100
Irrigated rice fields	1227353
Irrigation canal length, km	7900
Total	2048353

Table - 2: Institutional involved in Fisheries related activities

- Tribhuvan University
- Agriculture and Forestry University
- Kathmandu University,
- Purbanchal University,
- Pokhara University
- Directorate of Fisheries Development (13 Service Centers)
- Nepal Agricultural Research Council Stations:
  - Fisheries Research Division, Godawari
  - ARS (fish) Pokhara
  - ARS (fish) Trishuli)
  - Fish Hatchery, Kali Gandaki
  - Fisheries Program (RARS, Tarahara)
  - Fisheries Program (RARS, Parwanipur)
  - Fisheries Program (Nepalgunj)
  - Fisheries Program (Doti)
  - Cold water fish hatchery, Rasuwa

The institutions involved in fisheries promotional activities showed besides 5 Universities, Government institutions (Directorate of Fisheries Development) supervises 13 fish farms, there are 10 fish related research centers in the country (**Table - 2**). Among these Fisheries Research Program Nepalgunj, Fisheries Research Program (Doti) and Cold Water Fish Genetic Resource Center, Rasuwa will be established from the year 2013.

Box -1: Main fish groups cultivated in Nepal

1. Carp
   - Indigenous

   Sahar (*Tor putitora)*
   Asala (*Shizothorax* spp)
   Katle (*Neolissochilus hexagonolepis*)
   Rohu (*Labeo rohita*)
   Naini (*Cirrhinus mrigala*)
   Bhakur (*Catla catla*)
   - Introduced

   Common carp (*Cyprinus carpio*)
   Bighead carp (*Aristichthys nobilis)*
   Silver carp (*Hypophthalmus molitrix*)
   Grass carp (*Ctenopharyngodon idella*)
2. Rainbow trout(*Oncorhynchus mykiss*)
3. GIFT Tilapia (*Tilapia niloticus*)
4. Catfish a) Indigenous Mungri (*Clarias batrachus)* b) Exotic (*Clarias gairepinus*), c) Pangas (*Pangasius hypophthalmus*)
5. Ornamental fishes
6. Prawn (*Macrobranchius rosenbergii*)
7. Other indigenous fishes

The total fish production by pond aquaculture was about 54 thousand Mt 2011-12 (Table - 3). The contribution of fisheries sector is 0.93% in national GDP providing contribution to employment generation for about 0.5 million people.

Table - 3: Fish production (2011/12) in Nepal (DoFD 2013)

Total Fish Production	54357 mt
Capture	21500 mt
Culture Fisheries	32857 mt
Employment	551,000
Per capita availability	2.0 kg.
NGDP contribution	0.93 %
AGDP contribution	2.61%

Table - 4: Existing Human Resource in Fisheries Research (NARC)

Post	FRD	PKR	Tris huli	Tarah ara	Parwani pur	Total
Sen. Sci. (S-5)	1	-	-	-	-	1
Sen. Sci. (S-4)	-	2	1	-	-	3
Scientist (S-1)	2	1	-	1	-	4
Tech. Officer	3	6	3	3	3	18
Technicians	5	5	3	2	1	16
Adm. & others	16	19	20	5	2	62
Total	27	33	27	11	6	104

The total scientific human resource involved in scientific and technical areas under NARC has been given in Table - 4. At present there are altogether 8 scientist posts have been created. The number of scientist comparing to the potentiality of fisheries and aquaculture is far less.

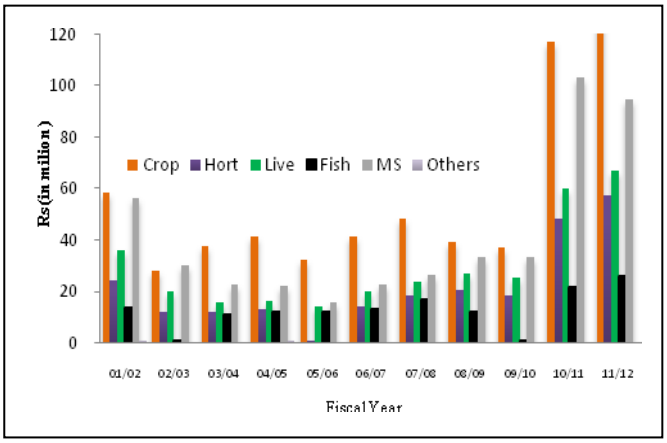


Fig. - 2: Investment in Fisheries Research in NARC

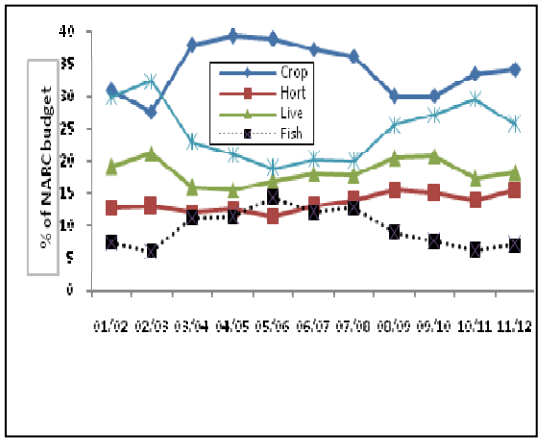
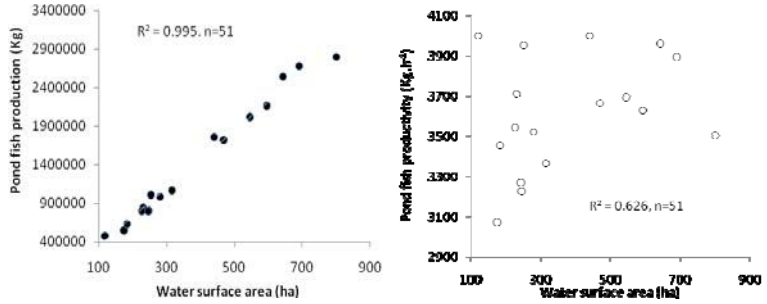


Fig. - 3. Investment (in %) on fisheries research in NARC

There has been some regular investment to promote fisheries sector from the state. Fig 2 shows the investment in different agricultural sub sectors under NARC. In fisheries comparatively the investment is far the least. Investment in fisheries from the year 2001/02 to 2011/12 showed that the minimum allocation of budget was in year 2008/09 worth only 10 million NRs, while maximum was in the year 2011/12 when about 22 million NRs was allocated. If we compare the allocation in terms of percentage the value ranges from 5 to 12% of total budget allocated to different commodity research in NARC (Fig 3).



(A) (B)

Fig. - 4: Relationship between pond fish production (A) and productivity (B) with water

The comparison of pond fish production against the water surface area showed the relationship was substantial (R^2=0.995, n=51) with highly positive correlation (Fig 4). But, when pond fish productivity was compared with the water surface area, there was positive correlation (R^2=0.626, n=51) **(**Fig 4**).** The result showed that fish production by pond aquaculture contributed highest from terai region 99% (Fig. 5).

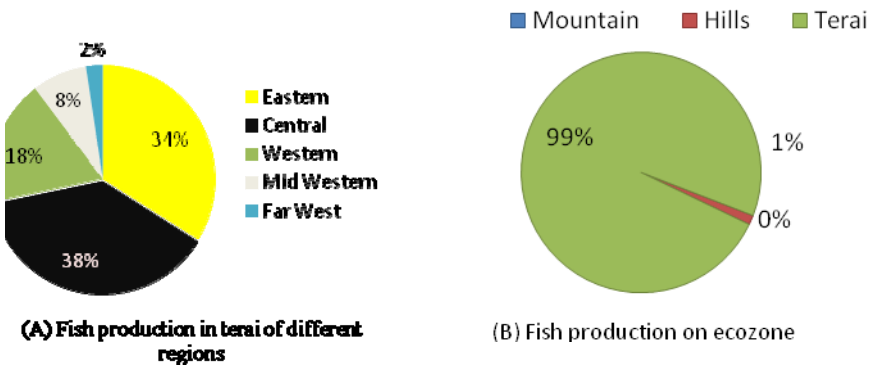


Fig. - 5: Status of fish production different ecozones of Nepal

The contribution of hill and mountains for pond fish production was only 1%. In terai region, when the production was estimated to different regions, the highest 38% was in Central region, while in eastern it was 34%. The western regions contributed 18%, mid western 8% and least 2% by far west (Fig. 5).

Per family pond holding and fish production were also evaluated (Fig 6A). The analysis revealed that the area coverage of pond holding per family has been declined than before. The family pond holding in 2002 was nearly 0.04 ha, but in 2010 that has declined to 0.35 ha. Similarly, when fish production per family was evaluated the production has steadily increased till 2007, and it remained almost same in 2008 but decline slightly too about 0.120 Mt per family. The highest fish production per family was 0.13 Mt in year 2007 (Fig. 6B).

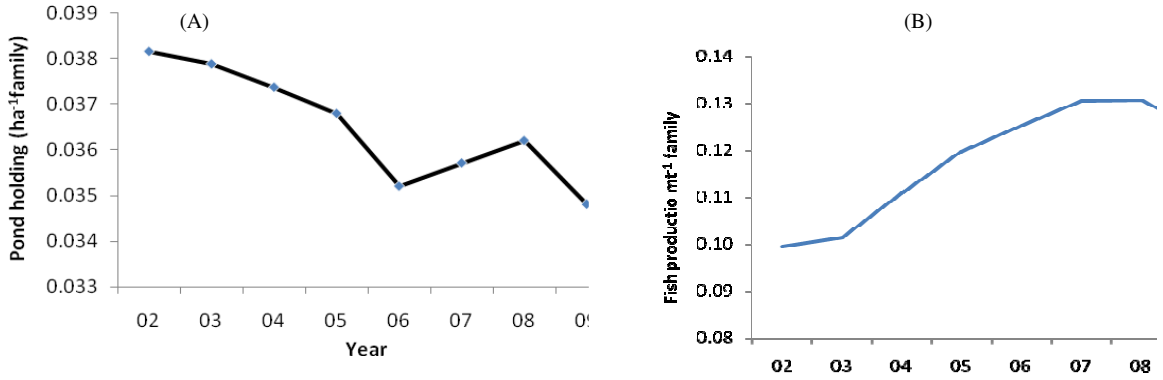


Fig. - 6: Area of pond holding (ha^{-1} family (A) and fish production mt^{-1} family (B) in Nepal

Fresh fish import

The yearly trend of fish import data collected from Kalimati whole sale market revealed that highest value of fresh fish import was only about 2800 Mt in year 2008/09 (Fig. 7A). During the interval from 2004/05 to 2009/10, the minimum value of fresh fish import was in 2004/05 represented by about 1800 Mt.

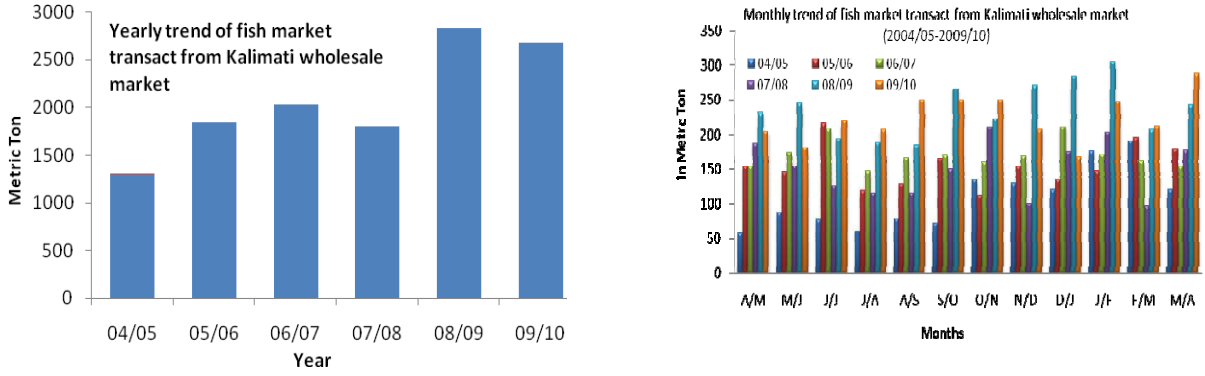


Fig. - 7: Yearly trend of fish import (A); and monthly trend in Kalimati whole sale market Kathmandu

Similar data when analyzed for monthly trend, there was not high fluctuation in fish import (Fig 7B). However, there was slight difference in between cold and warmer months. In January and February the import was high represented by about 300 Mt in a month. This showed approximately 10 Mt of fish each day was imported. The month on which fish were imported least were often the warmer month represented by March and April when nearly 52 Mt fresh fish were imported (Fig 7B).

DISCUSSION

Fisheries in Nepal is a small, and one of the fastest growing sub sector having immense potentiality for expansion as elsewhere in the world. Being a mountainous country the fish production in Nepal may not be as simple as in other Asian tropical countries because of limited suiTable - land (Fig 1). However, at present the major cultivable fishes for

production (99%) are contributed by carp in pond aquaculture (Box 1). The carp are represented by Chinese and indigenous major carp. The pond aquaculture, in general, is subsistence type, where carp mostly grow up on natural productivity subsisting on plankton food in ponds.

The water availability in the country is considered high almost representing about 5% of total land area of the country (Table - 1). There are about 6000 rivers which have been untapped for aquaculture and considered as a major source of water for fish production use. Lakes, reservoirs and village ponds only comprised 3.39% of total coverage of rivers. This suggests that there are ample opportunities of pond fish production, if the river water could be tapped for fish production. These imply that fish culture technologies suiTable - to low as well as high lands should be prioritized in our policies. Since there are so many rivers and other water bodies coinciding with the fact, the number of indigenous fish species is also high represented by 229 species (Rajbanshi, 2013**).** The higher abundance of indigenous fish suggest that innovation would be necessary to take the advantages of fish culture in Nepal utilizing the available fish species and lands unsuiTable - for crop and other agricultural use. At present a number of Universities and government institutions are working to expand and study fisheries activities in Nepal (Table - 2). There are several fisheries service center and research stations focusing fish cultivation in southern flat land for warm and cold water aquaculture in Nepal (Fig 1). Although there are handfuls of institutions working in fisheries production but a fisheries and aquaculture policy would be required to streamline the aquaculture and fisheries development in the country.

The recent data showed altogether aquaculture and capture fisheries contributes nearly 54 thousands metric ton of fish production in year 2011/12 (Table - 3). Earlier the contribution of the capture fish almost equals to cultivated fish (Swar *et al*., 2002 and Gurung, 2003). But the capture fish production has been succeeded by cultivated fish (Table - 3). The total contribution fisheries in national economy are 0.93% while it is 2.61%. In agriculture GDP It is expected in near future the contribution of fisheries and aquaculture in GDP would be increased with newly innovation and expansion in southern terai as well as in mid hills and mountainous regions. At present nearly 45 districts are engaged out of 75 districts in aquaculture development. Earlier, only about 30 districts were known to engage in fish cultivation. The technological packages developed on cold water fish rainbow trout (Gurung, 2008) have been helpful to expand the fish culture in hills and mountains rapidly. To support the cold water aquaculture more innovative technologies are expected. Contrarily, at present there are only limited scientific level human resources engaged in research (Table - 4). A country like Nepal, having a unique altitudinal set up would require additional scientific human resource for economic development using her agricultural and natural resources.

NARC Vision **(**2011) has envisaged fisheries as one of the important sectors in the country. Due to its comparatively limited programs, the budget allocation in fisheries sub sector is less. In a spell of 10 years from 2001/02 to 2011/12 the highest amount of allocated budget for fisheries and aquaculture was only 22 million Nepalese Rs (about 2.75 million US$). The

least budget was in year 2008/09 represented by about 12 million NRs. The budget allocated to fisheries and livestock research was about 9% of the total budget allocated to NARC. The highest amount of budget goes to crop research (Fig 3). The budget needs to be about double for developing more innovative aquaculture technologies. This would be important because the production and productivity of warm water carp as well as cold water trout are far less than other countries (Fig 4 A, B).

The pond fish production showed high degree of correlation (R^2=0.99, n=51) in relation to water surface area (Fig 4A). The correlation reflected that the fish production should be increased more with additional technological improvement and innovation. The pond fish productivity also showed positive and significant correlation (R^2=0.626, n= 51) with water pond water surface area, however, the magnitude of the strength was relatively weak. This indicated the diverse agro-ecological situation of due to higher altitudinal variations, management problems and inadequate skill in farmers. The pond fish farming expansion has also not been uniform in southern districts (Fig 5 A, B). In general, among the five developmental regions of the carp production was highest in Central region; and then Eastern; far less production occurred in Far West. This pattern suggests that more attention should be given in far west because this is the domain of communities having more skill and handling capacity of fish, as well as the geographic location and water availability due to abundant natural wetlands. The far west region is the most potential region.

Along with the far west, mid western and western regions should also be prioritized for aquaculture because these regions are located more close to market headquarters. Carp production showed to be highest in southern flat land terai (99%) and least in mid hills and mountains (1%). This feature suggests that innovative technologies for increasing fish production need to be emphasized on hills and mountain areas (Fig 5 B).

Carp pond area in relation to fish farming families showed decreasing pond holding area per family than before (Fig 6A, B). Perhaps, the trend reflects the family fragmentation in rural Nepal. The fish production per family has been contrarily showed an increasing trend; this might be due to increasing intensification of pond farming practice, availability of fish fry, etc popularity of fish farming, use of inputs (Fig 6B). These trends show that aquaculture prioritization have immense potentiality to increase fish production in Nepal.

At present the global average of fish consumption is about 16 kg per capita. The demand of fresh fish seems ever increasing in the country due to health and nutrition awareness, changing food habits, and life styles especially people especially among urban population. Comparing to demand fish production is far less. As a result huge amount of fresh food fish is imported. An estimate showed that fish import is equivalent to about 1.5 billion Nepalese Rupees per year (Gurung, 2012). The data collected from Government Agencies reflected an import of about 2980 Mt of fresh fish from abroad mainly India in year 2008/09. Fish traders reported that actual value of fish import all over the country should be about 10 folds than the present value collected by government agencies. To check the claim the monthly fish import was analyzed (Fig 7 A, B) with assumption that since the fresh fish consumption increases about 3-4 times more in winter (Dec-Feb) because there is mass belief that fish as

food is comparatively safe in winter than summer. Contrary to the assumption the monthly fish import pattern did not show this trend, except slight higher fish import in winter months (Fig 7 B), but that was not substantial as should have been assumed. This analysis suggested the present values obtained from the wholesale market should be far below than real values.

For harnessing the transformational impact from fisheries, it might be essential to enhance capabilities in academic area, quality human resource, structural & institutional, research & development, fish market channeling, post harvest and value addition. Besides that it would also be of prime importance as highlighted earlier that recognition of country's altitudinal set up of nearly 60 m elevation to world highest peak 8488 m from sea level within a short length of 800 km and 200 km wide trapezoidal area should always be in consideration. Unless the unique vertical gradient agro-ecology of Nepal is not recognized, innovation for economic growth would be not straightforward. Since, Nepal is renounced in inland water resources originating from highest mountains on the earth, the transformation economic impact could be possible through wise use. It is proposed that the water resources should be used for aquaculture in integration with hydropower.

Among the various institutions where fisheries and aquaculture have been undertaken as the research components, at present NARC seems to have the most extended networks of research activities focusing on technology generation comparing to others. Box 2 shows some of outstanding research findings by NARC.

Box - 2: Research accomplishment under Nepal Agricultural Research Council in Nepal

- Mass scale seed production of high valued and endangered indigenous fish *Tor putitora*
- Mass scale fish larval methodological development of *Tor putitora*
- Breeding success with hybrid production of catfish (*Clarias batrachus*)
- Increased hatchability of rainbow trout (*Oncorhynchus mykiss*)
- Increased survivability of trout larvae
- Initiation for producing all male population of Tilapia
- Breeding success of ornamental fishes such as:
  - Japanese Koi carp, Guppy, Gold fish, Molly, Sword tail
- Initiation of research work on production of several indigenous fishes of Nepal (Jalkapoor, Gardi)
- Strengthening on methods for conservation and restoration of lakes
- Breeding success with hybrid production of catfish (*Clarias spp* and others)

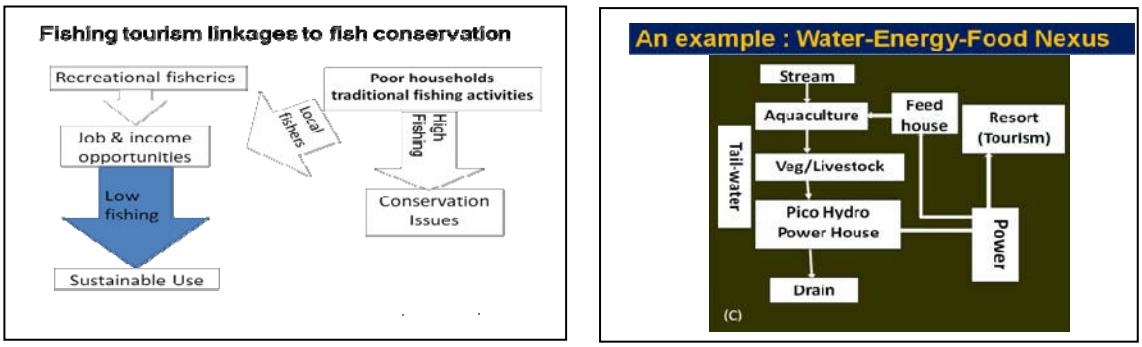


Fig. - 8: A model of fishing tourism for livelihood and fish conservation (A), water-energy-food

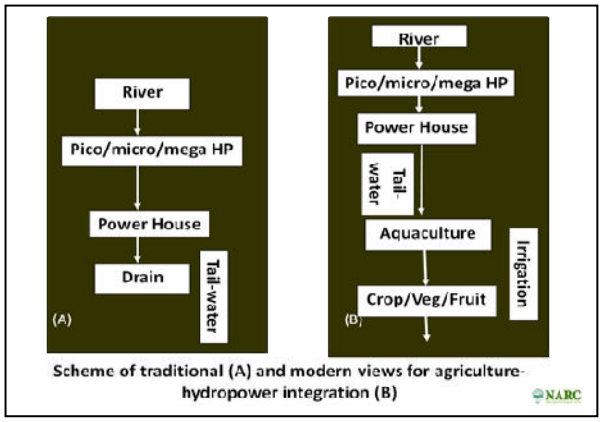


Fig. - 9: Schematic view of traditional (A) and modern view (B) of aquaculture hydropower integration for mountainous countries

In general, river waters are dammed or regulated to produce energy and the tail water is released in river (Fig 9 A, B). Instead, it is essential to use the tail water for aquaculture. Since the aquaculture only borrows the water temporarily without any consumption, therefore, the water discharge from aquaculture can again be used for irrigation or even for hydropower (Fig 9 B). Such an integration of hydropower- aquaculture - agriculture by harnessing the advantages of natural gravity flow due to altitudinal gradient of landscape can be expected to bring a substantial economic change in the country. The proposed integration of hydropower-aquaculture is possible with any pico, micro, and mega hydro powers. Earlier, it was difficult to cultivate the fish in cold water regions in higher mountain areas; however, with the success of technological development of highly commercial rainbow aquaculture, fish production can be visualized in any parts of Nepal.

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LANDMARK-BASED MORPHOMETRIC VARIATION AMONG THREE POPULATIONS OF ASALA (*SCHIZOTHORAX RICHARDSONII*) IN RIVERS OF NEPAL

Neeta Pradhan and Suresh Kumar Wagle
Fisheries Research Division, Godawari, Lalitpur, Nepal
E mail: pradhanita@yahoo.com

ABSTRACT

Morphometric differentiations among three populations of Asala (Schizothorax richardsonii) from rivers were studied using morphometric characters and landmark based truss network. Truss distances between 22 landmarks and 16 morphometric characters of 130 specimens were measured. Size adjustment transformations were assessed by dividing characters centroid size of specimen. Multivariate analysis of variance (MANOVA), principal component analysis and discrimination analysis were performed to investigate distinction and patterns of morphological variations between populations. The MANOVA (Wilk's test) indicated a significant difference for mean vectors of morphometric measurements and truss measurements (Wilks' λ =0.005 F46, 176 = 50.546, P<0.001). Discrimination analysis correctly classified 100% samples to their original groups for population. For morphometric and truss measurements, the first discriminant function (DF) accounted for 85.3% and second DF accounted for 14.7% among-group variability.

Keywords: Morphological discrimination, *Schizothorax richardsonii*, truss network system, habitat effect.

INTRODUCTION

The fishes of genus *Schizothorax* are the members of the family Cyprinidae, consist of 15 genera and over 100 species all over the world (Mirza, 1991). The genera *Schizothorax* locally known as Asala are the most important fish from the economic, sport fishery and biodiversity point of view. This genus is known to have six species in Nepalese cold waters (Rai *et al*., 2002). The *Schizothorax richardsonii* (Gray, 1832), one of the most dominant cold water species in mountain waters in Nepal, is popular for its taste and abundance throughout the foot and mid hill waters. *Schizothorax richardsonii,* commonly known as Snow trout, is distributed in confined to the Himalayan and Sub-Himalayan rivers and streams along Jammu Kashmir, Himachal Pradesh, Uttarakhand, Assam and Sikkim of India, Bhutan, Nepal, Pakistan and Afghanistan (Talwar and Jhingran, 1991). It is distributed from 850 m to 2810 m in Trishuli River, Melamchi River, Bhote Koshi River, Sabba Khola, Roshi River, Sunkoshi River, Kaligandki River and Karnali River in Nepal.

Nepal is comprised rich in its water resources. Utilization of the resources for the benefit of hilly farmers, development and adoption of the cold-water aquaculture technology could be a strong option. There are enormous opportunity and potentiality of cold water fish farming development using its clean and unpolluted Himalayan water for the production of hygienic high quality valued food. The introduction of economically viable coldwater species could

allow the coldwater resources of Nepal to be used more effectively. However, indigenous cold water fish of Nepal have a slow growth rate and Asala (*Schizothorax* spp.) is no exception. Masuda (1979) measured the four year old Asala collected from Trishuli River and found body weight ranged 226.2-363.6 g corresponding standard length between 226 to 257 mm. Studies conducted on growth performance of Asala by feeding different types of feed in Fisheries Research Centers of Nepal Agricultural Research Council (NARC) showed slow growth (15 to 17 g per year) and cannot be economical for farming with current technological knowledge. The reason of this extremely slow growth has not been clarified yet. Despite of slow growth in captivity, the reported size of Asala ranged 1.5 to 5.0 kg in different river system of Nepal (FRC, 1998). Therefore it can be expected that selection could solve the slow growing features of Asala. Before going in for a breeding program, a fish breeder ought to know the genetic make-up of the stocks as it would help in identifying the traits for which the stocks may be superior or inferior (Gopikrishna *et al*., 2006).

Morphometric and truss network has long been used for discriminating the natural stocks of fish species. Traditional multivariate morphometrics, accounting for variation in size and shape, have successfully discriminated between many fish stocks (Turan, 1999). In fish, morphometry has been used as a tool for measuring traits, especially related to body form. Morphometric differences among stocks of a species are recognized as important for evaluating the population structure and as a basis for identifying stocks. Usually, the morphometric studies have been restricted to the conventional measurements and their analyses. However, there has been a lot of debate concerning the appropriateness of their use. The Landmarks based Truss Network Analysis overcomes the disadvantages of conventional data sets and this method produces a more systematic geometric characterization of fish shape.

Landmarks refer to some arbitrarily selected points on a fish's body, and with the help of these points, the individual fish shape can be analyzed. In other words, a landmark is a point of correspondence on an object that matches between and within populations (Barlow 1961, Swain and Foote 1999). Morphometry based on truss network data has been used for stock identification (Bronte and Moore, 2007 and Shao *et al*., 2007), species discrimination (Palma and Andrade, 2002), ontogeny (Hard *et al*., 1999 and Debowski *et al*., 1999) and functional morphology (Dean *et al*., 2006). A sufficient degree of isolation may result in noTable - morphological, meristic, and shape differentiation among stocks of a species which may be recognizable as a basis for identifying the stocks. Geographical isolation can result in the development of different morphological features between fish populations because the interactive effects of environment, selection, and genetics on individual ontogenies produce morphometric differences within a species. There is lack of detailed information on the morphological characters of *Schizothorax richardsonii* species from various water bodies of Nepal. Therefore, the present study was considered as a first step towards the aim of exploring the stock structure of this species based on morphometric characters, using landmark based truss network system for successful development and management of aquaculture of this species in Nepal.

MATERIALS AND METHODS

Sample collection

All studied populations of Asala (*S. richardsonii*) were collected from Narayani River System. A total of 130 Asala (*S. richardsonii*) were collected from 3 sources: Khudi Khola in Lamjung district; Melamchi River in Sindhupalchowk district; and Trishuli River in Rasuwa district during fiscal year 2010-2011. The fish were 18.2-21.7 cm in total length (TL) and 53.9-112.5 g in weight. The sample size, mean TL, and weight are presented in Table - 1.

Table - 1: Sample size and mean length weight **(**± standard deviation) of Asala collected from different stocks

Source of fish samples	Sample size	Mean total length , cm	Mean weight, g
Khudi Khola, Lamjung	46	21.7±3.4	112.5±51.1
Melamchi River, Sindhupalchowk	30	18.7±2.6	64.2±30.7
Trisuli River, Rasuwa	46	18.2±4.1	53.9±34.2

Morphometric and truss measurement

Eighteen morphometric characters and body weights of the fish were measured to an accuracy of 0.05 mm and 1.0 g, respectively (Table - 2 and Fig:- 1). Definition of most measurements was obtained from Zafar *et al*., (2002) and Teugels *et al*., (1998). Eleven landmarks delineating 22 distances were measured on the body (Fig:- 2). Each landmark was obtained by placing a fish on a graph paper. At the point of the landmark, a hole was made on the graph paper, using a needle. After the landmarks were recorded the specimen was removed and the X-Y co-ordinate data were collected. The co-ordinates were then used to calculate the truss network distances between pairs of landmarks using the Pythagorean Theorem.

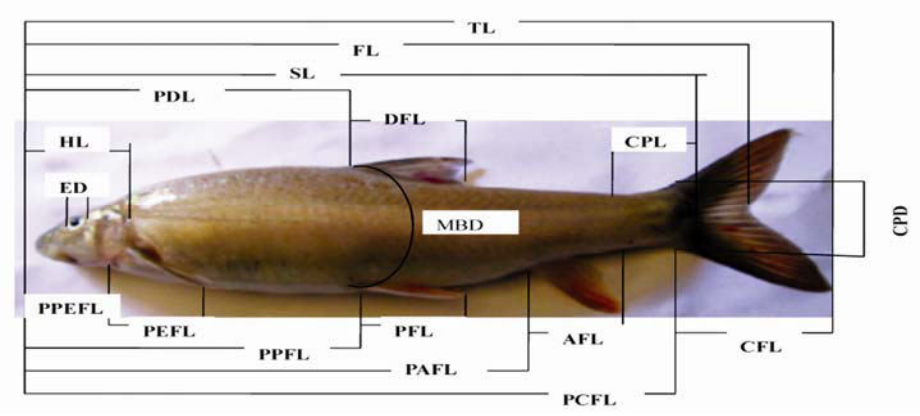

Fig. - 1: Morphological based truss distance of asala (*Schizothorax richardsonii*)

Table - 2: Morphometric characters used for analysis of *Schizothorax richardsonii* stock Variations

Character	**Description**
Total length (TL)	Distance from the tip of the snout to the longest part of caudal fin.
Standard length (SL)	Distance from the tip of the snout to the origin of caudal fin
Fork length (FL)	Distance from the tip of the snout to the point of bifurcation of caudal fin.
Maximum body depth (MBD)	Vertical distance from the anterior part of the 1st dorsal fin and ventral part of the body
Caudle peduncle depth (CPD)	Depth of caudal fin
Head length (HLN)	Distance from the tip of the snout to the posterior margin of the operculum.
Head width (HDP)	Width of the head
Eye diameter (EYD)	Maximum length of eye orbit from one margin to another.
Pre-dorsal length (PDL)	Distance from the snout tip to the anterior base of the dorsal fin
Pre-pelvic length (PPL)	Distance from the snout tip to the anterior base of the pelvic fin
Pre-pectoral length (PPC)	Distance from the snout tip to the anterior base of the pectoral fin
Pre-anal length (PAL)	Distance from the snout tip to the anterior base of the anal fin
Dorsal fin length (DFL)	Distance from the base of the dorsal fin to the tip of the dorsal fin
Pectoral fin length (PFL)	Distance from the base of the pectoral fin to the tip of the pectoral fin
Pelvic fin length (PVFL)	Distance from the base of the pelvic fin to the tip of the pelvic fin
Anal fin length (AFL)	Distance from the base of the anal fin to the tip of the anal fin
Caudal fin length (CFL)	Distance from the base of the caudal fin to the tip of the caudal fin
Caudal peduncle length (CPL)	Peduncle length

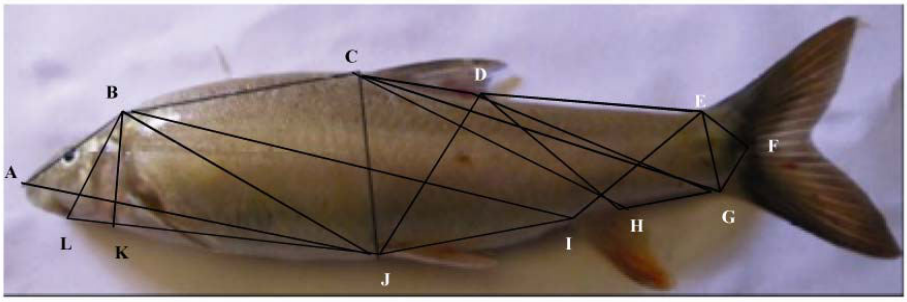

Fig.- 2: Locations of 13 landmarks used for shape analysis of Asala (*Schizothorax richardsonii*): (A) anterior tip of upper snout, (B) forehead (end of frontal bone), (C) anterior insertion of dorsal fin, (D) posterior insertion of dorsal fin (E) upper insertion of caudal fin, (F) end of lateral line (G) lower insertion of caudal fin, (H) posterior insertion of anal fin (I) anterior insertion of anal fin,(J) anterior insertion of pelvic fin, (K) anterior insertion of anal fin (L) posterior edge of angular bone

Statistical analyses

Univariate analyses (ANOVA) was conducted to examine body size differences between habitats. Since size distributions were highly overlapping between habitats, the data obtained were entered in a database for subsequent factor analysis. Because of differences in size (TL), size-adjusted values in data analyses were used. Therefore, it was necessary to remove size-dependent variations from all of the characters. An allometric formula given by Elliott *et al*. (1995) was used to remove the size effect from the dataset:

$M_{adj} = M (L_s / L_o)^{b}$;

Where; M is the original measurement, M_{adj} is the size-adjusted measurement, L_o is the TL of the fish, and L_s is the overall mean of the TL for all fish from all samples. Parameter b was estimated for each character from the observed data as the slope of the regression of log M on log L_o, using all fish in all groups.

A univariate analysis of variance (ANOVA) was carried out to test the significance of morphological differences. Principal component analysis (PCA) based on the correlation matrices were done to create uncorrelated principal components from the original variables. In addition, size-adjusted data were standardized and submitted to a discriminant function (DF) analysis. All statistical analyses were done using Statistica version (5.5) and SPSS version (11.5).

RESULTS AND DISCUSSION

Principal components with eighteen values higher than 1.00 of importance were considered (Chatfield and Collins, 1983). According to this 2 components remained, explaining about 78.77% of the variation of the original size-adjusted body morphology variables (Table - 2). The first component (PC 1) of morph does not show any size variation, while the second component (PC 2) shows variation on most of the characters except in eye diameter, preanal length and caudal peduncle length. The first component (PC 1) of truss shows size variation, in all character while the second component (PC 2) does not show any size variation.

Table - 2: Principal component analysis (PCA) forms Asala (*Schizothorax richardsonii*) from river populations. PCA was computed from correlation matrix using regression residuals as the initial morph and truss variables. The PCA loadings are listed together with the variables correlations (r) with the component scores. The highest component loadings are indicated in boldface

Morph component	**PC 1**	**r**	**PC 2**	**r**
FLN	0.46196	-.008918	0.63850	.053356
MBD	0.23005	-.009837	0.80828	.079416
CPD	0.05429	-.016258	0.78386	.081094
HLN	0.06422	-.009291	0.88482	.093367
HD1	0.10745	-.009881	0.88003	.091305
ED1	-0.02650	.001810	0.55026	.061841
PDLN	0.24518	-.011605	0.85927	.084163
PPLN	0.25239	-.012974	0.74423	.070969
PPCL	0.14451	-.010822	0.91191	.093408
PALN	0.20871	-.019587	0.04108	-.015486
DFLN	0.03867	-.013098	0.84164	.088637
PFLN	0.07595	-.009857	0.92550	.097343
PVFLN	0.11912	-.006719	0.90418	.094255
AFLN	0.16905	-.011412	0.89919	.091081
CFLN	0.10978	-.010715	0.86176	.089040
CPLN	-0.03903	-.001504	0.56802	.063501
Truss component				
AB	0.93455	.051858	0.08298	-.010320
AJ	0.97538	.050595	0.13500	-.006190
BL	0.93913	.052573	0.05287	-.013633
BK	0.95664	.056398	0.05090	-.013609
BJ	0.97024	.050858	0.14218	-.005176
BI	0.97977	-051374	0.12974	-.006748
BC	0.90188	.043113	0.14084	-.004740
CJ	0.89581	.050441	0.17660	.000951
CI	0.97214	.054448	0.11332	-.007655
CH	0.97811	.055677	0.08383	-.010836
CD	0.78814	.055984	0.02695	-.010841
DI	0.96730	.048731	0.15083	-.010841
DH	0.97377	.048731	0.11026	-.010841
DG	0.95981	.046976	0.12991	-.007012
DE	0.92555	.042022	0.13196	-.006721
EH	0.90185	.041514	0.17857	-.000924
EG	0.96418	.053040	0.13342	-.005480
EF	0.88887	.057415	0.01978	-.014611
FG	0.84609	.052829	0.03774	-.012211
GH	0.82783	.037320	0.16344	-.001067
IJ	0.94586	.049637	0.09692	-.009625
JL	0.96895	.049488	0.13295	-.006442
Eigen values	21.099		8.834	
% of variance	55.52		23.24	
Cumul. % of variance	55.52		78.77	

Discriminant function (DF) analysis was used to look for, in more detail, the body shape variables. Considering the first DF the Khudi Khola and Trisuli River populations are isolated. The Melamchi River population displayed intermediate characteristics between Khudi Khola and Trisuli River. Considering the second DF Trisuli and Khudi populations overlapped, while Melamchi population clearly differed. The DF was based on the correlation matrix of the size-adjusted variables, thus giving equal weight for variation in all variables. However, the functions emphasize the body-shape variables more than the principal component does (Table - 4).

Table - 4: Canonical discriminate function (DF), standardized by within variances with the size adjusted morphometric and truss variables (*denotes largest absolute correlation between each variable and DFs)

Morph character	**DF1**	**DF2**
FLN	0.690	0.057
MBD	0.016	0.104
CPD	0.092	-0.053
HLN	0.142	-0.004
HD1	0.091	-0.031
ED1	0.003	0.096
PDLN	0.157	0.053
PPLN	0.133	0.196
PPCLN	0.125	0.091
PALN	0.053	0.034
DFLN	0.070	0.023
PFLN	0.079	0.043
PVFLN	0.083	0.073
AFLN	0.122	0.074
CFLN	0.096	0.152
CPLN	0.020	-0.093
Truss component		
DI	0.123	-0.003
BC	0.123	0.052
EH	.123	-0.034
DE	0.122	-0.041
DG	0.121	-0.036
DH	0.118	-0.014
GH	0.118	-0.062
BJ	0.118	0.038
JL	0.117	-0.006
AJ	0.117	0.022
BI	0.114	0.012
EG	0.106	-0.020
CJ	0.102	0.082

CI	0.100	-0.015
IJ	0.100	0.031
CH	0.094	-0.014
AB	0.086	0.076
BK	0.082	0.025
BL	0.078	0.013
EF	0.069	0.041
FG	0.066	0.057
CD	0.041	0.005
Eigen value	36.537	6.295
Canonical correlation	0.98	0.93
Cumulative variance explained	85.3	100.0

Khudi Khola population is superior in all most all morphological characters (Table - 5). Trishuli and Melamchi populations were not significantly varied in most of the morph characters. Geographic separation could be a limiting factor for the phenotypic discreteness found in this study.

Table - 5: Mean size and variation of measured morphological characters and truss distance of Asala (*Schizothorax richardsonii*) among three population. Statistical differences among populations are based on multivariate (Wilks' λ) and univariate F-tests. Differences of morphological characters between habitats were determined by pair wise comparison (Tukey's test)

Traits	**Mean ± SD**			**Differences among habitats (Tukey's test)**	**P-values**
	Khudi	**Trisuli**	**Melamchi**		
Morph character					
AFL	3.63±0.7	3.01±1.8	2.81±0.4	Khu>Tri=Mel	0.000
CFLN	5.01±0.8	4.24±0.7	3.88±0.6	Khu>Tri=Mel	0.000
CPD	1.96±0.4	1.54±0.3	1.83±0.4	Khu =Mel> Tri	0.000
CPL	2.02±0.4	1.85±0.5	2.16±0.4	Khu=Tri=Mel	0.029
DFL	3.74±0.5	3.30±0.6	3.36±0.5	Khu>Tri=Mel	0.000
EYD	0.68±0.1	0.68±0.1	0.62±0.1	Khu>Tri>Mel	0.051
FLN	19.96±0.5	15.61±0.5	17.07±0.5	Khu>Tri>Mel	0.000
HDP	2.59±0.4	2.07±0.4	2.33±0.4	Khu >Mel> Tri	0.000
HLN	3.48±0.6	3.01±0.5	2.83±0.4	Khu>Tri=Mel	0.000
MBD	4.11±0.6	3.12±0.6	3.45±0.5	Khu>Tri>Mel	0.000
PAL	23.03±27.8	10.63±1.0	11.73±0.7	Khu>Tri>Mel	0.003
PDL	8.61±0.9	6.70±0.9	7.11±1.1	Khu>Mel =Tri	0.000
PFL	3.14±0.4	2.70±0.5	2.74±0.4	Khu>Mel =Tri	0.000

PPC	3.80±0.5	3.08±0.5	3.39±0.4	Khu>Mel =Tri	0.000
PPL	9.59±0.9	7.37±0.9	7.88±1.3	Khu>Mel =Tri	0.029
PVFL	3.02±0.4	2.60±0.5	2.56±0.3	Khu>Tri>Mel	0.000
Truss distance					
AB	3.08±0.5	2.65 ±1.5	2.59 ±0.4	Khu>Tri=Mel	0.000
AJ	9.71 ±1.5	7.66 ±1.7	8.18±1.3	Khu> Mel= Tri	0.000
BC	5.76 ±1.0	4.37±1.0	4.54 ±0.9	Khu>Tri=Mel	0.000
BI	11.34 ±1.9	8.74 ±2.1	9.48 ±1.3	Khu>Tri=Mel	0.000
BJ	7.51 ±1.2	5.88 ±1.3	6.19 ±0.8	Khu>Tri=Mel	0.000
BK	2.69 ±0.4	2.29 ±0.4	2.37±0.4	Khu>Tri=Mel	0.000
BL	2.92±0.4	2.52 ±0.4	2.62±0.4	Khu>Tri=Mel	0.040
CI	6.34 ±1.1	4.93±1.2	5.50 ±0.9	Khu>Tri=Mel	0.000
CJ	4.36±0.7	3.47 ±0.8	3.46±0.7	Khu>Tri=Mel	0.000
DE	6.09 ±1.0	4.52±1.1	5.28±0.8	Khu>Mel>Tri	0.000
DG	6.84 ±1.2	5.10 ±1.2	5.91±0.9	Khu>Mel>Tri	0.000
DH	4.89 ±0.8	3.66 ±0.9	4.16 ±0.6	Khu>Mel>Tri	0.000
DI	4.33 ±0.7	3.16 ±0.8	3.57 ±0.6	Khu>Mel=Tri	0.000
EF	1.75 ±0.4	1.47 ±0.3	1.48±0.3	Khu>Mel=Tri	0.000
EG	2.08 ±0.4	1.60 ±0.4	1.81 ±0.3	Khu>Mel=Tri	0.000
EH	3.00 ±0.5	2.29 ±0.5	2.61 ±0.4	Khu>Mel>Tri	0.000
FG	1.60 ±0.3	1.37 ±0.3	1.36 ±0.3	Khu>Tri=Mel	0.000
GH	2.28 ±0.4	1.72 ±0.4	2.03±0.3	Khu>Mel>Tri	0.000
IJ	4.50±0.8	3.41 ±0.9	3.69 ±0.7	Khu>Mel>Tri	0.000
JL	8.98 ±1.4	6.99 ±1.5	7.72 ±1.0	Khu>Mel>Tri	0.000
Multivariate P value based on Wilks' Lamda					<0.001

The first discriminant function (DF1) accounted for 85.3% among-group variability and clearly separated Khudi population from Trisuli and Melamchi populations. Morphometric and truss network data based univariate and multivariate (PCA and DFA) analysis revealed high isolation of the stocks under study. Both analyses showed that Khudi population is superior in body shape and form than that of the Trisuli and Melamchi populations. Whether the observed morphological patterns were produced through genetic differences or phenotypic plasticity is unknown. Hence, genetic studies are needed for selection and domestication of superior stock of Asala.

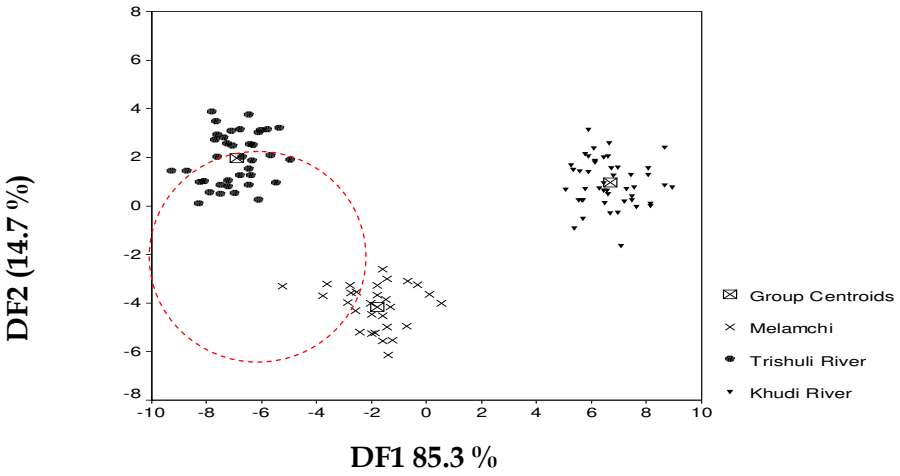

Fig. - 2: Discriminant function analysis scores (DFs) of morphometric characters and truss network measurements of asala (*Schizothorax richardsonii*)

CONCLUSION

Morphometric characters and landmark based truss network applied to identify the natural stocks of Asala (*Schizothorax richardsonii*) for the possible improvement of aquaculture stocks revealed high isolation of the stocks among their habitats. Landmark-based truss distance of Asala revealed that populations from Khudi River were found superior in their shape and size and has potential to be domesticated.

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FRY REARING OF GARDI (*LABEO DERO*) FED WITH DIFFERENT FORMULATED FEED

Surendra Prasad, Jay Dev Bista, Ram Prasad Dhakal, Agni Prasad Nepal and Md A Hussen
Fisheries Research Center, Pokhara
E-mail: g43sdp@yahoo.com

ABSTRACT

Gardi (Labeo dero) is a native fish species that is relatively easy to breed and rear, thus considered to be suiTable - for aquaculture. Fry rearing is one of the important phase and aims at obtaining high growth and survival for production of fingerlings required for stocking into grow out ponds as well as rehabilitation in natural habitat. Past study had showed Gardi could accept artificial food in captivity however, specific studies on different composition of feed and dietary evaluation is limited. Therefore, feed evaluation experiments on effect of three different formulated feeds on growth and survival of fry was carried out in 2 m^2 size hapa fixed in pond. Fry having mean body weight 0.02±0.003g were stocked at density of one million per hectare. Three different formulated diets viz. micro feed, powdered milk with egg, and soya milk were provided adlibtum to fry over a period of 45 days. Water temperature in ponds ranged from 29.0 to 30.0°C during study period. Survival was greater than 64 % in all treatment with no significant differences (P>0.05) observed among treatments. There were also no differences (P>0.05) in relative growth rate (2.23%) of the fish among treatments. Highest body weight gain occurred for fry fed with micro feed (0.523±0.080g) followed by powdered milk with egg (0.400±0.029g) and soya milk (0.330±0.034g), and the differences was significant (P<0.01) among treatments. The result suggested that there was an apparent effect of different diets at the level tested on body weight gain but gardi fry prefer micro feed containing high protein preferably of more animal origin in early stage.

Keywords: Fish diet, gardi fry, growth rate, *Labeo dero*, survival

INTRODUCTION

Gardi (*Labeo dero*) is one of important indigenous species relatively rich in river systems of Nepal (Shrestha, 1981; Shrestha, 2003). It is one of the main sources of animal protein for almost all low-income rural households in mid-hill region. Hatchery based induced spawning has been successful (Prasad and Rai, 2010). However, availability of gardi fry is still meager due to inadequate nursing technologies hatchlings to fry stage for commercial production. Hatchling rearing is one of the important phase aims for obtaining high growth and survival of fry for stocking into grow out ponds as well as rehabilitation in natural habitat. Higher survival and growth of fry depend on several factors, such as feeding being one of the most important (Pillay, 1993). The significance of qualitative and quantitative feeds for hatchlings has been well recognized for several commercial fishes (Das *et al*., 1991). Among several ingredients of feed level of protein is known to play fundamental role, because it significantly influences growth, survival and yield of fish (Manivannan and Saravanan, 2012).

At present there is only limited knowledge on feed, feeding and nutritional requirement of gardi especially during the stages from hatchling to fry stage for commercial production. Gubhaju (2002) observed that this fish feed on detritus and algae in natural condition. Gardi is considered herbivore (Raina and Petr, 1999); however in captivity they also accept supplemented feed (Prasad and Rai, 2010 and Prasad *et al.*, 2011). Therefore, this study aimed to evaluate the effect of three different formulated feeds on growth and survival of gardi from larval hatchling stage to fry.

MATERIAL AND METHODS

The study was conducted at Fisheries Research Center, Begnas, Pokhara over a period of 45 days from July to September, 2011. The pond were prepared as per standard pre-stocking management practices of nursery ponds for commercial carps involving drying, liming, fertilization, watering and chemical application for zooplankton regulation. The experiment was conducted in 2 m^2 size hapa (2m x 2m) fixed in pond. Four days fry (mean body weight 0.02±0.003g) were stocked at 200 m^{-3} (10, 00,000 no/ha). Three different formulated diets were used to test. Diet 1 was micro feed which was prepared from soya puff, fish meal, milk powder, egg yolk, fish oil, vitamin and mineral mixture. Gelatin was used as binder. Diet 2 was prepared from 50% instant full cream milk powder mixed with 50% egg yolk. Diet 3 was made from sole source of soybean. Roasted soybean was made powder and dissolved in water. The fish were fed daily with formulated diets to adlibtum over a period of 45 days. Each diet was supplied to replicate hapas.

Water temperature was measured daily. Weekly fish samples were taken to monitor the weight gain. Survival was recorded every two weeks after total counting of fry. Relative growth rate were calculated using following equations: Relative growth rate (RGR) = Final weight-Initial weight/Experimental duration X 100. Differences in total body weight gain, relative growth rate and survival between treatments were analyzed by t-test using Microsoft Excel program.

RESULTS AND DISCUSSION

In the present investigation, three different kinds of fish feed were formulated with varying feed ingredients and given to *L. dero* to assess the impact of the protein diet on its growth and survival. The results on fish growth from hatchling to fry are depicted in Fig:- 1**.** The overall growth of fish showed exponential growth in all treated diets.

The result showed that significantly ($P<0.01$) higher (0.52±0.08g) weight gain were recorded with diet 1 than diet 2 (0.40±0.03g) and diet 3 (0.33±0.03g). This result was comparable with weight gain in other species like common carp (ARS Fish 2010/11), Sahar (Bista *et.al*, 2006), gardi (Prasad *et al.,* 2011) and climbing perch, *Anabas testudineus* (Alam *et al.* 2010) in which they found weight gain of 0.40g-0.78g in nursing experiment with artificial diet. The results indicated formulated diet had positive impact on weight gain of fry. Amirkolai *et. al.*, (2010) in similar experiment found the formulate diet had positive effects on growth performance and survival rate for grass carp juveniles. However, the variation in weight gain might be

due to differences in diet composition and availability of nutritional condition in different types of feed used (Rahman *et al.,* 2012).

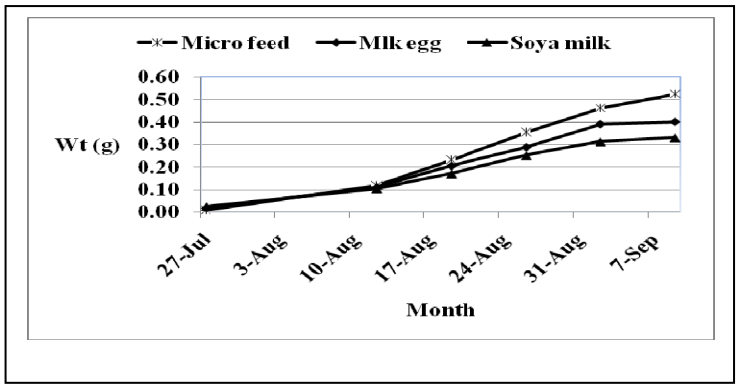

Fig. - 1: Body weight gain in gardi (*Labeo dero*) fry fed with different formulated diets

On other hand, there was no apparent effect of feed type on growth rate and survival of gardi fry at the level tested (Table -1). However, relative growth rate (RGR %day) obtained in the present study was similar to 2.27% reported for common carp *Cyprinus carpio* (Msiska *et al.,* 1991), 2.30 % for *Oreochromis karongae* (Nyirenda *et al.,* 2000) and 2.12% for a herbivore rabbit fish Siganus rivulatus (Saoud *et al.*, 2007) suggesting growth rate of gardi fry could be similar to that of cultured carps.

Table - 1: Growth characteristics of gardi (*Labeo dero*) fry fed with different formulated diets

Parameter	**Micro feed**	**Milk egg**	**Soy milk**
Total no fry stocked per hapa	200	200	200
Initial mean w eight (g) ± SD	0.010±0.004	0.017±0.012	0.026±0.001
Final mean weight (g) ± SD	0.523 ± 0.080^{a}	0.400 ± 0.029^{b}	0.330 ± 0.034^{c}
Relative growth rate (% day)	2.23^{ns}	2.18^{ns}	2.10^{ns}
Survival % ± SD	64.8^{ns}	64.3^{ns}	66.5^{ns}

The survival rate of fish fed with different feeds is presented in Fig:- 2**.** The survival rate 64-66% achieved in this study could be considered satisfactory in comparison of the results obtained in fry nursing of different cultivable species like gardi (Prasad *et al.,* 2011), *Cirrhina mrigala* (Rahman *et al.,* 2012), common carp and grass carp (ARS Fish, 2010/11). They reported variation in survival from 12.2 % to 98%. These differences could be attributed to difference in types of feed, feeding practices and species used. Coche and Edward (1988) reported that availability of proper type of food in required quantities is one of the major factors determines survival and growth of carp fry.

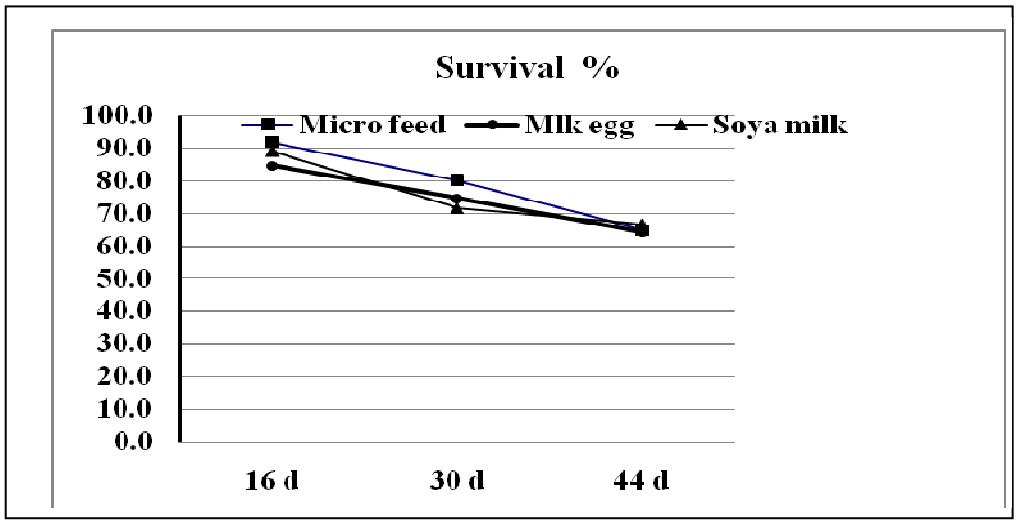

Fig. - 2: Survival rate of gardi (*Labeo dero*) fry fed with different formulated diets

This study was conducted in fertilized pond where natural food (plankton) was present to meet the minimum feeding requirements of fish which might be advantageous for growth and survival. Studies on larval nutrition have indicated that live food is essential for the few days after the start of exogenous feeding (Verreth *et. al.,* 1992). In similar experiment, Prasad *et al.* (2011) reported that young one of gardi feed both on zooplankton and artificial diet.

Water temperature is one of the important variable influenced the growth rate of fish. Water temperature of 29.0 to 30.0^{o}C observed in this study was conducive for accelerated growth of fry. Pillay (1993) pointed out that many freshwater species survived over a wide temperature range but the range for maximum growth for warm water species might be from 25^{0}C to 30^{0}C.

This study suggested that gardi fry easily accept and could be reared with different types of formulated feed in early stages. Though diet 1 (micro feed) resulted in high body weight gain, diet 2 (powdered milk mix with egg yolk) and diet 3 (soy milk) used in this study was equally good to increase survival and growth rate. However soybean milk could be one of the alternative sources of feed to increase survival and growth rate of gardi fry and eliminating the extra cost of animal protein source in diet. Further study is warned to develop cost effective diets based on different level of protein in future.

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MORPHOLOGICAL DISCRIMINATION OF THREE POPULATIONS OF ROHU (*LABEO ROHITA*) FROM A RIVER AND TWO HATCHERIES OF NEPAL USING MORPHOMETRIC AND TRUSS NETWORK MEASUREMENTS

Suresh Kumar Wagle and Neeta Pradhan
Fisheries Research Division, Godawari, Lalitpur
E-mail: waglesk@yahoo.com

ABSTRACT

Morphometric characters and landmark based truss network were applied to identify the stocks of rohu (Labeo rohita) from Koshi River and two public hatcheries for the possible improvement of aquaculture stocks. Truss distances between 22 landmarks and 16 morphometric characters of 56 specimens were measured. Significant differences were observed in all measured morphometric characters and truss network measurements among the populations. Multivariate analysis of variance (Wilks' test) indicated a significant difference for mean vectors of morphometric measurements (λ =0.001 F32, 76 = 62.302, P<0.001) and truss measurements (λ =0.023 F44, 64 = 8.114, P<0.001) among populations. For morphometric and truss measurements, the first discriminant function (DF) accounted for 94.2% and 66.6%, and the second DF accounted for 5.8% and 33.6% of the among-group variability. Although both morphometric and truss measurements explained 100% of the total among-group variability, the later method of morphological study seems more influential to classify the populations. Plotting of DFs of morphometric and truss network measurements revealed high isolation of the stocks. The analysis showed that most of the shape variation among these populations occurs in the head region, body depth and fin length. The characters that best discriminated the river and hatchery populations of rohu were associated with locomotion patterns and foraging behavior of fish.

Keywords: Isolation, locomotion, morphometric, rohu, truss network

INTRODUCTION

Rohu, *Labeo rohita*, is a teleost fish species distributed Ganga river network in North India and the rivers of Nepal, Pakistan, Bangladesh, and Burma. This carp species of great commercial importance and enjoys a prime position in Nepal's and neighboring countries aquaculture due to its fast growing nature and taste.

Aquaculture in Nepal revolves around the cultivation of native and exotic carps. The general practice is to rear together seven carp species in the same pond, including *Labeo rohita* (rohu). This polyculture technology, have been helpful to boost the fish culture in Nepal several folds, especially in southern belt due to climatically suitability. However, it has been demonstrated in several studies that any further improvement in production would require the maintenance of high genetic potential stock. Lack of stock improvement plan in the hatcheries is known to result in genetic underclass seed production that led to low productivity.

In fish genetically improvement programs, it is important to know the genetic make-up of the stocks as it would help in identifying the traits for which the stocks may be superior or inferior. In fish, morphometry has been used as a tool for measuring traits, especially related to body form. Morphometric differences among stocks of a species are recognized as important for evaluating for identifying the population stocks (Turan, 2004). Geographical isolation may result in noTable - morphological, meristic and genetic differences among stocks within a species. Morphometric characters have been commonly used as markers in fisheries biology for stock identification (Haddon and Willis, 1995). Multivariate morphometrics have successfully been employed in aquaculture studies, in assessing fish health (Loy *et al*., 2000), estimation of biomass (Hockaday *et al*., 2000), conservation driven biogeographically studies (Haas and McPhail, 2001) and population discrimination (Pakkasmaa *et al*., 1998). Usually, the morphometric studies have been restricted to the conventional measurements and their analyses.

The Truss Network Analysis overcomes the disadvantages of conventional data sets and this method produces a more systematic geometric characterization of fish shape and has demonstrated increasing resolving power for describing inter-specific shape differences (Gopikrishna *et al*., 2006). Landmarks refer to some arbitrarily selected points on a fish's body, and with the help of these points, the individual fish shape can be analyzed. In other words, a landmark is a point of correspondence on an object that matches between and within populations (Swain and Foote, 1999). Truss network systems constructed with the help of landmark points are powerful tools for stock identification. A sufficient degree of isolation may result in noTable - morphological, meristic, and shape differentiation among stocks of a species which may be recognizable as a basis for identifying the stocks. The characteristics may be more applicable for studying short-term, environmentally induced disparities, and the findings can be effectively used for improved fisheries management and identification superior stocks for aquaculture (Smith and Jamieson, 1986 and Turan, 2004).

Improvement of aquaculture stock through selective breeding requires high level of genetic variation for traits of interest. Inclusion of wild stock with superior character in shape and size in hatchery stocks would restore genetic variation. Therefore, there is need to study the different stocks of rohu (*Labeo rohita*) that are available in hatchery and natural water of the country. The information thus gained would be very much helpful in planning a selective breeding program for this species. Hence, the present study examines the stock differences of rohu (*L. rohita*) obtained from different locations and sources, through morphometric measurements and truss network analysis using the concept of size and shape.

MATERIALS AND METHODS

From October 2011 to June 2012, 56 rohu (*L. rohita*) were collected from 3 sources: Koshi River in Sunsari District and the two hatcheries in Sunsari and Rupandehi Districts (Fig:- 1). The fish were 13.2-30.0 cm in total length (TL) and 28-275 g in weight. The sample size, mean TL, and weight are presented in Table - 1.

Sixteen morphometric characters and body weights of the fish were measured to an accuracy of 0.05 mm and 1.0 g, respectively (Table - 2 and Fig:- 2). Definitions of most measurements were obtained from Zafar *et. al*. (2002) and Teugels *et al*. (1998). Eleven landmarks delineating 22 distances were measured on the body (Fig:- 3). Each landmark was obtained by placing a fish on graph paper. At the point of the landmark, a hole was made on the graph paper, using a dissecting needle. Finally, distances on the graph paper were measured using vernier calipers. After the landmarks were recorded the specimen was removed and the X-Y co-ordinate data were collected. The co-ordinates were then used to calculate the truss network distances between pairs of landmarks using the Pythagorean Theorem.

Fig. - 1: Map of Nepal showing sampling sites of *Labeo rohita:* population 1-Koshi River, population 2- hatchery stock of Sunsari District (HS) and population 3- hatchery stock of Rupandehi District (HR)

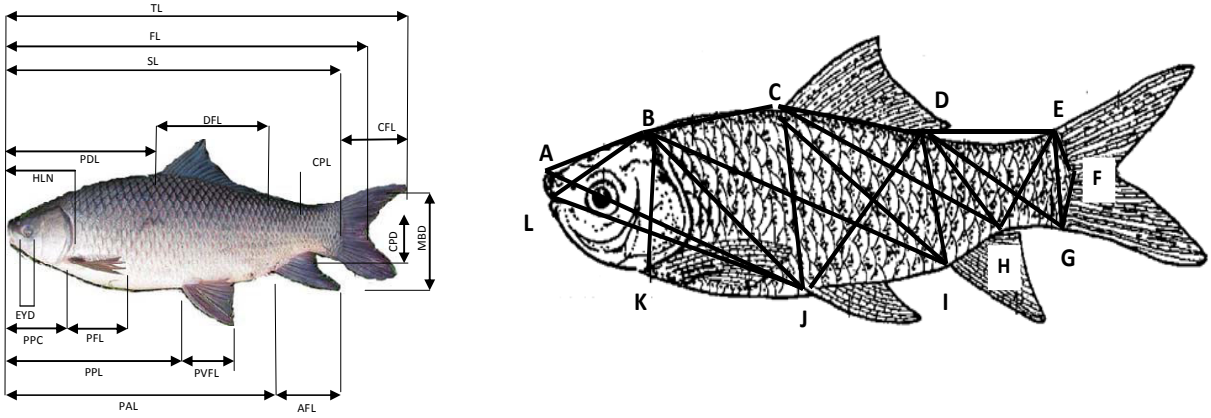


Fig. - 2: Morph (left) and locations of 11 landmarks (right) used for the shape analysis of rohu (*Labeo rohita*).

Univariate analyses (ANOVA) was conducted to examine body size differences between habitats. Since size distributions were highly overlapping between habitats, the data obtained were entered in a database for subsequent factor analysis. Because of differences in size (TL), size-adjusted values in data analyses were used. Therefore, it was necessary to

remove size-dependent variations from all of the characters. An allometric formula given by Elliott *et al*., (1995) was used to remove the size effect from the dataset:

$M_{adj} = M (L_s / L_o)^{b}$;

Where M is the original measurement, M_{adj} is the size-adjusted measurement, L_o is the TL of the fish, and L_s is the overall mean of the TL for all fish from all samples. Parameter b was estimated for each character from the observed data as the slope of the regression of log M on log L_o, using all fish in all groups.

Table - 1: Collection of *Labeo rohita* samples from different stocks

Source of fish samples	Status of the fish stocks	Sample size	Mean total length (cm) ± S.D.	Mean weight (g) ± SD
Koshi River in Sunsari District	Wild	25	164.0±46.0	25.0±2.6
Hatchery at Sunsari (HS)	Hatchery	16	110.0±31.5	23.0±2.2
Hatchery at Rupandehi (HR)	Hatchery	15	108.0±38.8	21.0±2.8

Table - 2: Morphometric characters used for analysis of *Labeo rohita* stock variations

Character	Description
Total length (TL)	Distance from the tip of the snout to the longest caudal fin ray
Standard length (SL)	Distance from the tip of the snout to the end of the vertebral column
Fork length (FL)	Distance from the tip of the snout to the middle part of the fork of the tail
Maximum body depth (MBD)	Vertical distance from the anterior part of the 1st dorsal fin and ventral part of the body
Caudle peduncle depth (CPD)	Caudle peduncle depth
Head length (HLN)	Distance from the tip of the snout to the posterior margin of the opercula
Eye diameter (EYD)	Diameter of the eye
Pre-dorsal length (PDL)	Distance from the snout tip to the anterior base of the dorsal fin
Pre-pelvic length (PPL)	Distance from anterior base of pelvic fin to snout
Pre-pectoral length (PPC)	Distance from anterior base of pectoral fin to snout
Pre-anal length (PAL)	Distance from anterior base of anal fin to snout
Dorsal fin length (DFL)	Dorsal fin length
Pectoral fin length (PFL)	Pectoral fin length
Pelvic fin length (PVFL)	Pelvic fin length
Anal fin length (AFL)	Anal fin length
Caudal fin length (CFL)	Caudal fin length
Caudal peduncle length (CPL)	Caudal peduncle length

A univariate analysis of variance (ANOVA) was carried out to test the significance of morphological differences. Principal component analysis (PCA) based on the correlation matrices were done to create uncorrelated principal components from the original variables.

In addition, size-adjusted data were standardized and submitted to a discriminant function (DF) analysis (DFA). All statistical analyses were done using Statistica version 5.5 (StatSoft, Inc.) and SPSS version 7.

RESULTS

Principal components with eighen values higher than 1.00 of importance were considered (e.g. Chatfield and Collins 1983). According to this criterion, two components remained, explaining about 74% of the variation of the original size-adjusted body morphology variables (Table - 3). The first component (PC 1) for morphometric characters was composed mainly of the maximum body depth, head length, head width, pre-dorsal fin length, pre-pelvic fin length, pre-pectoral fin length, pectoral, pelvic and caudal fin length. The second component (PC 2) consisted of the fork length and caudle peduncle depth. Thus, the PC 1 and PC 2 pooled characters are associated with the swimming ability, feeding and foraging behavior of the fish.

Principal components with eighenvalues higher than 5.00 explained about 75% of the variation of the size-adjusted landmark-based truss distances (Table - 4). The first PC composed of BI, BC, CH, DI, DH, DG, DE, EH, GH and IJ. The second PC mainly comprised of AB, AJ, BL, BK, BJ, CJ, CD, EG, EF, FG and JL. Thus, the PC 1 and PC 2 of landmark-based truss distances are associated with the swimming ability, feeding and foraging behavior of the fish.

Table - 3: Principal component analysis (PCA) form rohu (*Labeo rohita*) from river and hatchery populations. PCA was computed from correlation matrix using size adjusted data as the initial morph variables. The PCA loadings are listed together with the variables correlations (r) with the component scores. The highest component loadings are indicated in boldface.

Morph component	**PC 1**	**r**	**PC 2**	**r**
Fork length (FLN)	0.564	-0.013	**0.706**	0.204
Maximum body depth (MBD)	**0.799**	0.104	0.279	-0.018
Caudal peduncle depth (CPD)	0.077	0.173	**-0.918**	-0.405
Head length (HLN)	**0.727**	0.119	0.113	-0.076
Head width (HDP)	**0.922**	0.178	-0.010	-0.163
Eye diameter (EYD)	0.686	0.146	-0.086	-0.155
Predorsal length (PDL)	**0.759**	0.115	0.577	0.045
Preanal length (PAL)	0.682	0.071	0.655	0,057
Prepelvic length (PPL)	**0.800**	0.061	0.532	0.089
Prepectoral length (PPC)	**0.927**	0.174	0.016	-0.152
Dorsal fin length (DFL)	0.124	-0.090	0.665	0.262
Pectoral fin length (PFL)	**0.777**	0.071	0.447	0.057
Pelvic fin length (PVFL)	**0.872**	0.104	0.362	0.004
Anal fin length (AFL)	0.844	0.122	0.223	-0.050
Caudal fin length (CFL)	**0.748**	0.082	0.223	0.019
Caudal peduncle length (CPL)	0.469	0.003	0.501	0.133
Eigenvalues	9.988		1.932	
% of variance	62.42		12.08	
Cumul. % of variance	62.42		74.50	

Discriminant function analysis (DFA) was used to look for, in more detail, the body shape variables which are most explicitly differentiating among the three populations of *L. rohita* originating from a river and the two hatcheries. The discriminant function (DF) was based on the correlation matrix of the size-adjusted variables, thus giving equal weight for variation in all variables. The DFA produced 2 DFs (the 1st and 2nd DFs) for both morphometric and landmark measurements.

For morphometric and landmark measurements, the 1st DF accounted for 94.2% and 66.6%, and the 2nd DF accounted for 5.8% and 33.4% of among group variability, respectively, and together they explained 100% of the total among-group variability. Pooled within-group correlations between discriminant variables and DFs revealed that among the 16 morphometric measurements, 4 measurements of AFL, CPL, PFL and PVFL dominantly contributed to the 1st DF, while the remaining 12 contributed to the 2nd DF (Table - 5). Among the 22 truss measurements, 17 measurements (AJ, BC, BI, BJ, BK, CD, CH, CI, CJ, DE, DH, DI, EG, DG, EH, FG, GH, IJ and JL) dominantly contributed to the 1st DF, and the remaining 5 contributed to the 2nd DF (Table - 5).

Table - 4: Principal component analysis (PCA) forms rohu (*Labeo rohita*) from river and hatchery populations. PCA was computed from correlation matrix using size adjusted data as the initial landmark-based truss distances. The PCA loadings are listed together with the variables correlations (r) with the component scores. The highest component loadings are indicated in boldface.

Truss distance	PC 1	r	PC 2	r
AB	0.026	-0.043	**0.867**	0.113
AJ	0.439	-0.001	**0.765**	0.083
BL	0.136	-0.016	**0.899**	0.108
BK	-0.232	-0.044	**0.760**	0.106
BJ	0.564	0.021	**0.736**	0.071
BI	**0.899**	0.098	0.304	-0.004
BC	**0.753**	0.076	0.216	-0.007
CJ	-0.102	-0.058	**0.924**	0.126
CI	0.671	0.061	0.650	0.049
CH	**0.755**	0.079	0.554	0.032
CD	0.091	-0.039	**0.852**	0.109
DI	0.783	0.096	0.402	0.009
DH	0.941	0.134	0.091	-0.039
DG	0.951	0.132	-0.107	-0.063
DE	0.928	0.140	-0.211	-0.077
EH	0.802	0.075	0.364	0.009
EG	0.512	0.019	**0.789**	0.079
EF	0.032	-0.048	**0.822**	0.109
FG	0.072	-0.018	**0.833**	0.102
GH	**0.747**	0.075	-0.114	-0.046
IJ	**0.888**	0.111	0.151	-0.026
JL	0.558	0.023	**0.728**	0.071
Eigenvalues	12.559		5.538	
% of variance	52.33		23.08	
Cumul. % of variance	52.33		75.41	

Table - 5: Canonical discriminant function (DF), standardized by within variances with the size adjusted morphometric variables and truss distances (* denotes largest absolute correlation between each variable and DFs)

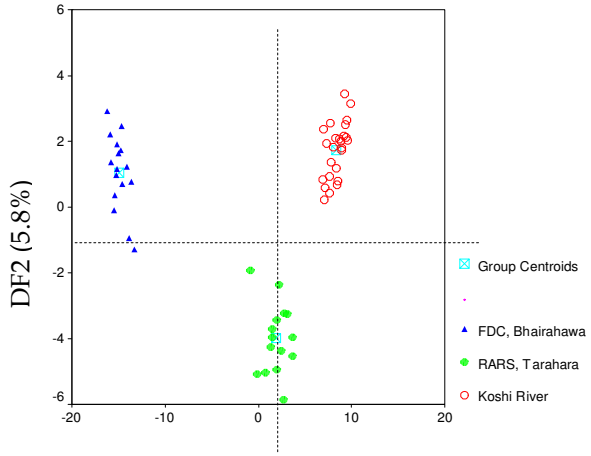
Morph character	DF1	DF2	Truss distance	DF1	DF2
AFL	0.054	0.135*	AB	-0.130	-0.257*
CFL	0.054*	0.051	AJ	-0.311*	-0.182
CPD	-0.243	0.355*	BC	-0.287*	0.037
CPL	0.055*	-0.006	BI	-0.377*	-0.015
DFL	0.072	-0.435*	BJ	-0.330*	-0.042
EYD	0.023	0.194*	BK	0.100*	-0.062
FLN	0.346	0.389*	BL	-0.174	-0.178*
HDP	0.040	0.175*	CD	-0.133*	-0.060
HLN	0.033	0.080*	CH	-0.301*	-0.063
MBD	0.072	0.102*	CI	-0.303*	-0.051
PAL	0.174	0.179*	CJ	-0.234*	-0.087
PDL	0.132	0.144*	DE	-0.263*	0.072
PFL	0.070*	0.046	DH	-0.292*	-0.003
PPC	0.040	0.179*	DI	-0.349*	0.022
PPL	0.123	0.170*	EF	-0.144	-0.162*
PVFL	0.074*	0.058	EG	-0.280*	0.047
			DG	-0.277*	0.068
			EH	-0.307*	0.080
			FG	-0.211*	-0.202
			GH	-0.156*	0.135
			IJ	-0.335*	0.015
			JL	-0.311*	-0.086
Eigen value	100.972	6.273	Eigenvalue	6.826	3.422
Canonical correlation	0.99	0.92	Canonical correlation	0.93	0.88
Cumulative variance explained	94.2	100.0	Cumulative variance explained	66.6	100.0
Wilks' λ =0.001 $F_{32,76}$ = 62.302, P<0.001			Wilks' λ =0.023 $F_{44,64}$ = 8.114, P<0.001		

Because the PCA and DF showed that the populations of *L. rohita*, separated by river and confined habitat, differed with one another, a further analysis was performed. Multivariate (Wilks' λ) and univariate F-test run for each habitat as the independent variable and all morphological characters (regression residuals were used to equalize variances) revealed differences in several traits (Table - 6).

Table - 6: Mean size and variation of measured morphological characters of rohu (*Labeo rohita*) among sources of population (natural-Koshi river (KO), hatchery bred from Sunsari (HS) and Rupandehi districts (HR). Statistical differences among source populations are based on multivariate (Wilks' λ) and univariate F-tests. Differences of morphological characters between habitats were determined by pair wise comparison (Tukey's test)

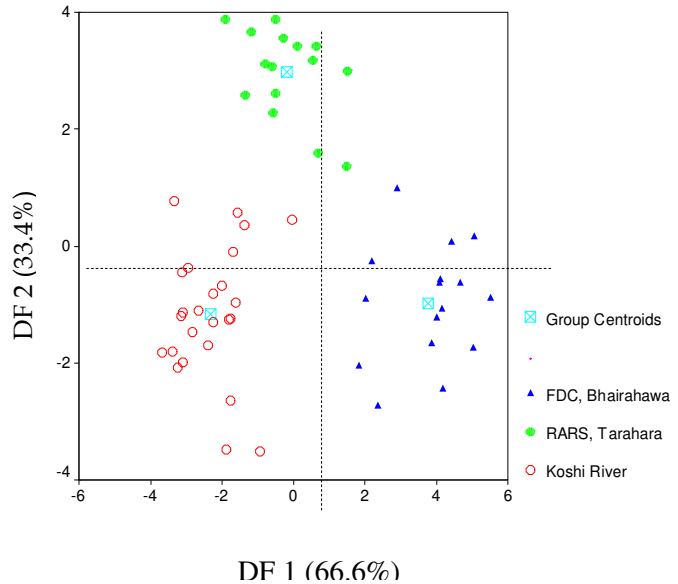
Morph character	Mean ± SD			Differences among habitats (Tukey's test)	P-values
	KO	HS	HR		
AFL	4.02±0.4	3.49±0.5	3.38±0.4	KO>HS=HR	0.000
CFL	5.86±0.6	5.52±0.5	5.17±0.5	KO=HS >HR	0.001
CPD	2.45±0.2	2.27±0.2	4.44±0.5	KO=HS<HR	0.000
CPL	2.49±0.3	2.38±0.4	2.05±0.3	KO= HS > HR	0.001
DFL	4.91±0.4	6.12±0.8	4.09±0.6	HS >KO> HR	0.000
EYD	1.20±0.1	1.01±0.2	1.09±0.1	KO= HR > HS	0.001
FLN	22.08±0.5	19.89±0.4	17.99±0.5	KO> HS > HR	0.000
HDP	4.33±0.7	3.61±0.3	3.74±0.5	KO> HS = HR	0.000
HLN	4.98±0.8	4.54±0.3	4.44±0.5	KO> HR = HS	0.023
MBD	5.62±0.7	4.86±0.9	4.35±0.6	KO= HS > HR	0.000
PAL	15.70±0.8	14.14±0.6	12.66±0.7	KO> HS > HR	0.000
PDL	9.60±0.5	8.56±0.6	7.64±0.7	KO> HS > HR	0.000
PFL	4.01±0.4	3.70±0.3	3.3±0.5	KO= HS > HR	0.000
PPC	5.23±0.6	4.51±0.5	4.64±0.4	KO> HS = HR	0.000
PPL	10.62±0.6	9.46±0.6	8.67±0.7	KO> HS > HR	0.000
PVFL	3.88±0.4	3.54±0.3	3.15±0.5	KO> HS > HR	0.000
Multivariate P value based on Wilks' Lamda					<0.001

In Koshi River, the population had larger fin length (AFL, CFL, CPL and PFL) while dorsal fin length was large for HS populations (P<0.001) among populations under study. *L. rohita* in Koshi River also tended to have longer and broad head (P<0.001) than the hatchery populations. Among 16 variables measured, only one morph character (CPD) was larger (P<0.001) in HR population than the other two populations. All measured morph characters were shorter to this population except CPD and EYD compared to that of the Koshi populations.



The multiple scatter plots of discriminant function (DF) of morphometric measurement showed nearly complete separation between HR and river populations on DF 1 and much overlap between the river populations on DF2 (Fig:- 3). In contrary to this, the HS populations overlap with Koshi populations at DF1 and separated at DF2. The DF1 alone accounted for 94.2% of the variation among the three populations.

Fig:- 3: Discriminant function analysis scores (DFs) of morphometric characters of rohu (*Labeo rohita*)



The plotting of discriminant function (DF) of landmark-based truss network revealed virtually complete separation between Koshi River and HR populations and overlap of HS populations between hatchery and Koshi River populations on DF 1(Fig:- 4). HS populations separated distinctly while Koshi River and HR populations overlap On DF2, The DF1 and DF2 accounted for 66.6% and 33.4%, respectively, of the variation among the three populations.

Fig. - 4: Discriminant function analysis scores (DFs) of truss network measurements of rohu (*Labeo rohita*)

DISCUSSION

Morphometric differences among stocks are expected, because they are geographically separated and may have originated from different ancestors. Therefore, it is not unlikely that obvious environmental variations exist in these 3 habitats (the Koshi River, and the two hatcheries). Fish are very sensitive to environmental changes and quickly adapt themselves by changing necessary morphometrics. It is well-known that morphological characters can show high plasticity in response to differences in environmental conditions, such as food abundance and temperature (Swain *et al.*, 1991 and Weinberger, 1992).

With multivariate statistics (PCA and DF) the morphological characters that best discriminated rohu populations of hatcheries and river origin were identified. Especially the head size, body depth, pre-dorsal fin length, pre-pelvic fin length, pre-pectoral fin length, pectoral, pelvic and caudal fin length appeared to differentiate the populations. Those characters reflect the swimming, feeding and foraging ability of the fish. On the basis of morphological data, particularly the distant origin of the fins and their length, the River population was the most divergent. However, the body depth of fishes increases in response to warmer water temperature (Reilly and Horn, 2004) and shorter pectoral fin length associated with colder water temperature (Barlow, 1961) did not support our present findings.

The eye diameter can reflect the light conditions where the fish are living (Pakkasmaa *et al.*, 1998). In this respect, the rohu population in one of the hatchery population has close and small eye, because the ponds where this hatchery population raised was characterized as

atrophic and light does not penetrate very deep. Rohu live in perennial rivers, where water is quite clear, and they have large eyes. Baumgartner *et. al*. (1988) suggested that the eye size may as well be related to feeding behavior.

The adaptation of the river populations of rohu reflects their body morphology: they are relatively robust with long fins, which are related to slow and precise movement (Erlanger, 1990); large fins are also of advantage in maintaining one's position in the river (Riddell and Leggett, 1981). The river populations are more streamlined. That kind of body shape allows for efficient cruising, foraging for patchily distributed prey in large volumes of torrential open water, and migrating (Baumgartner *et al*., 1988 and Robinson and Watson, 1996).

The phenotypic discreteness found in this study suggests a direct relationship between the extent of phenotypic divergence and geographic separation, which indicates that geographic separation, is a limiting factor to migration among stocks. Mustafa *et al*. (2010) also found similar results for *Labeo calabash* populations from the Yamuna and Hilda Rivers and a hatchery stock in Bangladesh.

The phenotypic plasticity of fish is very high. They adapt quickly by modifying their physiology and behavior to environmental changes. These modifications ultimately change their morphology (Stearns 1983). The truss network system can effectively be used to distinguish morphology between the hatchery and wild stocks. In this study, more-significant differences were expected because of the two completely different habitats i.e., one is an open-water habitat and the other is closed water. Relationships among the three stocks differed according to whether the 1st or 2nd DF was considered (Fig:- 3 and 4). Considering the 1st DF with 94.2% variation using morphometric measurement (Fig:- 3), the hatchery stocks are completely separated from the river population. Despite the Koshi River possesses a unique environment that differs from other two hatchery populations, the DF2 showed small variation in morph characters. However, due to small environmental differences among hatchery populations, the resulting morphological differences in fish may be so small that they might be impossible to discern with gross morphomeristic characters (Mustafa *et al*., 2010). Therefore, truss network measurements were employed in this experiment. Considering 1st DF (Fig:- 4), the hatchery stock of RARS, Tarahara displayed intermediate characteristics between the Koshi River and hatchery stock of FDC, Bhairahawa. There could be possibility of mixing of rohu from Koshi River as RARS; Tarahara has made efforts to improve their hatchery stock through the inclusion of wild stock for several years. Based on the 2nd DF, the stocks from Koshi River and FDC, Bhairahawa, however, broadly overlapped, while the hatchery stock from RARS, Tarahara clearly differed. The 1st DF accounted for much more (66.6%) of the among group variability than did the 2nd DF (33.4%). It is obvious that the 2nd DF explains much less of the variance than does the 1st DF. The 2nd DF is; therefore, much less informative in explaining differences among the stocks.

Plotting DFs revealed high isolation in morphometrics among the stocks. Whether the observed morphological patterns were produced through genetic differences or phenotypic plasticity is unknown. Populations could diverge via alternative, genetically based

morphologies, or through environmentally induced phenotypes (Langerhans *et al*., 2003). However, morphological and genetic characters of fishes have been shown in some cases to co-vary (Dynes *et al*., 1999). Greatest differences in genetic, morphometric and meristic data are known between wild and cultured tilapia (*Oreochromis* spp.*)* with high and low levels of genetic variation, respectively (Barriga-Sosa *et al*., 2004). Indeed, low genetic diversity is commonly reported for natural population of fishes, perhaps largely because of high gene flow in the continuous water environment (Grant and Bowen, 1998). The analyses of the present study revealed variation among rohu populations in several morphological characters: body depth, head size, dorsal fin length, pectoral fin length. This apparent plasticity may be an adaptive response (Scheiner and Callahan, 1999) to the complex and varied environmental conditions under which this species exists. The results of the study are useful as baseline information of rohu populations for further studies. In both aquaculture and open-water management, it is essential to select genetically superior stocks along with better features. More research especially genetic studies are needed for conservation and mass seed production of selected stocks for aquaculture.

CONCLUSION

The analyses of the present study revealed variation among rohu populations in several morphological characters and this apparent plasticity may be an adaptive response to the complex and varied environmental conditions under which this species exists. Whether the observed morphological patterns were produced through genetic differences or phenotypic plasticity is unknown. The results of the study are useful as baseline information of rohu populations for further studies. More research especially genetic studies are needed for conservation and mass seed production of selected stocks for aquaculture.

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EFFECT OF WATER QUALITY IN TROUT FARM WITH SERIES TYPE RACEWAYS ON FISH SURVIVAL AND PRODUCTION

Suresh Kumar Wagle, Rajaman Mulmi, Neeta Pradhan and Asha Rayamajhi
Fisheries Research Division, Godawari, Lalitpur
E-mail: waglesk@yahoo.com

ABSTRACT

The farming of rainbow trout (Oncorhynchus mykiss) in flow-through systems that use raceways is common practice in coldwater aquaculture of Nepal. Currently, 85 trout farms are involved in production of trout, with a production volume of around 180 Mt. Most of the trout farms adopted serial type raceway system receiving water in top-down cascade. The potential impact of deteriorated water quality and effluents from serial type raceway system in lower cascade on fish production is not well studied in Nepal. The aim of this study was to assess the water quality and its potential impact on trout farms with serial type raceways. Three representative trout farms were selected from Nuwakot, Dhading and Sindhupalchok districts. Seasonal water samples were captured for the two year from first, middle and last raceways located in serial order for each studied trout farms. Serial type trout farms had a significant impact ($p<0.05$) on dissolved oxygen (DO), pH and ammonium (NH_4-N) in last raceway in all seasons, summer, wet and winter. Mean DO value decreased from 9.8 mg/L in first raceway to 7.9 mg/L in last raceway. NO_2+NO_3-N increased from 0.39 to 1.99 mg/L, NH_4-N from 0.026 to 0.17 mg/L, PO_4-P from 0.013 in first raceway to 0.057 mg/L in last raceway. Changes in water temperature, nitrite plus nitrate (NO_2+NO_3), orthophosphate (PO_4-P) and total dissolved solids (TDS) values were insignificant ($P>0.05$). During the study period, high fish mortality (11.0%) in last raceway was evident compared to the mortality (5.6%) in first raceway. ANOVA revealed that the mortality rate of trout significantly ($P<0.05$) affected by the variation in water temperature, dissolve oxygen and orthophosphate in serial type raceways. Mean trout productivity (13.9 kg/m^2) in first raceway was significantly higher ($P<0.05$) than last raceway (10.3 kg/m^2), although correlation between most of the water quality variables and fish productivity did not exist.

Keywords: effluents, flow-through, serial raceway, trout, water quality

INTRODUCTION

Water quality determines to a great extend the success or failure of a fish culture operation (Piper *et al*., 1982). Water is an essential requirement for fish farming, so any proper-prepared plan for aquaculture must describe the quality and quantity of water available for this purpose (Summerfelt, 2000). The achievement of rainbow trout as an aquaculture species is dependent on technological advances and production of fish with great amounts of high quality protein (Johansen and Overturf, 2005 and Cohen *et al.,* 2005). It has lately been accepted that the welfare of farmed fish merits consideration, where welfare can be considered to represent the physical and mental state of animal is relative to its environment. Proper stocking density has been emphasized due to an apparent increasing on mortality in the likelihood of poor welfare at higher stock densities. Rainbow trout

(*Oncorhynchus mykiss*) are recognized as being less tolerant of poor water quality, *e.g.* low oxygen and ammonia than warm water species. Inappropriate levels of water quality parameters affect physiology, growth rate and efficiency, cause pathological changes and organ damage and, in severe cases, cause mortality and all these too associated poor welfare of cultured animal. Poor water quality may also have an indirect effect on health by increasing susceptibility to disease. Moreover in restricted exchange environments, there is a risk of high levels of nutrients accumulating in one area, causing hypernutrification and potentially creating undesirable effects (MacGravin, 2000 and Carrol *et al*., 2003). Studies on spatial changes in physical and chemical characteristics of water which is used for aquaculture by raceway system present essential information for best management options at all time.

The farming of rainbow trout (*Oncorhynchus mykiss*) in flow-through systems that use raceways is becoming common practices in Nepal. Most of the trout farms developed raceways in serial order to optimize water use from limited water sources. In serial type flow-through aquaculture systems like raceways and tanks, effluents are discharged to the down raceways with enhanced concentrations of nutrients and solids. Such effluents may have a serious negative impact on the growth and survival of fish in raceways at lower cascade and quality of the receiving water when discharged untreated (Miller and Semmens, 2002; Schulz *et al*., 2003). Systematic design of raceway with regard to shape, size and slope gradient is not properly followed by few trout farmers so the raceways are constructed as per availability of shape and size of land. The number and size of raceways constructed are seldom based on available volume of inflow water. Low water volume and improper design might result in solid waste and metabolic waste accumulation in subsequent raceways in trout farm where serial type raceways are constructed. Variation in fish survival and productivity among fish growing units in serial type raceways has been often complaints by the farmer. Interaction between water quality change and fish productivity of trout farms with serial type raceways has yet not gain attention to improve the management for enhancing farm productivity. The objective of this work was to evaluate physical and chemical water quality factors in rainbow trout farms with serial type raceways. Although the quantity of water available is of importance and would play dominant role, only water quality parameters are considered here.

MATERIALS AND METHODS

Three private trout farms with serial type raceways located in Nuwakot, Dhading and Sindhupalchowk districts were selected for monitoring water quality and trout productivity. The number of raceways represented by the farms ranged from 11 to 38 and the volume of inflow water during dry season varied between 9-22 L/sec among sampled farms.

Characteristics of trout farms and their raceways in serial order selected for monitoring is given Table - 1. Water quality, fish mortality and productivity were monitored in first, middle and last raceway lies in serial order by representing climatic season viz. dry (March-April), wet (July-August) and winter (November-December) for the two consecutive years

from July 2010 to Jun 2012. Water quality measurements comprised of temperature, dissolve oxygen (DO), pH and total dissolved solid (TDS) in-situ at each sampling period using respective electrode sensors. Water samples were taken for ammonium (NH_4-N), nitrite plus nitrate (NO_2+NO_3-N) and orthophosphate (PO_4-P) and the samples were stored at 4 ^oC until laboratory analysis in Fisheries Research Division, Godawari. Standard methods adopted for the analysis of NH_4-N, NO_2+NO_3-N and PO_4-P by Bower and Hansen (1980), Dowens (1978), Murphy and Rilay (1966), respectively.

Table - 1: Characteristics of trout farms with serial type raceways and the order of raceways for monitoring water quality and fish productivity

Trout farm	Altitude, masl	No. of raceway	Raceway area, m2	Water Source	Intake flow, L/sec	Raceway No. in serial order	Raceway monitored
Sindhupalchock[1]	1830	38	934.7	Ghatte Khola	22	5	1, 3, 5
Dhading[2]	1410	11	294	Mul Khola	14	11	1, 5, 11
Nuwakot[3]	1650	13	272.2	Doban Khola	9	12	1, 6, 12

[1] Mansarobar trout farm, Tatopani, Sindhupalchock
[2] Agro Top Industries Co. Nepal, Mul Khola, Thakre-6, Dhading
[3] Gopal Lama, Doban, Kakani 4, Nuwakot

Standing fish number and biomass was estimated by direct counting and weighing 100 fish at each sampling period. Farmers from Nuwakot and Dhading had sold the fish from last raceways in dry season of the first sampling year. This missing data was recovered from the stock and harvest record maintained by the farmers.

Water quality and fish productivity data were pooled by season and raceway order from the monitored sites. Statistical analyses (mean water quality parameters, standard deviations and correlation coefficients) were evaluated by Stat Graphics plus ver. 3.0 software. Analysis of variance (ANOVA) of water quality by season and raceway order, and interaction among water quality and fish mortality and productivity were performed by SPSS version (7.0). Water quality date was plotted by Microcal Origin.

RESULTS

Large variation in values of water quality parameters within season and same order raceway among monitored trout farms was measured (Table - 2). Altitudinal differences (1410-1830 masl), varying water inflow rates (9-22 L/sec), standing biomass and feed quality and feeding practices in trout farms might have the influential role to very water qualities in a reference season and raceway.

Water temperature varied greatly among studied farms during winter season from 5.9 to 14.7 ^{o} C while the variations were low in dry and wet season. An increase in mean

temperature was evident in last raceway by 0.9 ◦ C and 0.3 ◦ C compared to the first raceway during dry and wet season, respectively. Contrasting temperature profile was measured during winter season that the mean temperature decreased from 10.2 ◦ C in first raceway to 9.7 ◦ C in last raceway. However, ANOVA revealed that no statistical significant differences (P>0.05) in mean temperature among raceways in serial order within each season (Fig:- 1).

Table - 2: Value range of different water quality parameters in trout farms with serial type raceway in different climatic season

Sea-son	Raceway order	Temperature, ^{0}C	Dissolve oxygen, mg/L	pH	Total dissolve solid, mg/L	Ammonium-N, mg/L	Nitrite plus nitrate, mg/L	Orthophosphate, mg/L
Dry	First	16.9-19.2	8.8-9.8	7.1-7.9	70.4-288	0.006-0.057	0.024-1.256	0.0-0.055
	Middle	17.0-19.5	7.1-9.2	7.5-7.8	83-312	0.018-0.146	0.027-2.67	0.021-0.32
	Last	17.9-20.0	6.8-7.8	7.7-8.1	89-328	0.022-0.379	0.082-3.456	0.038-0.12
Wet	First	16.8-18.5	8.9-9.8	6.9-7.8	83-367	0.0-0.146	0.272-2.67	0.0-0.077
	Middle	17.3-18.2	7.6-8.7	7.1-8.1	89-366	0.009-0.379	0,078-3.456	0.016-0.102
	Last	15.5-18.2	7.4-9.7	6.9-7.8	96-385	0.0-0.086	0,46-2.34	0.022-0.134
Winter	First	5.9-14.7	9.5-12.3	7.1-7.7	76-179	0.0-0.024	0.04-0.56	0.008-0.032
	Middle	6.3-14.2	8.6-9.8	7.2-8.2	83-211	0.013-0.06	0.128-1.22	0.01-0.0912
	Last	6.5-14.2	6.9-9.1	7.6-8.5	90-254	0.014-0.095	0.528-3.181	0.028-0.134

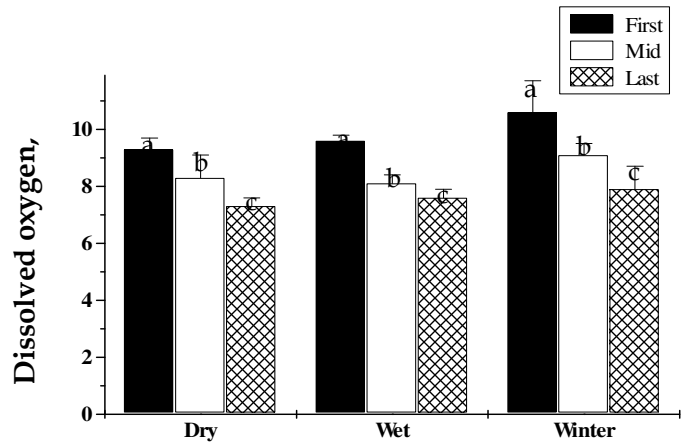

Fig.- 1: Mean dissolved oxygen of raceways in serial order in different season

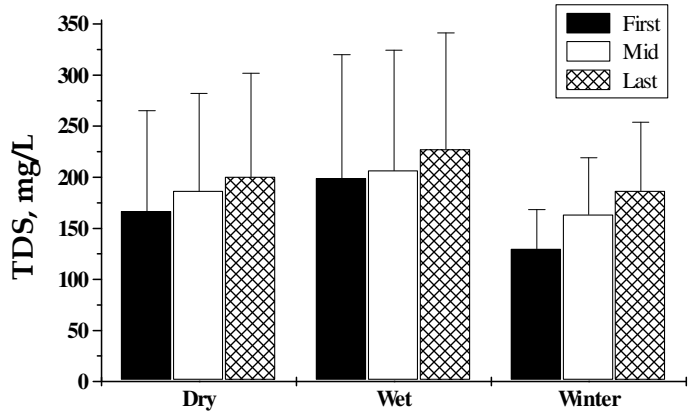

Fig:- 2: Mean total dissolve solid (TDS) of raceways in serial order in different season

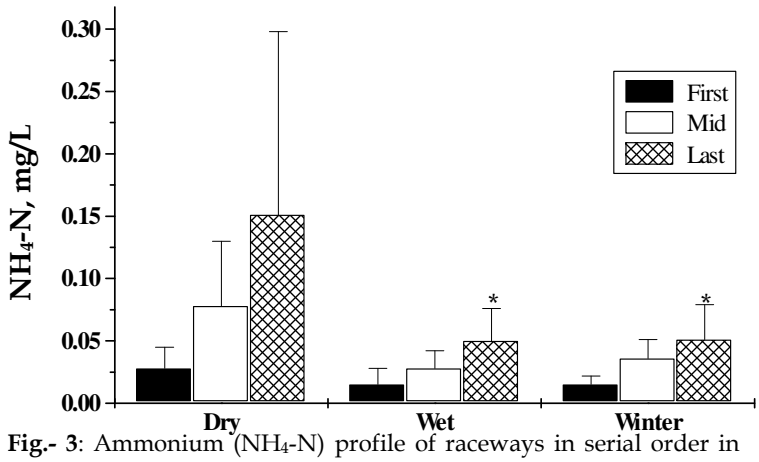

Fig.- 3: Ammonium (NH_4-N) profile of raceways in serial order in different season

The pH of water as an index of hydrogen ion (H^+) activity of water measured was also varied greatly within raceway order among trout farms in all the three seasons. The variation in pH within reference raceway between farms ranged from 0.3 to 1.0 unit (Table - 2). Increase in pH by 0.5 units was recorded in last raceway from the pH of 7.5, 7.0 and 7.4 in inflow water of trout farm in dry, wet and winter season, respectively. This increase in pH did follow significant pattern ($P<0.05$) in between raceways monitored in a specific season (Fig:-2). Oxygen is the first limiting factor for growth and well-being of fish. Variation in dissolved oxygen (DO) concentration among farms was ranged from 0.9 to 2.8 mg/L irrespective of raceway order in different season (estimated from Table - 2). DO decreased significantly ($P<0.05$) from first raceway to last raceway in all season. The lowest mean DO measured was 7.3 mg/L in last raceway in dry month.

Total dissolved solids (TDS) by definition, are the inorganic salts, organic matter, and other dissolved materials in water (US EPA 1986). TDS varied greatly (70.4-385 mg/L) among farms and the seasonal variation among raceway of a farm was low (Fig:- 4).

A slight increase in TDS in subsequent raceway in all season was measured but the differences was not significant (P>0.05).

Ammonium (NH_4-N) concentration increased in last raceway compared to the concentration in first raceway (Fig:- 5). Although high level of NH_4-N measured during dry season in last raceway, differences in concentration among raceway order was significant only in wet and winter season. The mean highest concentration of NH_4-N (0.151 mg/L) with a range of 0.022-0.379 mg/L was measured for last raceway during dry season (Table - 2).

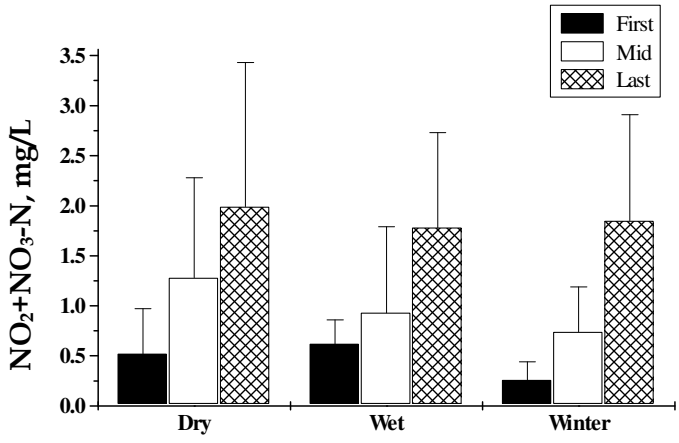

Fig. - 4: Nitrite plus nitrate (NO_2+NO_3-N) profile of raceways in serial order in different season

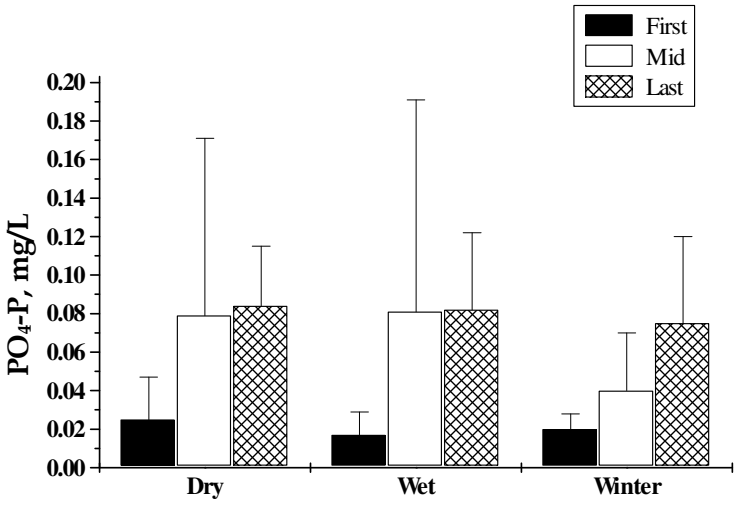

Fig. - 5: Orthophosphate (PO_4-P) profile of raceways in serial order in different

Similar pattern of increase in nitrate plus nitrite (NO_2+NO_3-N) and orthophosphate (PO_4-P) in last raceway compared to the concentration measured in first and middle raceway was evident in all season (Fig:- 6 and 7). The highest mean concentration of 1.99 mg/L with range of 0.082-3.456 NO_2+NO_3-N) and 0.084 mg/L with a range of 0.038-0.12 mg/L PO_4-P was measured in last raceway during dry season (Table - 2). However, the increase in concentration of NO2+NO_3-N and PO_4-P in drainage of last raceway irrespective of season was not significant (P>0.05) to that of the concentration measured in first and middle raceway.

Farmers were aware of accumulation of solid waste sediment in subsequent raceways in serial order. Fish stocking density was kept low in raceways in lower cascade. The highest mean density of fish was 100/m^2 in first raceway during dry season while the mean lowest density was 67

fish/m^2 in last raceway during winter season (Table - 3). Variance estimate revealed that fish density in raceway order from top to lower cascade was significantly lower ($P<0.05$) at all season.

Fish mortality during the growing period was low (5.6% across season) in first raceway with a range from 4.4% in winter to 6.7% during wet. Mortality significantly increased ($P<0.05$) in middle and last raceways with 8.1% and 11.0%, respectively (Table - 3). Mean fish productivity (13.9 kg/m^2 across season) was highest in first raceway compared to the mean productivity of 10.3 kg/m^2 in last raceway. The differences in productivity between first and last raceways within season and throughout the study period was significantly different ($P<0.05$). However, the productivity between middle and last raceways was statistically similar in all season (Table - 3).

In an assessment of water quality impact on production parameter of trout showed that density, temperature, DO, NH_4-N and PO_4-P had some influence on mortality and productivity in different season (Table - 4). Variation in water temperature, DO and PO_4-P significantly ($P<0.05$) affected the survival of fish of raceways in lower cascade of trout farm during the study period. Likewise low trout productivity in last raceway in serial type trout farm was markedly affected ($P<0.05$) by elevated NH_4-N and PO_4-P.

Table - 3: Mortality and productivity of trout in serial type raceways in different seasons

Seasons	1st Raceway	Mid Raceway	Last Raceway
Dry			
Density	100^{a}	88^{ab}	80^{b}
Mortality, %	5.8^{a}	8.3^{a}	11.2^{b}
Productivity, kg/m^2	14.2^{a}	12.6^{b}	9.6^{b}
Wet			
Density	94^{a}	83^{a}	71^{b}
Mortality, %	6.7^{a}	7.8^{a}	10.1^{b}
Productivity, kg/m^2	12.8^{a}	12.2^{b}	10.1^{b}
Winter			
Density	90^{a}	78^{b}	67^{c}
Mortality, %	4.4^{a}	7.5^{b}	11.3^{c}
Productivity, kg/m^2	14.5^{a}	12.9^{ab}	11.0^{b}
Across season			
Density	95^{a}	84^{b}	72^{c}
Mortality, %	5.6^{a}	8.1^{b}	11.0^{c}
Productivity, kg/m^2	13.9^{a}	12.4^{b}	10.3^{c}

DISCUSSION

According to Summerfelt (2000) the standard environmental temperature (SET) for rainbow trout is 15 °C. Best growth of rainbow trout occurs in a temperature range of 10 °C up to 16 °C (Boyd and Tucker, 1998). From the present study, it has been shown that the temperature fluctuate between 15.5 to 20.0 °C during dry and wet months (Table - 2). The temperature raise in last raceways by 0.9 °C in dry months had significant impact on both fish mortality and productivity (Table - 4). Furthermore, mean temperature increased from 9.7 °C in winter to 18.8 °C in dry months in last raceway. Temperature controls the solubility of gases in water, and the reaction rate of chemicals, the toxicity of ammonia, and of chemotherapeutics to fish (Summerfelt, 2000). Klontz (1991) reported that the increase of water temperature from 9°C to 15°C generates 12.8% decrease in oxygen concentration and a 58.8% increase in environmental unionized ammonia. Decreases in DO in the last raceway over the season due to temperature increase during the study period are corroborated with the findings of Klontz (1991).

The pH varied from 6.9 to 8.5 in different season and this variation is within the accepTable - range for trout (Boyd and Tucker 1998). Sudden changes in pH of 1.7 would result in fish mortality (Summerfelt, 2000), and this limit of pH change was not exceeded in the present study. It seems that temperature is more critical than pH in water management in these raceways. The difference in growth rates was likely due to the increased stress and reduced access to feed due to the turbid water in raceways in lower cascade.

Table - 4: Interaction of water quality parameters, fish stock density on the mortality and productivity of trout in serial type raceways over season and across the seasons

Seasons	**Interaction (ANOVA)**							
	Density	**Temp**	**pH**	**DO**	**TDS**	**NH_4**	**NO_2+NO_3**	**PO_4**
Dry								
Mortality, %	-	*	-	-	-	-	-	-
Productivity, kg/m^2	-	*	-	-	-	-	-	-
Wet								
Mortality, %	-	-	-	-	-	-	-	-
Productivity, kg/m^2	-	-	-	-	-	*	-	-
Winter								
Mortality, %	*	-	-	-	-	-	-	-
Productivity, kg/m^2	-	*	-	-	-	-	-	-
Across season								
Mortality, %	-	*	-	**	-	-	-	**
Productivity, kg/m^2	-	-	-	-	-	*	-	**

A common generalization about oxygen requirements for aquaculture is that the minimum DO should be greater than 6 mg/L for growth coldwater fishes at their optimum temperature (Summerfelt, 2000). The lowest mean DO measured during this study period was 6.8 mg/L in last raceway in wet season. Although, accepTable - range of DO measured in all subsequent raceways under study, significant impact of DO exist as revealed by

interaction analysis on high mortality and low productivity of trout in last raceway. The increased temperature in last raceway might have reduced the solubility of oxygen and thus availability of oxygen to the fish would have been low than the measured value. The dissolved oxygen in the water should have a pressure of >90 mm Hg and this is a departure from the traditionally accepted dissolved oxygen limit of 5 mg/l, which under certain circumstances of temperature is less than 90 mm Hg pO_2 (Klontz, 1991). Furthermore, the DO levels also depend on altitude variations since the DO was measured at higher level than (please mention the possible interaction).

NH_4-N, ammonia is generated in the system as the end-product of protein metabolism (Klontz, 1991). The major source of ammonia in a water of a heavily stocked culture pond or in the effluent of a raceway is from excretion of fish, mostly via their gills (Boyd, 1990). In the aquatic environment the measured ammonia occurs in two forms: dissociated or ionized (NH_4-N), which is nontoxic for fish, and undissociated or unionized (NH_3-N), which is toxic for most finfish at continuous levels exceeding 0.03 mg/L (Klontz, 1991). Mean NH_4-N measured in this study was 0.15 mg/L in last raceway during dry period. Yearly fluctuation of NH_4-N did show effect on trout productivity (Table - 4). Although NH_4-N is nontoxic to fish, as pH and temperature increases, the toxicity of ammonia increases because the relative proportion of unionized ammonia increases (Brinkman *et al*., 2009 and EPA, 1999). Furthermore increase in ammonia, enhance the water pH, therefore pH could go out of allowable range. With an increase in these (pH or ammonia) parameters concentration of DO decreases and the condition can become hazardous for fish health. Continual cleaning of raceways from fish excretion cause fish stocks to be healthy. On the other hand, establishment of a proper waste water management system can decrease adverse environmental impacts of aquaculture in the area. Another option would be providing multiple-pass systems with supplemental aeration into either the inflow end of each successive raceway or throughout the length of each raceway for enhancing oxygen and nitrification process. Research is warned for raceway engineering (design/device/ operation) to facilitate quick flushing of effluents even at low discharge of water.

Mean TDS measured was 165 mg/L in first raceway and 205 mg/L in last raceway across season during the present study. Although the toxicity of TDS on fish depends on concentration of inorganic salt and organic matter, no significant impact of TDS was found on mortality and productivity of trout. After egg hardening, fish do not appear to be affected by elevated concentrations of TDS up to 2000 mg/L (Scannell and Jacobs, 2001). The mean concentration of NO_2+NO_3-N was 1.87 mg/L in last raceway over the seasons and this concentration did not show negative effect on trout. The accepted tolerance level of nitrite is 0.55 mg/L (Klontz, 1991); the proportion of nitrite could not be separated from the present measurement.

In the present study, mean concentration of orthophosphate (PO_4-P) increased from 0.021 mg/L in first raceway to 0.08 mg/L in last raceway. A significant effect of elevated PO_4-P on trout mortality and productivity was estimated in this study; however, the experimental evidences of how PO_4-P could impact directly on fish growth and survival are poor.

Metabolic products (dissolved nutrients) and food wastes (solids and particulate nutrients) are the main source of PO_4-P in flow through raceway system (Boardman *et al*., 1998 and Hinshaw and Fornshell, 2002).

In flow-through aquaculture systems like raceways, effluents are discharged to the environment with enhanced concentrations of nutrients and solids. Such effluents may have a serious negative impact on the quality of the receiving water when discharged untreated (Miller and Semmens, 2002 and Schulz *et al*., 2003). The majority of nitrogen, phosphorus and organic carbon released from trout farms are sediment bound (VWRC, 2002). These sediment contains a large variation in particulate nutrient fractions, ranging from 30% to 80% of phosphorus and 7– 32% of nitrogen (Cripps, 1995; Cripps and Bergheim, 2000). With increased interest in implementing environmentally friendly and sustainable fish farming practices, the aquaculture industry has been focusing in recent years on ways to reduce waste through waste management and effective feed management (MacMillan *et al*., 2003; Schulz *et al*., 2003). Removing suspended solids is the best approach to reduce pollutant loading to receiving streams (Cripps 1992; Boyd *et al*., 1998 and VWRC, 2002), and sedimentation is the most widely applicable and feasible way for reducing solids and associated nutrients from flow-through trout farms (Hinshaw and Fornshell, 2002; MacMillan *et al*., 2003). In the present context, it might be important to examine what could be the role of settling basin at alternate raceways to remove the suspended solids in the serial type raceway trout farms where the water flow becomes the limiting factor. Formulation of cost effective high energy low polluting diet (high energy low fat, extrusion, feed integration, etc.) to reduce the effluent load in successive raceway would have been the subject of research.

CONCLUSION

Raceway arranged for serial passage of water has been found one of the more serious constraints to water quality management. In systems utilizing 3-5 serial water uses, the status of fish survival and productivity in succeeding raceways was progressively worse. This condition was influenced by at least three major factors within the system, fish density and biomass; the successive accumulation of waste products (fecal material and ammonia) and uneaten food; and the successive depletion of dissolved oxygen. Improved feeding management and small structural modification is needed to improve the productivity of raceways in serial order. Research needs have been identified to improve the water quality and productivity of serial type raceways.

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ESTIMATION OF LC_{50} VALUE OF WATER SOLUBLE ALKALOID OF SWEET FLAG RHIZOMES (*ACORUS CALAMUS* LINN.) AGAINST COMMON CARP FRY (*CYPRINUS CARPIO)*

Abhilasha Jha, Suresh Kumar Wagle, Asha Rayamajhi
Fisheries Research Division, Godawari, Lalitpur
E-mail: abhi.sonijha@gmail.com

ABSTRACT

Water soluble alkaloids of rhizomes of sweet flag (Acorus calamus Linn.) was investigated for its toxicity on common carp (Cyprinus carpio) fry in optimizing its safety in long term management of ectoparasite problem of fish. An experiment was conducted in 20 L glass aquarium with different concentrations of water soluble alkaloid (WSA) of sweet flag rhizomes ranging from 0.0 to 450 mg/L with concentration interval of 75 mg/L. Common carp fry (mean weight of 7.7± 2.2 g) were stocked at density of one fish/1.5 L water in aquarium in all respective treatments of WSA of A. calamus. Probit analysis revealed that the WSA of A. calamus exhibited high activity against common carp fry with LC_{50} value of 288.4 mg/L at water temperature between 8.0 to 19.5 ^{o}C in different seasons. Dissolved oxygen (DO) level declined rapidly at higher concentration of WSA of A. calamus and the rate of DO decline among treatments were highly significant different ($P<0.01$). Although not significant ($P>0.05$) among treatments, pH of WSA of A. calamus treated water increased gradually from 7.1 at start to 7.6 at the end of experiment. Administration of WSA of A. calamus at 75 mg/L in rearing water has shown safety for carp fry in this toxicity study. Nevertheless, further studies are needed to establish full toxicity profile of WSA of A. calamus against fish.

Keywords: Common carp, LC_{50}, soluble alkaloid, sweet flag, toxicity

INTRODUCTION

Great loss in fish production every year occurs due to various disease problems in Nepal. Large number of external and internal parasitic worms is known to cause various diseases in fish. It is assumed that there is 15-20 % loss in total fish production and 30-40 % loss in fish seed production due to various disease problems every year (Mandal and Prasad, 2011). Ectoparasites mainly habitats on gills and skin of fish, are one of the major cause for significant economic loss in total production of fish. Chemotherapy measures are available for ectoparasite control but continuous and indiscriminate use of these chemicals has led to chemical toxicity, environmental contamination, resistance development and residual effects on food products. At present, research thrusts have been geared towards the development of plant based ectoparasicidals. Among many herds with medicinal and pesticidal properties, sweet flag (*Acorus calamus*) have been reported to have ecto and indo-parasicidal properties (Duke, 1985; Nandi *et al*., 2008)

Sweet flag under the genus *Acorus* comprises 40 species, however, only few species like *Acorus calamus* (Linn.), *A. christophii A. tatarinowii* (Schott.) and *A. gramineus* (Solandin Ait.) have been investigated for their chemical composition and bioactivities. Probably, *A. calamus*

has been most extensively investigated plant species among others. It is reported as a good source of active constituents possessing several useful bioactive properties. Sweet flag has commercial promise as a natural pesticide, antifungal and antibacterial agent (Panchal *et al*., 1989). Of the several plant origin materials, use of sweet flag (*Acorus calamus*) is widely spread in Asia, North America and Europe. Traditionally, it has been used in remedies for numerous ailments and the rhizome part of the *Acorus calamus* plant has been shown to possess several medicinal properties, which is used in the treatment of insomnia, melancholia, neurosis, remittent fevers, delirium and hysteria (Kim *et al*., 2009; 2011; Muthuraman and Singh, 2012).

The essential oil obtained from rhizome (by steam distillation of *Acorus calamus*) showed pronounced insecticidal properties (Nandi *et al*., 2008). Duke (1985) reported that the sweet flag has deworming properties to control internal parasites in ruminants. Recent study on ectoparasite control in fish revealed that the prevalence rate of *Dactylogyrus* parasite in common carp (*Cyprinus carpio*) fry was significantly ($P<0.05$) reduced to 3.38 in number when treated with water soluble alkaloids (WSA) of *A. calamus* at 25.0 mg/L concentration compared to that of 10.12 number in untreated condition (FRD, 2012). *A. calamus* is listed as an insecticide, an antifungal agent, an antibacterial agent, and a fish toxin (Anon, 1975). However, the application of *A. calamus* against ectoparasites of fish would require a thorough knowledge on its toxicity to fish, which is scanty, particularly for carp fish species. Therefore, the present study aimed to establish LC_{50} value of *A. calamus* against *Cyprinus carpio* fry so that a safe dose of the *A. calamus* to fish could be established for the effective management of ectoparasite of carps.

MATERIALS AND METHODS

Rhizomes of *A. calamus* were collected from forest surrounding Fisheries Research Division, Godawari and the rhizomes were sun dried for **7** days. Water soluble alkaloids (WSA) of *A. calamus* rhizomes was prepared by mixing 100 g dried Bozo powder in one liter of distilled water, filtered and water evaporated at room temperature. The extraction rate of WSA of *A. calamus (*AC) rhizomes was 2.55% from dried AC powder.

A bioassay experiment was conducted in 20 L glass aquarium with different concentrations of WSA of AC ranging from 0.0 to 450 mg/L with concentration interval of 75 mg/L. Common carp fry (mean weight ± standard deviation=7.7±2.2 g) were stocked at density of one fish/1.5 L water in aquarium in all respective WSA-AC treatments with triplicates. Experimental fish were acclimatized for an hour in respective aquarium before the administration of WSA-AC. Trial was conducted for 24 hours and experimental aquaria were provided with artificial aeration for the first 18 h of experiment. Experiment was repeated at two different water temperature regimes 19-23 ^{o}C and 8-10.5 ^{o}C, representing summer and winter seasons, respectively. Behavioral change and mortality of fish and water quality parameters were monitored and recorded at onset of experiment, one hour's interval for initial 6 hours followed by 3 hours interval till the termination of trial. Water quality parameters comprised of temperature, dissolved oxygen (DO) and pH were measured in

situ using respective electrode sensors. Fish behavior and mortality was monitored through visual observations.

Probit Analysis is commonly used in toxicology to determine the relative toxicity of chemicals to living organisms. Mortality data were transformed in log10 and control mortality was estimated by using Abbott's formula:
Corrected mortality (%) = $[(M_{obs} - C_{control})/ (100 - C_{control})] \times 100$
Corrected mortality data were probit transformed and then the probit values were regressed against log10 concentrations using linear equation:
$Y= a+ bx$

Log10 concentration associated probit 5 was used to estimate Lc_{50} value of WSA-AC against *C. carpio* fry. Estimation of Lc_{50} of WSA-AC and variation in water quality parameters among treatments was analyzed using software StatGraphics Plus ver 3.0.

RESULTS AND DISCUSSION

Fish mortality was first noticed after 18 h of WSA-AC treatments at concentration 375 mg/L and above when artificial aeration was withdrawn from all the experimental units. Lowest fish mortality (10%) was observed at 150 mg/L while all fish died at 450 mg/L concentration of WSA-AC within 24 h of experiment (Table - 1). No fish mortality was observed from the control group (0.0 mg/L). Observation of fish behavior at higher concentrations (>300 mg/L) of WSA-AC revealed that fish become sluggish, reduced swimming activity and all fish gathered in cluster in the bottom of aquarium. At dying stage, fish showed anoxic behavior gulping air at the surface of aquarium.

Table - 1: Effective concentration of water soluble alkaloid of *Acorus calamus* **(WSA-AC)** to induce mortality of *Cyprinus carpio* fry in 24 h of bioassay experiment in aquarium

Concentration (mg/L)	Log(10) conc.	Total number of fish/aquaria	Dead fish No.+	Percent mortality+	Probit value
0	-	10	0	0	0
75	1.875	10	0	0	0
150	2.176	10	1	10	3.72
225	2.352	10	1.5	15	3.96
300	2.477	10	6	60	5.25
375	2.574	10	8.5	85	6.04
450	2.653	10	10	100	>7.33

+ Mean of treatment replicates

Probit analysis revealed that the WSA-AC exhibited high activity against common carp fry with LC_{50} value of 288.4 mg/L (log10 concentration 2.46) at water temperature between 8.0 to 19.5 ^{o}C in different season (Fig:- 1). Regression equation of probit mortality of carp for 24 h bioassay against log10 concentration of WSA-AC estimated was: Y (probit mortality) = -

9.627+6 log10 WSA-AC concentration. The regression model derived from the mortality data set was significant ($P<0.05$, $r^2=0.886$) for the estimated slope parameter (b).

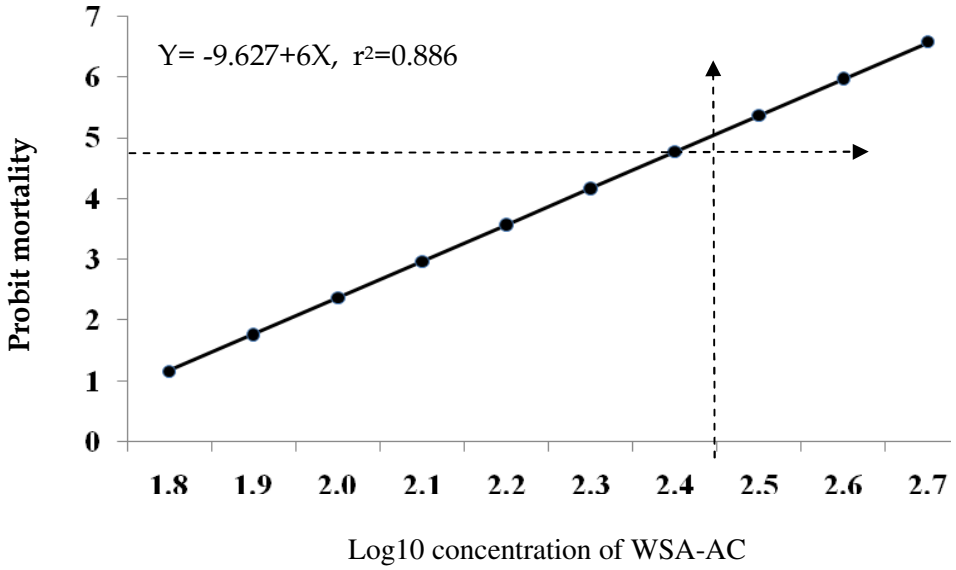

Fig. - 1: Regression of probit mortality of *Cyprinus carpio* fry against log10 concentration of water soluble alkaloid *Acorus calamus* **(**sweet flag) rhizome

Water temperature during the bioassay experiment was ranged between 19 to 23 ^oC for Augst (1st set of experiment) and 8 to 10.5^oC for December (2nd set of experiment). No significant different in temperature profile was found within each set of experiment among WSA-AC treatments. Dissolve oxygen (DO) concentration was within allowable limit (≥5.0 mg/L) in all treatments until the experimental units received artificial aeration for the first 18 h of bioassay study (Fig:- 2). When artificial aeration withdrawn after 18 h, the DO level sharply declined in all WSA-AC treated aquariums. The magnitude of DO depletion was scoring in higher concentration of WSA-AC (Table - 2). The rate of DO decline among treatments of WSA-AC concentration after withdrawn of aeration was highly significantly different ($P<0.01$).

Table - 2: Comparison of dissolve oxygen concentration before and after withdrawn of artificial aeration in water soluble alkaloid of *Acorus calamus* rhizomes treated aquarium with experimental fish, *Cyprinus carpio*

Condition	**DO level (mg/L) in different WSA-AC concentration (mg/L)**					
	0	**150**	**225**	**300**	**375**	**450**
Start of experiment, 0 h	10.7	10.4	10.2	10.4	7.6	7.8
Withdrawn of aeration, 18 h	7.6	5.1	4.8	4.6	7.4	7.3
End of experiment with no aeration, 24 h	5.9	3.9	2.4	2.4	2.0	1.5

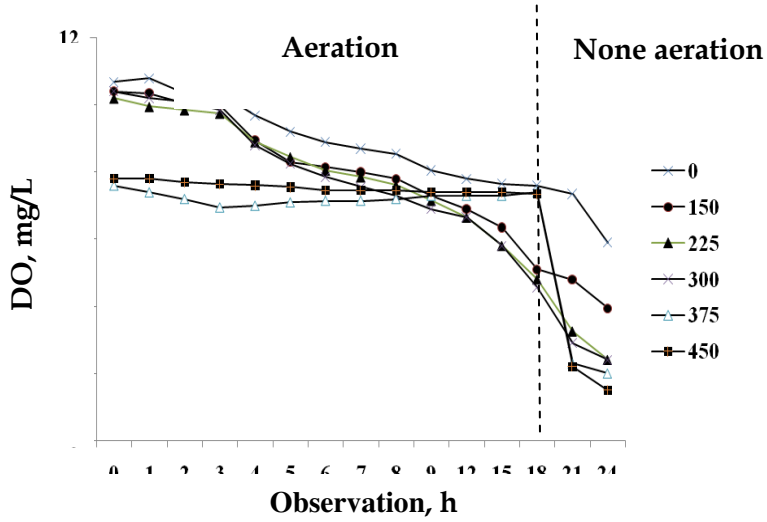

Fig. - 2: Dissolved oxygen concentration of water soluble alkaloid of *Acorus calamus* rhizomes treated aquaria at different time interval of observation

Although not significant (P<0.05) at each time interval, the pH of WSA-AC treated water was elevated (Fig:- 3). Irrespective of WSA-AC treatments, the mean pH value of 7.2 at the beginning was raised to 7.6 at the termination of experiment. The pH in control aquarium remained somewhat constant 7.1 to 7.3 throughout the experimental period.

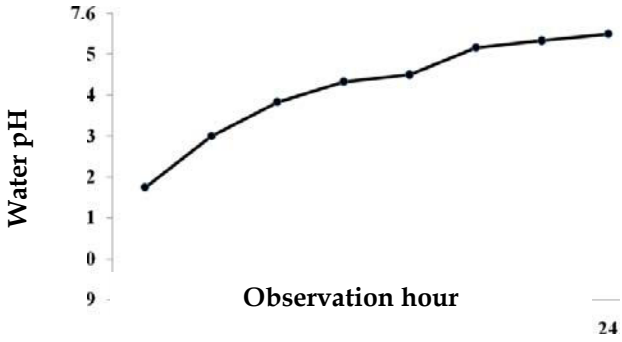

Fig:- 3: Mean value of pH in water soluble alkaloid of *Acorus calamus* rhizomes treated water in different time period of observations

Pharmacological, insecticidal as well as ecological significance of *A. calamus* and its active chemical constituent α- and β-asarone along with other constituents, such as caryophyllene, isoasarone, methyl isoeugenol, and safrol have been impressively increased in the past few years (Ganjewala and Srivastava, 2011; Mittal *et al*., 2009 and Dong *et al*., 2010). Most of the biological actions of *A. calamus* have been attributed to presence of α- and β- asarones (Wang *et al*., 2011 and Sanddep and Nair, 2011). In a recent finding beta-asarone was shown to possess ameliorative potential in cognitive impairment thereby suppressing the neuronal apoptosis (Geng *et al*., 2010). Some chemical constituents of *A. calamus* beta-asarone in

particular have been demonstrated to possess toxic effects like hallucinogen, carcinogenic, and genotoxic action in dose dependent manner (Bjornstad *et al*., 2009 and Chen *et al*., 2009).

Phytochemicals is indeed worldwide accepted therapeutic approach for the control of diseases and parasites, particularly in the adaptation approach of better management practices (BMP) in aquaculture. There has been enormous rise in the number of uses of traditional medicine and new scientific evidences are coming up regarding the safety of the medicinal plants. Therefore, this creates a warning regarding the toxicity and therapeutic effect of drugs from plant origin including *A. calamus* (Bjornstad *et al*., 2009 and Chen *et al*., 2009). The phyto-constituents of *A. calamus* have been documented to possess a number of beneficial effects on certain disease and parasites of human, livestock and to some extent aquatic organisms. The plant of *A. calamus* biosynthesizes and accumulates haem peroxidase enzymes which serves as part of antifungal defense system during the pathogenesis (Ghosh, 2006). Water extracts of *A. calamus* has also demonstrated allelopathic effects on the growth of two water bloom-forming algal species *Microcystis aeruginosa* and *Chlorella pyrenoidosa* (Hu *et al*., 2009). A study by Ghosh *et al*. (2010) has highlighted the efficacy of *A. calamus* extract against cattle tick *Rhipicephalus microplus*. The extract has been found to be safe and did not show any reaction in animals treated even with 50% of the concentration. Bhuvneshwari and Balasundaram (2009) derive the derivatives against fish pathogen *Aeromonas hydrophila* from *Acorus calamus* residue for showing the antibacterial activity of the plant. From a study, FRD (2012) reported that water soluble alkaloid of *A. calamus* has promising action to control ectoparasite (*Dactylogyrus sp*) of fish.

The scientific toxicological reports of *A. calamus* will be of great help in optimizing its safety in long term management of parasites of aquatic organisms. The results of the present study indicate that WSA-AC is well tolerated in fish fry up to concentration of 75 mg/L. Mortality and moderate behavioral symptoms were observed at concentration of 150 mg WSA-AC/L of water, 100 % mortality was noted at 450 mg WSA-AC/L of water. According to classification of US Environmental Protection Agency, LC_{50} values above 100 mg/L is considered as practically non-toxic but represent a low hazard (nicnas.gov.au 2013). The LC_{50} value of *A. calamus* in the present study suggested that the *A. calamus* plant could be regarded as practically non-toxic to fish.

Changes in water quality, particularly the rapid decline in DO level after the withdrawn of aeration was evident in WSA-AC treated aquarium. Supporting information whether *A. calamus* when dissolved in water has reduction potential of DO was not available and warned further study. An increased water pH recorded from WSA-AC treated experimental unit suggesting that the extract of *A. calamus* might have alkaline characteristic that could alter the buffer system of water. The hematopoietic system is one of the most sensitive targets for toxic substances and it also an important marker of physiological and pathological status in human and animal studies (Ferrario *et al*., 2008). Such studies need to be carried out in future to establish full toxicity profile of *A. calamus* against fish.

CONCLUSION

From this toxicity study, it may be concluded that water soluble alkaloid of *A. calamus* at concentration of 288.4 mg/L (LC_{50}) has shown hazardous to *Cyprinus carpio* fry. Nevertheless, further studies on water quality and physiological changes in fish are needed to establish full toxicity profile of WSA-AC on fish.

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FRESH FISH QUALITY EVALUATION PRESERVED WITH ICE

Achyut Mishra[1], Neeta Pradhan[2] and Nanda K. Roy[2]
[1]Food Research Division, Khumaltar, Lalitpur
[2]Fisheries Research Division, Godawari, Lalitpur
Email: achyutmishra2000@gmail.com

ABSTRACT

The freshness of raw fish samples were analyzed by subjective evaluation by more than 15 panelists including fish researchers, farmers and distributers, and found to be quite fresh. The raw fish samples were then taken for chilling with fish and ice ratio of 1:1 for whole and degutted and 1:0.5 only for degutted fish samples in Styrofoam box and the corresponding temperatures were recorded in every one hour till that exceeded the normal refrigeration temperature (about 7°C). From the statistical analysis, there was no significant difference in temperature increasing rate between the fish to ice ratio 1:1 and 1:0.5 till the 53 hours of observation (P<0.05).

From the organoleptic test, there was no any noticeable off odor in the preserved fish at the end of the study. The estimation of microbial load of fresh fish showed that total plate count (TPC), Coli-form and fungi counts for whole fish (1:1), degutted (1:1) and degutted (1:0.5) fish. The results were found TPC; $1.5x10^3$, $1.6x10^1$ and $6.5x10^2$ cfu/mg, Coli-form; 10, 0 and 0 cfu/mg and fungi (as yeast and mold); $4.78x10^3$, $2.55x10^2$ and $3.1x10^2$ cfu/mg, respectively. In overall impression, the fish seems to be safe. Similarly, the chemical composition of fresh fish (degutted and with scale) in terms of moisture, fat, protein, ash, AIA and PV were in the range of 74-76 %, 0.68-1.94%, 18.81-20.52%, 3.36-4.95%, 0.04-0.37% and 0.012-0.032 Meq/Kg, respectively.

Key words: Fresh fish, ice, Styrofoam, chilling, quality evaluation

INTRODUCTION

Live fish is normally considered to be sterile, but microorganisms are found on all the outer surfaces (skin and gills) and in the alimentary tract of live and newly caught fish in varying numbers. A normal range of 10^2-10^7 cfu (colony forming units)/cm^2 on the skin and between 10^3 and 10^9 cfu/g in the gills and intestines has been observed (Liston, 1980). When fish dies, its entire body resistance mechanisms breakdown, giving way to microorganisms or the enzymes they secrete to invade or diffuse into the flesh where they react with the complex mixture of natural substances present. During storage a characteristic flora develops, but only a part of this flora, known as the specific spoilage organisms (SSO), contribute to spoilage. Temperate fish have psychrotrophic (cold-tolerant) bacteria of the genera *Pseudomonas, Moraxella, Acinobacter, Shewanella, Flavobacterium, Vibrio, Photobacterium* and *Aeromonas* as part of their natural flora whereas tropical fish normally have mesophilic spoilage bacteria that make tropical fish spoil much faster than temperate water fish in the absence of ice. *Pseudomonas* and *Altermonas putrefaciens* are probably the major bacterial species that cause fundamental spoilage of usually iced fish. These can use the non-protein

nitrogen compounds present in the fish such as trimethyl amine oxide (TMAO) that result in several volatile odoriferous compounds. These volatile compounds are responsible for the off-odours and off-flavours characteristic of spoiled fish (Regenstein and Regenstein, 1991).

The most crucial factors determining the quality of fishery products are time and temperature tolerance. Proliferation of microorganisms requires appropriate high temperatures, while at lower temperatures close to 0°C; their activity is reduced, thereby extending the shelf life of fish products. Temperature is the single most important factor affecting post-harvest quality of the products. It is often critical to reach the desired short-term storage temperature rapidly to maintain the highest visual quality, flavor, texture, and nutritional content of fresh fish. The rate of spoilage is dependent upon the holding temperature and is greatly accelerated at higher temperatures, due to increased bacterial action.

Apart from the microorganisms that fishes have at the time of capture, more is added via unhygienic practices and contaminated equipment such as storage facilities. This was demonstrated by studies that compared the quality and storage life of completely aseptically treated fish (aseptic handling), washed fish, iced in clean plastic boxes, with clean ice (clean handling) and with un-washed fish, iced in old, dirty wooden boxes (normal handling) (Clucas,1985). A considerable difference was found in the bacterial contamination of the three batches, the latter heavily contaminated with a reduction in storage life compared with the other samples (Huss *et al.,* 1974). The design of a fish hold is of great importance as far as hygiene in the hold is concerned. Hold design should enable the purge (drip loss) to be collected easily. The amount of purge was suggested to be higher at 5-7°C; at which temperature there is greater spoilage since the purge is a very good medium for bacterial growth (Hermansen, 1983).

Similarly, rough handling will result in a faster spoilage rate. This is due to the physical damage to the fish, resulting in easy access for enzymes and spoilage bacteria. Physical mishandling in the net, such as very large catches, fishermen stepping on fish or throwing boxes, containers and other items on top of the fish, may cause bruises and rupture of blood vessels.

In addition to this, the micro-flora on tropical fish often carries a slightly higher load of Gram-positives and enteric bacteria but otherwise is similar to the flora on temperate-water fish (Liston, 1980). Basically, bacteria populations on temperate fish are predominantly psychrotrophic reflecting water temperatures of about 10°C while fish from the tropics have largely mesophilic bacteria (Gram and Huss, 1996).

In bulk-storage, the weight of the pile may crush the fish at the bottom, leading to a loss of weight (yield) as well as other physical damage. It has been reported that when haddock is kept in a short, deep pile of about 3 ft, the bottom fish lose 15% of their weight compared to a normal weight loss of 3-8%, which is entirely due to biochemical changes that cause a loss of water holding capacity leading to drip (Regenstein and Regenstein, 1991). Crushing of the fish by ice or other fish can seriously affect the quality of fish by releasing enzymes from the

gut into the fish muscle thereby accelerating autolysis processes. The main objective of this study was to carry out preservation of fresh fish by using ice. Beside this, evaluations of the quality of preserved fish by microbial and chemical analysis were the secondary objectives.

MATERIALS AND METHODS

Fish samples were collected from the pond of Fisheries Research Centre (ARS), Trishuli in morning time, stunned by leaving for 10 minutes in clean floor. The freshness of raw fish samples were analyzed by subjective evaluation by more than 15 panelists including fish researchers, farmers and distributers, and the samples were found to be quite fresh. Viscera were removed from the fifty percent of total fish samples and both degutted and non degutted fish were washed with poTable - water. For the quality analysis both degutted and whole fish samples (about 500g) at zero hour from harvest were taken in polyethylene bag by maintaining cold chain. Immediately, prepared fish were packed in Styrofoam box by keeping ice cubes in top and bottom of the box and alternate layer of fish in 1:1 ratio for both whole and degutted and 1:0.5 only for degutted fish. The Styrofoam boxes were sealed with cello tape in joining. From the top of the each box a probe type digital thermometer was inserted to the core point inside the box by piercing in to the fish and leakage was covered by taping. The changes in temperatures in every hour were recorded until that exceeded the refrigeration temperature 7^{o}C. For the quality analysis, samples from all boxes were taken for subjective evaluation for freshness and further quality analysis. The obtained data were analyzed by ANOVA method using the program GenStat (2012).

RESULTS AND DISCUSSIONS

In the beginning, the core temperature of fish was 27^{o}C, which was gradually reduced to 0.1^{o}C within four hours of ice packing. The core temperature was gradually increased gradually increased after four hours of ice packing and finally crossed 7^{o}C (outside dry bulb temperature was 22-30^{o}C) at about 53 and 48 hours in Styrofoam (dimension 40x40x30cm) in fish: ice ratio1:1 and 1:0.5 respectively (Fig:- 1). There was no significant difference ($P<0.05$) in temperature increasing rate between the fish to ice ratio 1:1 and 1:0.5 till the temperature crossed 7.1^{o}C in 53 hours of observation. From the organoleptic test, there was no any noticeable off odor in the preserved fish at the end of the study.

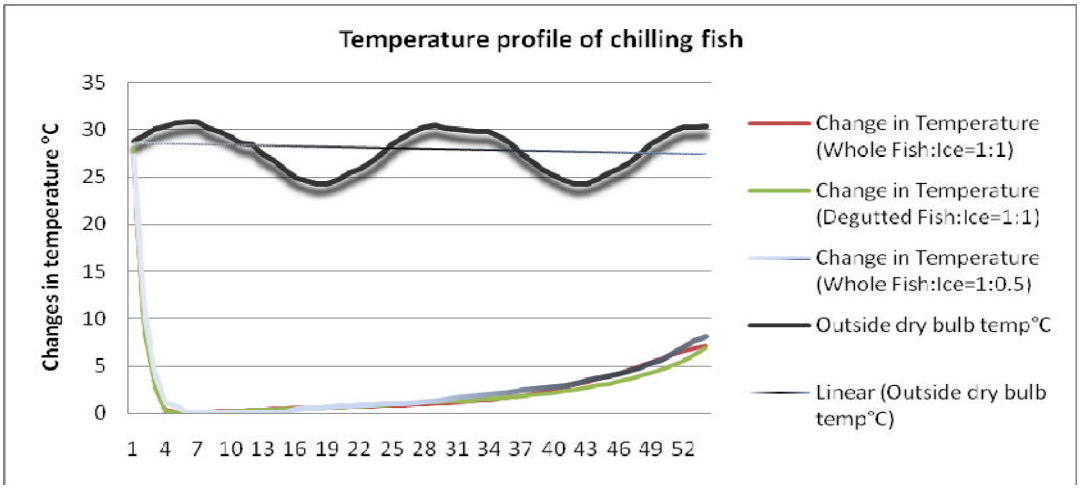

Fig. - 1: Temperature profile of chilling fish in Styrofoam

The microbial parameters of fresh fish in terms of total plate count (TPC), Coli-form and fungi counts for whole fish (1:1), degutted (1:1) and degutted (1:0.5) and were found TPC; $1.5x10^3$, $1.6x10^1$ and $6.5x10^2$ cfu/mg, Coli-form; 10, 0 and 0 cfu/mg and fungi (as yeast and mold); $4.78x10^3$, $2.55x10^2$ and $3.1x10^2$ cfu/mg respectively. Bacteriologically, the fish seems to be safe compare to the value given by Liston, 1980 in range of 10^2-10^7 cfu (colony forming units)/cm^2 on the skin and between 10^3 and 10^9 cfu/g in the gills and intestines and the value is also lesser than the value cited by FRD, 2012 and the range is 10^5 to 10^6 cfu. Samples being immediately degutted and chilled ones may be the lower microbial load. However, test showed that there is the presence of yeast and molds which might be due to the use of contaminated water or unhygienic handling. Similarly, the chemical composition of fresh fish (degutted but with scale) in terms of moisture, fat, protein, ash, AIA and PV are shown in Table - 1.

Table -1. Result of proximate analysis of tested fish

Parameters	Obtained value	Reference value (FRD, 2012)
Moisture	74-76 %	71.54-75.91%
Fat	0.68-1.94%	0.9-7.57%
Protein	18.81-20.52%	18.24-21.13%
Total Ash	3.36-4.95%	3.74-5.90%
Acid Insoluble Ash	0.04-0.37%	0.26-2.17%
Peroxide Value	0.012-0.032 Meq/Kg	0.294-2.645%

The obtained proximate composition values are very much comparable to the value of preserved and marketed fish mentioned in the Annual Report of Food Research Division (NARC), 2012. The quality of both fresh and thereafter preserved fish mainly depends on methods of capture, initial bacterial load, hygiene of fish handlers, and mode of storage or preservation.

CONCLUSION

Bacteria are the most important factor responsible for the spoilage of fish. Quality levels are based on the plate counts for acceptance or rejection of fishery products for human consumption with representative sample units not less than five, plate counts below 5×10^5 are considered of good quality (ICMSF 1986), so, from this research TPC for whole fish [Fish:Ice (F:I)=1:1], degutted fish (F:I=1:1) and degutted (F:I=1:0.5) were found $1.5x10^3$, $1.6x10^1$ and $6.5x10^2$ cfu/mg seems to be safe. From the statistical analysis, there was no significant difference in temperature increasing rate between the fish to ice ratio 1:1 and 1:0.5 till the 53 hours of observation ($P<0.05$). From this study, it has known that the fresh fish can be stored in very accepTable - condition for at least two days (temperature range 22-30 ^oC) using ice by half to equal proportion of fish. In future, this research can be remodeled in farmers' condition.

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EFFECT OF DIFFERENT PROTEIN SOURCES IN FEED ON THE GROWTH OF RAINBOW TROUT (*Oncorhynchus mykiss*)

Nand Kishor Roy[1], Suman Dheke[2], Sadhu Ram Basnet[2] and Shant Kumar Shrestha[1]
[1]Fisheries Research Division, Godawari, Lalitpur
[2]Department of zoology, Tribhuwan University, Kirtipur, Nepal
[3]Agro Top Industries, Company Nepal, Satghumti, Dhading
Email: nand_nutrition@hotmail.com

ABSTRACT

An experiment was conducted in farmer's raceway for two months to study the growth of rainbow trout (Oncorhynchus mykiss) fry by feeding four different types of feed. Four feed treatments were employed viz. control (CON), synthetic amino acid (SAA), silkworm pupae (SWP) and silkworm moth (SWM). There was significant different (P<0.05) among formulated feeds on the growth trout fry. The highest growth rate (17.5 mg per day) was observed in fish fed with silkworm pupae containing feed followed by control feed (15.7 mg per day). The lowest growth rate (2.3 mg per day) was observed for fish fed with synthetic amino acid. Survivability estimation at the end of experiment revealed that control feed (95.8%) was significantly superior (P<0.05) among the feed formulations. Likewise control and feed containing silkworm pupae exhibited the lowest feed conversion ratio (FCR, 1.32-1.33) and the difference between these two feed formulation was not significantly different (P>0.05). The feed with synthetic amino acid proved to be inferior in all feeding indicators to rainbow trout fry. Results indicated that the silkworm pupae could be used to completely replace shrimp in the area where it is available locally.

Keywords: formulated feeds, growth rate, trout fry, feed conversion ratio

INTRODUCTION

An increase in trout production requires corresponding increases in nutrition, feeding and better food stuffs. A continual supply of protein is needed throughout life for maintenance and growth of trout. Fish feeds are the largest single operating cost in aquaculture in the world including Nepal. The protein component of aquaculture diets is the single most expensive portion and important dietary nutrient. Fish meal remains the major dietary protein sources (20-35% protein) in the trout feed due to its high nutrient density and high digestibility. It contents high level of protein and appreciable quantities of fat and minerals. The protein in fish meal has high biological value because it is rich in essential amino acids particularly lysine and sulphur amino acids.

Fish meal and shrimp meal, procured from India, has been the main protein supplement for trout Feed in Nepal (Nepal *et. al*., 2002). Limited market accessibility with relatively high cost, the shrimp remains one of the major elements to raise production cost of trout farming (Roy *et al*.,1999; Pradhan, 1999 and FRCT, 2004). Feed alone comprised 76% of total variable cost and 40% of the total production cost of trout farming (Nepal *et. al*., 2002) and this is one of the major constraints after seed supply to expand trout farming in Nepal. Therefore, most

of the studies have been focused on finding alternate source of protein supplement in trout feed which are locally available at relatively cheaper cost without affecting the growth-production and quality of trout. A review of selected research literature on investigations into the use of plant feedstuffs in trout feed indicated that it is possible to utilize processed soybean meal at high level (up to 60%) in trout diet without impairing growth and environment (Bista *et. al.*, 2008).

In Nepal, very limited number of feed ingredients is available to choose for the formulation of balanced diet. Grain and by-products are quite insufficient, as there is a competition among fish, poultry, human and other livestock for some of these ingredients. Silkworm (*Anaphe infracta*) caterpillar is the larva of moth butterfly, a waste product of silk industry, could be used as a top class unconventional protein and energy feed for fish after proper processing at reasonable cost. Synthetic amino acid could be supplemented in trout diet as an alternative to animal based protein source. Hence, feed was formulated using nonconventional ingredients (silkworm and synthetic amino acid) and evaluated against trout fry. The present report describes the preliminary findings of alternative protein sources in the diet on trout growth and survivability.

MATERIAL AND METHODS

An experiment was conducted in farmer's field at Agro Top Industries, Company Nepal (P), Satghumti, Dhading for two months from 5 March to 14 May 2012. Three feed formulations were prepared using synthetic amino acid, silkworm pupae feed, silkworm moth as major source of protein and one formulation based on shrimp served as control. Compositions of test formulations are given in Table - 1. Proximate analysis was performed for each ingredient and formulated diets at Food Research Division, NARC (Table - 2).

Table - 1: Composition ingredients and approximate cost of formulated diets

Ingredients	**Control diet**	**Synthetic amino-acid diet**	**Silk worm pupae diet**	**Silk worm moth diets**
Big shrimp powder	50	-	-	-
Silk worm pupae	-	-	50	-
Silk worm moth	-	-	-	50
Lysine	-	30	-	-
Methionine	-	10	-	-
Soybean(roasted) powder	35	35	35	35
Wheat(whole) powder	15	25	15	15
Additives	-	-	-	-
Vitamin premixes	1	1	1	1
Mineral premixes	1	1	1	1
Vitamin-c	0.1	0.1	0.1	0.1
Crude protein %	44.44	44.29	44.89	44.44
Cost/kg	153.5	234	148	141

Table - 2: Proximate analysis of feed ingredients, %

Ingredients / crumbles feeds	**Moisture**	**Ash**	**Crude fats**	**Crude protein**	**Crude fiber**
Big shrimp powder	10.59	10.09	3.21	64.80	3.25
Silk worm pupae powder	6.65	4.01	31.29	57.21	2.39
Silk worm(moth) powder	11.84	4.74	29.05	54.55	4.84
Wheat(whole) powder	12.40	7.00	1.30	11.90	-
Soybean(roasted) powder	8.70	5.10	21.00	37.00	-
Formulation					
Control diet	8.97	11.67	8.62	38.27	2.65
Synthetic amino-acids diet	11.54	5.06	6.48	48.47	1.86
Silk worm pupae diet	10.35	5.65	17.01	42.68	2.80
Silk worm moth diets	3.66	7.13	20.85	46.01	3.11

Trout fry with body weight ranging between 0.28 - 0.34 g were stocked at density of 2000 per m^2 in triplicate nursing cages (0.5m x 0.5m x 0.5m), for each feed formulation, placed in a raceway. Fry were provided respective feed up to satiation at the interval of one hour for 8 hours during day time. Intermediate growth data were obtained at every two-week interval until harvest at the end of two month experimentation. Yield and survival data were obtained upon harvest. Growth and production data were subjected to ANOVA using Stat Graphics ver 3.0 for interaction among feed formulations (treatments).

RESULTS AND DISCUSSION

Trout fry grew exponentially fed with the three formulations containing animal protein. The periodic growth of fry was somewhat stagnant with feed comprised of synthetic amino acid (SAA) (Fig:- 1). There was significant difference ($P<0.05$) among formulated feeds on the growth rate of trout fry. The highest absolute growth rate (17.5 mg per day) was obtained in fish fed with silkworm pupae (SWP) containing feed followed by control feed (CON, 15.7 mg per day). The lowest growth rate (2.3 mg per day) was observed for fish fed with SAA. Similar trend in relative growth was evident. The highest relative growth of 9.8% was for fish fed on SWP, 7.4% for CON, 5,9% for SWM and the lowest of 1.3% was for SAA feed formulation (Table - 3). Survivability estimation at the end of experiment revealed that control feed (95.8%) was significantly superior ($P<0.05$) among the feed formulations. Survival rate of trout fry fed with SWP (85.5%) was comparable to the survival rate estimated for fry fed with SWM (84.3%). Trout fry fed on SAA had the least survival rate (22.7%) among feed treatments.

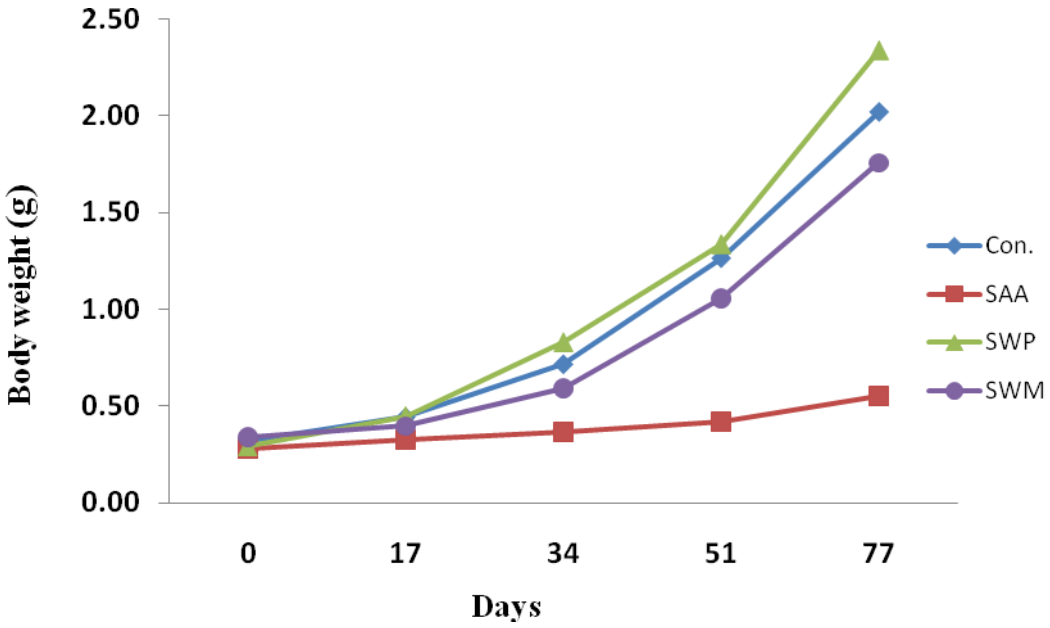

Fig. - 1: Average weight gain of trout fry fed by different feeds

Likewise control and feed containing silkworm pupae exhibited the lowest feed conversion ratio (FCR: 1.31-1.33) and the difference between these two feed formulation was not significantly different ($P>0.05$). The highest FCR of 10.14 was estimated for SAA feed.

In the present study, the feed with silk worm pupae has shown superiority in all feeding indicators to rainbow trout fry and the growth results are comparable to that of the results obtained with the feeding of shrimp based diet. Usefulness of silkworm pupae as feed for Indian major carps and common carp fingerlings have shown that it is more suiTable - than mustard oil cake and rice bran as feed (Chakrabarthy *et al*. 1973). In an earlier study conducted by Nandeesha *et. al*. (1990), it was shown that feeding common carp with diets

containing up to 30% pupae resulted in progressive increase in growth with the increasing level of pupae as compared to a fishmeal based 30% protein diet, and the highest weight was recorded at 30% of pupae incorporation. Bhuiyan *et. al*. (1989) reported that silkworm pupae are low cost ingredients and rich both in protein and lipid compared to shrimp. Silkworm pupae contains 48.25% protein, 21-38% lipid, crude fiber 8.42% and crude ash 8.34 % and have amino acid profile which is comparable with that of fish meal (Solomon and Yusufu, 2005). [Discuss on the availability of silkworm pupae in Nepal and correlate with your findings on how trout farmers will be benefitted)

Table - 1: Comparison of weight gain, survival and feed efficiency for trout fry fed with different feed formulations

Description	Control (CON)	Synthetic amino acid (SAA)	Silkworm pupae (SWP)	Silkworm moth (SWM)
Individual wt. at stocking, g	0.32	0.28	0.29	0.34
Total No. of stocked fish	1849	1589	1938	1741
Individual wt. at harvest, g	1.26	0.42	1.34	1.06
Total No. of harvested fish	1771	361	1657	1468
Feed conversion ratio (FCR)	1.31	10.14	1.33	1.53
Survivability, %	95.8	22.7	85.5	84.3
Absolute growth rate, mg/day	15.7	2.3	17.5	12.0
Relative growth rate, %	7.4	1.3	9.8	5.9

The present study also showed that trout fry growth and survival is poor in synthetic amino acid based feed. These results with synthetic amino acid are in disagreement with the findings of Cheng et al. (2003), Hui *et al*, (2008). Dietary crude protein could be reduced from 41.26 to 35.52% in the diets of *L. vannamei* as long as synthetic amino acids are supplemented (Huai *et al*, 2008). Cheng et al. (2003b) found that rainbow trout fed fish meal-based diet containing 37% CP grew as fast as those fed 42% CP diets supplemented with lysine, methionine, threonine, and tryptophan. Recently, Botaro *et al*. (2007) reported that reducing 2.7% of dietary digestible CP (from 27.0 to 24.3%) with SAA had no negative impact on growth performance of Nile tilapia. Although. SAA resulted in poor growth of trout fry in the present study, given that feed is the biggest source of nutrient loading in trout production from intensive and semi-intensive system, the role of SAA in trout diet has to be further investigated as SAA contained diets have the properties of low nitrogen and ammonia release in the environment.

CONCLUSION

The findings from this preliminary study indicated that the use of silkworm pupae in trout diet as the sole source of animal protein is possible without affecting the growth and survival of young trout and could be an alternative to substitute more expensive shrimp meal. Although the performance of synthetic amino acid (SAA) was found poor to improve the growth of trout, considering its properties of low environmental pollution, further studies are warned to incorporate SAA along with other plant origin protein sources (eg, soybean) in trout diet.

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Animal Nutrition

EFFECT OF BREED, FEEDS AND PROBIOTICS ON THE PERFORMANCE OF MEAT TYPE RABBIT

Manoj Kumar Shah, Budhi Ram Acharya, Yamuna Kumar Shrestha, Purna Bhadra Chapagain and Keshab Prasad Dhungana
Regional Agricultural Research Station, Lumle, Kaski
E-mail: manoj_iaas@yahoo.com

ABSTRACT

Rabbit is a small coprophagy animal and could be alternative source of animal protein in human diet. Meat of rabbit is not attached to any social or regional taboos that restrict or limit any religious or ethnic group from consuming it. Thus, rabbits are being grown remarkably for meat production in the western hills. An effort has been designed and implemented to evaluate the effect of breed in relation to feed and probiotics supplementation on growth performance of rabbits. An experiment was conducted at Regional Agricultural Research Station, Lumle, Kaski on 32 rabbits (Hyaline California and Soviet Chinchilla) allocating into eight treatments with 4 replications by using Completely Randomized Design with factorial combination (2x2x2 factorial) for 70 days. Two levels of probiotics were supplemented to experimental rabbits (with or without probiotics). Rabbits of all groups were fed with concentrate feed once daily at morning were as water and grasses were provided twice daily ad libitum. Results of the study showed no significant differences in growth performance of Soviet Chinchilla and Hyaline California breed during the entire experimental period. Similarly, the body weight did not differ significantly and same is the case of feed intake except that of the 4th week. Pellet and mash feeding to rabbits showed significantly ($P<0.05$) higher body weight gain. Supplementation of probiotics in rabbit diets significantly ($P<0.05$) increased the body weight of meat type rabbits over the treatment group that received no probiotics supplementation.

Keyword: Rabbit, pellet and mash feed, probiotics

INTRODUCTION

In Nepal, the population of rabbit is 15138 (SINA, 2012). The rabbit meat was increased during the decade 0 t to 153 t in meat (FAO, 2011). Rabbit is a small coprophagy animal and could be alternative source of animal protein in human diet. Rabbit meat is white meat which contains protein- 21%, fat-8%, energy- 160 Kcal. As meat of rabbit is accepted by most of ethnic groups, rabbit farming are growing as remarkably for meat production. The meat type rabbit may provide a new avenue for meat production because of its small size, low space requirement, rapid growth rate, high productive efficiency, and ability to utilize non-competitive feed. Also one of the major advantages of rabbit farming in this area is that they can be fed forages and agricultural by-products that are not suiTable - for human consumption. The rabbit meat is delicious, tender, juicy, and high in protein content with little fat and hence would be suiTable - for all categories of people. Probiotic, the live microbial feed supplements, beneficially affects the host animals by improving its intestinal microbial balance. There have been very few studies on the effects of rabbit growth by probiotic use in their diets. Therefore, the present experiment was undertaken to investigate

the effect of breed in relation to feed and probiotics supplementation on the growth of rabbits.

MATERIALS AND METHODS

The experiment was carried out at the Regional Agricultural Research Station (RARS), Livestock farm Lumle, Kaski for 70 days. A total of 32 rabbits were randomly distributed to 32 pens. Eight treatments with 4 replications were randomly allocated to 32 pens following a Complete Randomized Design with factorial combination (2x2x2 factorial). Two breeds (Hyaline California and Soviet Chinchilla), two types of feeds (Pellet and Mash feed), and two levels of probiotics supplementation (with or without probiotics) were tested. The composition of pellet feed was crushed maize - 40%, wheat bran – 22%, mustard cake- 25 %, fish meal – 5 %, molasses – 5 %, vitamin and mineral mixture – 2.5 %, common salt- 0.5%. Similarly the mash feed composition crushed maize -40 %, Rice bran- 20 %, Rice polish – 10%, mustard cake – 22 %, fish meal – 5 %, vitamin and mineral – 2.5%, common salt – 0.5 %. The commercial probiotic Biovet - YC @ of 1 kg per ton of feed was utilized. The green grass oat and mixed grass grown at station farm were used as their feed. Other feeding and all management practices were uniform throughout the experimental period. The dry matter (DM), Crude Protein (CP), Crude fiber (CF), Ether Extract (EE), and Ash content of feeds were analyzed by using proximate analysis of feeds (AOAC, 1997). The data obtained from the experiments was analyzed by using analysis of variances at 5%, Microsoft Excel, and Mstat-version 1.3 Michigan University 1994.

RESULTS AND DISCUSSION

Chemical Composition of feedstuff

The percent chemical composition of feed is presented in Table - 1. Crude fibre (10.56 %) was slightly higher in mash feed than pellet feed. Whereas, dry matter (92.12%), crude protein (16.4%), ether extract (10.4%) and total ash (7.23%) content where higher in pellet feed than mash feed. The result of chemical analysis is given in Table - 1.

Table - 1: Chemical composition of different feedstuffs (%DM Basis)

Ingredient	DM	CP	CF	EE	TA
Pellet Feed	92.12	16.4	10.27	10.4	7.23
Mess Feed	90.06	15.05	10.56	9.95	6.54
Oat grass	25.10	10.00	22.30	2.11	7.32
Mixed Grass	27.04	11.20	25.54	3.86	8.74

Weekly cumulative live weight

The weekly cumulative live weight of experimental animals is presented in Table - 2.

Table - 2: Weekly cumulative live weight (kg) under different treatment of rabbits

Factors	Periods in Week									
	Initial	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**
Breeds (A)										
Soviet Chinchilla	1.45	1.51	1.56	1.62	1.66	1.74	1.80	1.89	2.04	2.16
Hyaline California	1.39	1.42	1.51	1.60	1.65	1.72	1.79	1.94	2.05	2.14
Probability	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Feeds (B)										
Mess Feed	1.39	1.43	1.51	1.56	1.61	1.69	1.76	1.89	2.02	2.13
Pellet Feed	1.45	1.50	1.56	1.66	1.70	1.77	1.84	1.93	2.07	2.17
Probability	ns	ns	ns	*	ns	ns	ns	ns	ns	ns
Probiotics (C)										
Probiotic	1.43	1.48	1.59	1.70	1.72	1.78	1.86	1.92	2.09	2.22
No Probiotic	1.41	1.45	1.48	1.52	1.59	1.67	1.74	1.91	2.00	2.07
Probability	ns	ns	*	**	*	*	*	ns	ns	**
SEm ±	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.06	0.04	0.02
CV%	9.16	8.96	9.34	7.84	8.37	8.66	7.89	11.91	7.67	4.47

Note: **Significant at 1% (P<0.01), *Significant at 5% (P<0.05) and nsNot-significantly different (P>0.05)

Mean weekly cumulative live weight under different treatment of meat type rabbit is presented in Table - 2. Results of the study not different significantly reared on the Soviet Chinchilla and Hyaline California breed in all weeks. The higher weekly cumulative live weight of 1.51kg, 1.56kg, 1.62kg, 1.66kg, 1.74kg, 1.80kg from 2nd to 7th week, respectively and 2.16kg in 10th week in Soviet Chinchilla breed of rabbits. However, lower 1.42kg, 1.51kg, 1.60kg, 1.65kg, 1.72kg, 1.79kg from 2nd to 7th week and 2.14kg in 10th week of in Hyaline California breed of rabbits. So far as the feed material was concerned, the body weight did not differ significantly in all weeks among treatments except the 4th week in which rabbits kept on pellet feeding and mash feeding showed significantly **(**P<0.05) higher body weight. The higher mean weekly cumulative live weight such as 1.50kg, 1.56kg, 1.66kg, 1.70kg, 1.77kg, 1.84kg, 1.93kg, 2.07kg and 2.17kg during 2nd to 10th week respectively for the rabbit reared with pellet feed. Whereas, lower mean weekly cumulative live weight such as 1.43kg, 1.51kg, 1.56kg, 1.61kg, 1.69kg, 1.76kg, 1.89kg, 2.02kg and 2.13kg during 2nd to 10th week respectively for the rabbit reared with mash feed. Supplementation of probiotics in diets significantly **(**P<0.05) increased the body weight indicating 1.48kg, 1.59kg, 1.70kg, 1.72kg, 1.78kg, 1.86kg, 1.92kg, 2.09kg and 2.22kg and diet without probiotics were 1.45kg, 1.48kg, 1.52kg, 1.59kg, 1.67kg, 1.74kg, 1.91kg, 2.00kg, and 2.07kg during 2nd to 10th week respectively. The growth promoting effect of probiotics observed in this study is in accordance with many investigators (Kabir *et al.,* 2004; Kannan *et al.*, 2007). *Bacillus subtillis* in broiler chicken diets effectively improved body weight at market age and such increment was at AGP level (Carvalho, 2005). Panda *et al* (2005) concluded that the beneficial effect on health status, growth performance as well as nutrient utilization are mainly the reasons, why feed additives are widely used.

CONCLUSION

Results obtained from this study suggested that the meat type rabbit Soviet Chinchilla and Hyaline California can be equally considered as a good breed. Likewise, pellet feed and mash feed can be equally appropriate for such performance. The supplementation of probiotics increases the body weight of meat type rabbit than no probiotic supplementation. The finding is very useful for poor and marginal farmers as an alternative source of meat production and as an alternative mean of livelihood.

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SUPPLEMENTATION OF CONCENTRATE MIXTURE DURING GESTATION PERIOD OF DOE AND THEIR EFFECT ON PRODUCTION PERFORMANCE OF KIDS

Shiva Hari Ghimire, Devi Prasad Adhikari, Dipak Adhikari and Ram Prasad Ghimire
Agriculture Research Station (Goat), Bandipur, Tanahun
Email:drshibahari@yahoo.com

ABSTRACT

The present study was aimed to examine the effects of concentrate feed supplementation on doe during late pregnancy. This is an approach to improve milk yield and kid performance after kidding. Generally, high kid mortality has been known in Nepalese hills. Several approaches might be examined to reduce the kid mortality. Here, we present the results of one of such experiments conducted to find out appropriate level and duration of supplementation to the pregnant does. Experiment was conducted by applying completely randomized design (CRD) with factorial arrangements and replicated three times. First factor used in the experiment was the duration of concentrate feeding (15 days, 30 days, 45 days and 60 days) before kidding and second was amount of concentrate supplementation (2%, 1.75%, 1.5% and 1.25% @ of body weight). Birth weight, weaning weight, milk yield and kid mortality in different groups were recorded. Birth weight (2.3±0.15 kg) and weaning weight (10.94±0.41 kg) were found higher in 60 days supplemented group. Both birth weight and weaning weight were found higher with 2 percent concentrate feeding group than others. Milk yield recorded for fourth week showed that higher milk yields were found in 2 percent concentrate supplemented group with 60 days time period. The result showed that by increasing the level of concentrate during late gestation period of does increased the birth weight, weaning weight of kids and increased milk yield of does. So the higher level of concentrate supplementation during 45 to 60 days of late gestation in does is suggested.

Keywords*:* Weaning weight, birth weight, milk yield, goat

INTRODUCTION

Goats are primarily raised for meat production in Nepal. Total meat production of Nepal in 2010/2011 was 277625 Mt in which goat contribution is 19.02% (MoAD, 2011). Moreover, different Governmental Organizations (GOs) and Non Governmental Organizations (I/NGOs) are using the goat as a powerful poverty reduction tool in the rural areas. As a result, goat farming has been one of the rapidly growing enterprises in Nepal and plays significant role to increase the agricultural economy.

Goat is particularly important in subsistence agriculture farming system, because of its unique ability to adopt and maintain itself in harsh environment (Devendra *et al.,* 1970). Likely, goats are multipurpose animal and potential source of meat, milk, hide, hair and manure. Goat meat is accepted by all ethnic groups and is important for some religious purpose. On the other hand, the kid mortality reaches as high as 35% (Pokharel *et al.,* 2001) and one of the reasons is the poor lactating performance of doe due to the under

nourishment during gestation period. Small amount of maize flour as supplement is provided during gestation and lactation period of does in rural areas. Therefore, it is likely that total protein supply is below than physiological requirements particularly during late gestation. The birth weight of a kid on has been shown to be associated positively with the nutrition of the doe, particularly the level of protein at late gestation period (Solaiman, 2011).

Pradhan (1979) suggested that poor feeding management during pregnancy period of doe's influences on birth weight of newly born kids. This is important for building stores of nutrients for use in early lactation (Rangoma, 2011). In line with all suggestions, the present study was undertaken to assess the appropriate level and duration of concentrate feed to pregnant does and their effect on new born kids.

MATERIALS AND METHODS

The experiment was conducted in Completely Randomized Design (CRD) with factorial arrangement (4x4) and replicated three times at experimental crates in Agriculture Research Station (Goat), Bandipur, Tanahun. The first factor examined in the experiment was the duration of concentrate feeding (15 days, 30 days, 45 days and 60 days prior to kidding and second factor was amount of daily concentrate feed supplementation @1.25%, 1.50%, 1.75% and 2% of their body weight. Animals with same breed and similar parity were selected for the experiment. Deworming was done prior to the experiment with the Fenbendazole @ 5 mg / kg body weight. Adaptation period of one week was carried out before starting the experiment. Data of daily feed intake and refusal, kidding size, kids' birth weight, monthly weight, weaning weight and milk production of does from first week to fourth week were recorded. The recorded data was analyzed by using Analysis of Variance technique (GenStat Discovery Edition 4 (2013).

RESULT AND DISCUSSION

Growth performance of kids

The effect on the growth rates of kids from birth to weaning weight due to the duration and level of concentrate supplementation are presented in Table - 1. From the experiment, the doe's supplemented concentrate feed for 60 days before kidding had higher birth weight of kids than other shorter duration of supplementation. Birth weight of kids with different duration of supplementation were highly significant ($p<0.01$). The birth weights of kids were 2.30 kg, 1.99 kg, 1.93 kg and 1.53 kg with standard error of 0.15 kg for 60, 45, 30 and 15 days supplementation periods, respectively. Similarly, first month weights of kids were also higher in 60 days duration (5.5kg) followed by 45 days (4.75 kg), 30 days (3.99 kg) and 15 days (3.61 kg) and were highly significant ($P<0.001$). Similar trend was found in second, third and fourth months. In fourth months (weaning), the kids body weight for 60 days concentrate supplemented does was 10.94 kg followed by 45 days (9.63 kg), 30 days (8.38 kg) and 15 days (7.10 kg) supplemented does. Growths of kids were highly significant ($p<0.01$) form first to fourth month.

Birth weights of kids with 2 percent level of concentrate group were significantly higher ($p<0.05$) than other level of concentrate group. Birth weight of kids were 2.10 kg, 2.0 kg, 1.75 kg and 1.89 kg in 2% 1.75%, 1.50% and 1.25% level of concentrate groups, respectively. In first and second month, weights of kids with different level of concentrate were significantly different ($p<0.05$) and 2% concentrate level supplemented group had higher weight than other levels of supplementation. Weaning weight (four month weight) of kids with 2% level of concentrate were 9.64 kg followed by 1.25% (9.0 kg), 1.75% (8.6 kg) and 1.50% (8.55 kg). The growth rate of kids supplemented with different level of concentrates were significant at $p<0.05$ up to second months, and were no significant ($p>0.05$) in third and fourth months. This might be due to the contribution of kids' trait in later stages and likely reduced doe's contribution.

Table - 1: Growth performance of kids produced by the does supplemented with different level of concentrate for different duration prior to kidding

Duration * Feed %	**Birth wt (kg)**	**Monthly weight (kg)**			
Duration		**1st month**	**2nd Month**	**3rd Month**	**4th month**
15 days	1.53	3.61	5.53	6.06	7.10
30 days	1.93	3.99	5.56	6.63	8.38
45 days	1.99	4.75	6.55	8.05	9.63
60 days	2.30	5.50	7.63	10.00	10.94
F-cal	<0.01	<0.001	<0.01	<0.01	<0.01
SE	0.15	0.13	0.26	0.41	0.41
LSD 0.05	0.34	0.36	0.73	1.41	1.62
Feed quantity (% body wt.)					
1.25	1.89	4.33	6.03	7.58	9.00
1.50	1.75	4.34	6.10	7.55	8.55
1.75	2.00	4.34	6.09	7.32	8.60
2.0	2.10	4.70	6.58	8.05	9.64
F-cal	<0.05	<0.01	<0.05	NS	NS
SE	0.15	0.13	0.26	0.42	0.42
LSD 0.05	0.34	0.35	0.72	1.41	1.62

NS = Non significant, SE = Standard error, LSD 0.05 = Least significant difference @ 5 %.

Many studies have revealed that the higher rate of kid mortality and the post weaning weight of the kids are associated with its birth weight and level of feeding (Dhakal, 1995). Malau-Aduli *et al.* (2004) investigated the effect on Red Sokoto goat supplemented with crop residue and rations during third trimester of pregnancy. The author found that the goats supplemented with 2% level of conventional concentrate had higher birth weight (1.40 kg) followed by kids of those does supplemented with 2% of crop residue test ration (1.34 kg) and 1% of conventional ration (1.3 kg). Whereas three months weight of kids in the same experiment was highest in 2% level of conventional concentrate supplementation (6.25 kg) followed by 1% level of conventional concentrate (5.54 kg) and 2% of crop residue test ration

(5.33 kg). Furthermore, they found that in control group (without supplementation), birth weight was 1.31 kg and third month weight was 4.16 kg. The results of the author support the result of the present study. The similar result was obtained in a study in Bangladesh Agricultural University - Animal Nutrition Field Laboratory, where the average birth weight of kids in concentrate supplemented and none supplemented group were 1.45 kg and 0.85 kg, respectively (Salim *et al.,* 2002). From this study it is revealed that increment in level and duration of concentrate feeding, resulted improvement in birth weight and weaning weight of kids. The interaction effects of duration and levels of concentrate supplementation to does during late pregnancy in kids performance were similar (P>0.05) from birth to four months.

Milk yield of doe

The milk yields of does supplemented with different level of concentrate for different duration are presented in Table - 2. The milk yield of does were highly significant (P<0.01) from first to fourth week. From the experiment, milk yield of does supplemented for 45 days duration during late pregnancy had higher milk yield (373.75 ml) followed by 60 days (363.75 ml), 15 days (225 ml) and 30 days (147.5 ml) duration in first week. In second week, milk yield was higher in the group supplemented for 60 days duration followed by 45 days, 15 days and 30 days. Whereas, in third and fourth weeks, milk yield were higher in 60 days concentrate supplemented groups followed by 45 days, 30 days and 15 days, respectively. Similarly, 2% concentrate supplementation group had higher milk yield (338.75 ml) in comparison to 1.75% (311.25 ml), 1.50% (230 ml) and 1.25% (230 ml) in first week. In second, third and fourth week, milk yield of does supplemented with 2% concentrate had higher milk yield followed by 1.75%, 1.25% and 1.50% supplemented group and were significantly different (p<0.01) from first to fourth week. In a similar study in Nigeria by Malau-Aduli *et al.* (2004), 620 ml, 480 ml and 250 ml of daily milk yield were found in 2%, 1% and 0% conventional concentrate supplementation during third trimester of pregnancy in Red Sokoto goats and were significantly different (p<0.001). Insufficient milk yield in doe is one of the causes of kid mortality. So, increasing the nursing capacity of does through sufficient milk production to their kids may be one of the strategies for reducing kid mortality. In order to reduce the losses from kid mortality, concentrate supplementation with 2% of their body weight for 45 to 60 days duration during late pregnancy could be one of the better alternatives.

Table - 2: Milk yields of does up to fourth week, supplemented with different level of concentrate for different duration prior to kidding

Duration of feeding and feed quantity (% body wt.)	**Weekly milk production (ml day^{-1})**			
Duration	1st Week	2nd Week	3rd Week	4th Week
15 days	225	163.75	111.25	132.50
30 days	147.5	151.25	161.25	176.25
45 days	373.75	277.5	261.25	253.75
60 days	363.75	320	300	300.00
F-cal	<0.01	<0.01	<0.01	<0.01
SE	30.4	22.42	22.71	19.38
Feed quantity (% body wt.)				
1.25	230	201.25	178.75	197.50
1.50	230	175	176.25	180.00
1.75	311.25	248.75	207.5	226.25
2.0	338.75	287.5	271.25	258.75
F-cal	<0.01	<0.01	<0.01	<0.01
SE	26.51	18.33	17.12	15.8

The interaction effect of durations of supplementation and different concentrate levels in case of milk yield of does up to fourth weeks is presented in Table - 3. The interaction effect was significantly different ($P<0.01$) in all weeks from first to fourth. Those does supplemented with 2% concentrate for 60 days had higher milk yield up to 4 weeks (415, 390, 355, 345 ml) than other groups followed by 45 days supplementation with 2% concentrate (470, 350, 320, 310 ml).

Table - 3: Interaction effect of level and duration of concentrate supplementation to the pregnant doe on weekly milk production

Duration	**Feed quantity (% body wt.)**	**Weekly milk production (ml day^{-1})**			
		1st week	**2nd week**	**3rd week**	**4th week**
15 days	1.25	240	175	110	140
	1.5	160	100	60	90
	1.75	190	160	75	110
	2	310	220	200	190
30 days	1.25	125	95	100	155
	1.5	145	120	155	165
	1.75	160	200	180	195
	2	160	190	210	190
45 days	1.25	225	230	210	195
	1.5	290	210	215	205
	1.75	510	320	300	305
	2	470	350	320	310
60 days	1.25	330	305	295	300
	1.5	325	270	275	260
	1.75	385	315	275	295
	2	415	390	355	345

Late pregnancy is the most critical stage of fetus development. At this stage, the fetus is developing its organs and also increasing in size, gaining 70% of its birth weight in later 6 – 8 weeks of pregnancy. Rapid increase impinges on the size of the rumen. Good quality feeding is needed so that though feed intake is low it meets the requirements of the animal, because under nutrition causes low birth weight, low production of colostrums and reduction in milk production (Rangoma, 2011). It has direct effect on the growth and development of the kids and mortality as well. The present study also very close to the authors findings.

CONCLUSION

Supplementation of 2% concentrate of their body weight (daily) during later 60 days of their gestation had resulted heavier body weight of the kids and higher milk yield. This combination increases the kidding size, birth weight of kids and milk yield of doe which leads to gain the better growth of kids as well as support to make healthy kids which ultimately decreases kid mortality in goats.

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MECHANICALLY COMPRESSED FEED BLOCK FOR DAIRY ANIMALS IN RICE AND WHEAT GROWING AREAS OF NEPAL

Netra Prasad Osti[1], M. Huneid Azad[1], Bimla Shah[1], Bhola Shankar Shrestha[2] and Pulkit Mandal[1]

[1]Animal Nutrition Division, Khumaltar, Lalitpur

[2] Animal Breeding Division, Khumaltar, Lalitpur

Email:n_osti@yahoo.com

ABSTRACT

Nine dairy animals were randomly assigned to three treatments. The ration was formulated considering 3 percent of dry matter of the body weight at 1:3 concentrate to roughages ratio. The roughages were again divided in to 1:3 ratios as green forage and straw. In the treatment 1, chaffed (1" size) rice straw was mixed with 0.5 percent urea, 1800 ml sugarcane molasses and manually compressed in a machine to make 5 kg block (1 cubic feet size), likewise in the treatment 2, chaffed (1" size) wheat straw was mixed with 0.5 percent urea and 1800 ml sugarcane molasses and manually compressed as rice straw block and in treatment 3 same proportion of urea and sugarcane molasses mixed in rice straw and fed as such (non block). Animals were adopted prior to 7 days and last for 45 days from July 1 to August 15, 2011. Animal were fed two times a day and data were collected on milk composition and milk yield. There was increasing milk production trend observed from 5 liters to 8 liter per day and there was no mold growth found in compressed straw based blocks even in rainy season of the trial.

Keywords: Feed block, urea, molasses, and animal nutrition

INTRODUCTION

Feed is the main component to improve animal production. At present about 36 percent livestock feed deficit in the country and whatever available are low in quality, less digestible due to higher fiber content like rice and wheat straws etc (Upreti and Shrestha, 2006). These feed resources generally are nutrient deficient ones, resulted in low absorption, high roughage and wastage, on addition to transportation, handling and storage problems due to space consuming volume. In Nepal, it is generally, December to early June when animal forage becomes the most feed scarce. As a result, milk production substantially goes down and milking animals become lean and thin. In the plain areas of Nepal where rice and wheat are the principle cereal crops huge amount of straw are produced, which left in field or burn in the field as waste.

Due to high volume of the straw transportation cost to long distances becomes high. Recently, few studies have reported that bulk of straw may be transported easily and stored for long duration in smaller spaces (Anon 2004). In Nepal, the knowledge of compressed straw forages may have additional advantages, because mid hills are considered for livestock production while southern terai is more suiTable - for wheat and rice out of which straw are produced. There are only little knowledge on nutrient contents of these straw animal feed. The fibrous feed ingredients can fortified with deficient nutrients like protein

in the form of free nitrogen, amino acids, vitamins, calcium, phosphorous and other deficient minerals (McDonald *et al*., 1995). After fortification these fibrous feed resources can be mechanically compressed with heat and make dry porTable - and easy to storage as a feed block. These compressed feed blocks will be better utilized for commercial animal (dairy and meat) production in hills and where cereal production is low and scarce in dry winter and summer months.

MATERIALS AND METHODS

First it would be clearer if few lines mention how the rice/wheat straw compressed concentrate was prepared. Nine dairy animals were randomly assigned to three treatments. The ration was formulated considering 3 percent of dry matter of the body weight at 1:3 concentrate to roughages ratio. The roughages were again divided in to 1:3 ratios as green forage and straw. In the treatment 1, chaffed (1" size) rice straw was mixed with 0.5 percent urea, 1800 ml sugar cane molasses and manually compressed in a machine to make 5 kg block (1 cubic feet size), likewise in the treatment 2, chaffed (1" size) wheat straw was mixed with 0.5 percent urea and 1800 ml sugarcane molasses and manually compressed as rice straw block and in treatment 3 same proportion of urea and sugarcane molasses mixed in rice straw and fed as such (non block). Animals were adopted prior to 7 days and last for 45 days from July 1 to August 15, 2011. Animal were fed two times a days and record were taken in milk composition and milk yield.

RESULTS AND DISCUSSION

In result give the size and weight of the concentrated wheat and rice straw. The average milk yield from three treatments was found 5.69 kg per dairy animal per day which is not differed among the treatments (Table - 1) but during the block feeding and before block feeding was found significantly difference (Fig:- 1). Milk production was low at farm practice, when blocks were fed milk production increases consistently.

Table - 1: Milk yield and composition of dairy cattle kept under feed block trail

Treatment	Milk Composition				Milk yield (kg/d)
	Fat %	SNF %	Protein %	Conductivity	
Rice straw based Block (T1)	4.23	8.84	3.29	6.87	6.16
Wheat straw Based Block (T2)	4.72	8.72	3.25	7.04	5.19
Rice straw based non block (T3)	4.65	8.66	3.22	6.47	5.73
Mean	4.43	8.70	3.24	6.52	5.69

Other milk composition parameters were not differed among the treatments and before and after block feeding. The average fat, SNF protein percent, and conductivity were 4.43, 8.7, 3.24 and 6.56, respectively. Similar findings were also reported by FAO (2012) where Indian milk production has been significantly increased when crop residue based densified balance ration feeding program was launched in dairy buffalo and cattle. Another advantage is course feeding resources like wheat straw could be fed without any detrimental effect and animal very much liked due to addition of molasses and soft by pressure applied during

densification. Animals in imbalanced ration not only less milk but also emitted higher amount of methane per liter of milk produced (Capper, Cady and Bauman. 2009 and Garg, 2011), higher parasitic load and low immune function (Spears, 2000), and therefore, balancing and densification of ration ultimately reduces methane emission, lower parasitic load and better immune function in dairy animals.

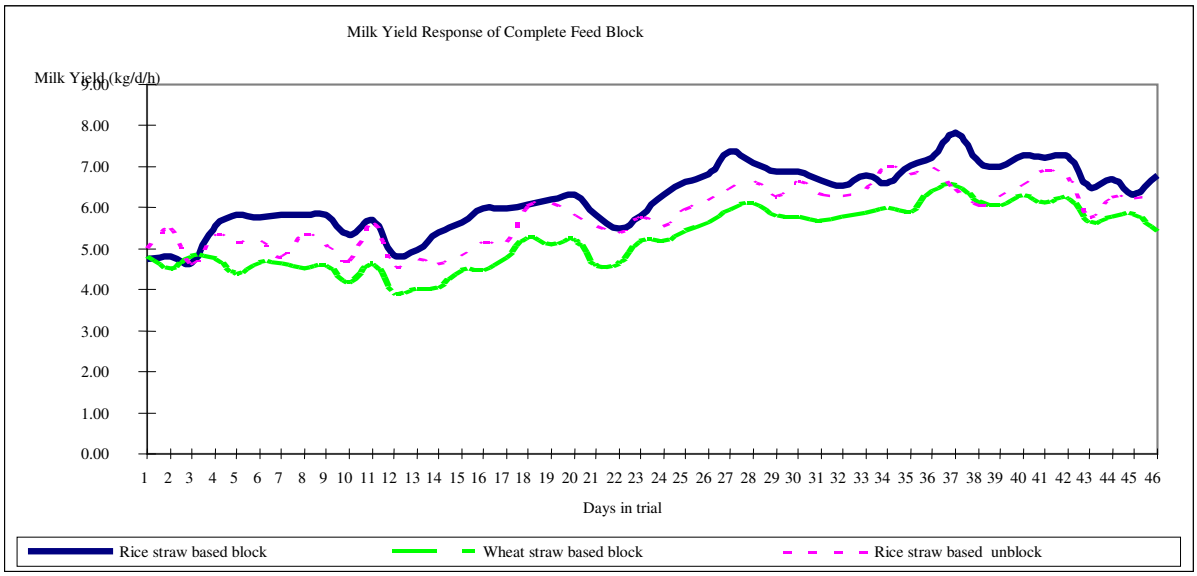

Fig. - 1: Milk response of complete feed block

CONCLUSION

Rice and wheat are the major food crops; rice is grown mainly in Terai and mid hills whereas wheat is grown from mountain to low land (Terai). Considerable amount of straw as byproducts from grain harvesting has been available to feed ruminant animals. Due to low nutrients contain and high volume there is transportation difficulties and low supply of nutrients for productive animals. Nutrients fortification and densify block prepared from rice and wheat straw got promising result from this research for milk production of dairy animals.

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EFFECTS OF SUBSTITUTION LEVELS OF SOYBEAN MEAL BY SUNFLOWER MEAL WITH OR WITHOUT ENZYME ON GROWTH PERFORMANCE OF BROILER CHICKENS

Devi Prasad Adhikari[1], Ram Prasad Ghimire[1], Dipak Adhikari[1], Shiva Hari Ghimire[1] and Megh Raj Tiwari[2]

Agriculture Research Station (Goat), Bandipur, Tanahun[1]

National Animal Science Research Institute, Khumaltar, Lalitpur[2]

Email:dpadhikari2@gmail.com

ABSTRACT

The experiment was conducted in the premise of Institute of Agriculture and Animal Science (IAAS)-Livestock Farm, Rampur, Chitwan from 19th March to 1st May, 2008. The objective of the study was to find out the effect of substitution levels of soybean meal (SBM) by sunflower meal (SFM) with or without enzyme on growth performance and economics of broiler production. Altogether six treatment combinations were prepared and applied as the experimental diets. Each of six treatments was organized by complete randomized design. i.e., T1= 0% SFM without enzyme supplementation, T2= 0% SFM with enzyme supplementation, T3= 25% SBM substitution with SFM without enzyme supplementation, T4= 25% SBM substitution with SFM with enzyme supplementation, T5= 50% SBM substitution with SFM without enzyme supplementation, T6= 50% SBM substitution with SFM with enzyme supplementation. Significantly ($p<0.05$) highest cumulative body weight was observed in T4 in fourth week (1103.3g), fifth week (1558.0g) and sixth week (1958.0g), respectively. Similarly, significantly ($p<0.05$) maximum body weight gain (455.0 g) and (400.0 g) was recorded in T4 and minimum in T5 (341.7 g) and (291.6g) in fifth and sixth week, respectively. Dressing percentage was observed highest in T4 (72.7) and lowest in T5 (68.2). The total variable cost bird^{-1} was increased with the higher levels of soybean meal and with enzyme supplementation. Accordingly, the highest income (NRs 208.21) was obtained from dietary treatment (25% SBM substitution with enzyme) followed by T3 and T2 (NRs 190.13 and 188.04, respectively).

Keywords: Soybean meal, sunflower meal, enzyme, broilers, growth performance, economic analysis

INTRODUCTION

Poultry enterprise is one of the most popular agro-businesses in Nepal. Small and scattered poultry production system in the past, is now steadily transforming into specialized and large-scale commercial production. With a population of 39530620 poultry birds, a total amount of 36085 Mt. meats is produced annually (CBS, 2011**)**. Similarly, poultry sector is providing employment for more than 65 thousand people. Feed cost is the major contributing factor of the poultry enterprises. On the other hand, proper nutrition is essential in maintaining the health of poultry birds. Soybean is most popularly used ingredient as protein feed for monogastric feeding, as it falls in the group of those feeds with a balanced amino acid content (Sokarovski *et al*., 1990). For many decades, sunflower meal has also been recognized as a viable feed ingredient in poultry diets (Petit

et al., 1944). Since then, sunflower meal has been used extensively in poultry diets and has been described as a good protein source for poultry, provided that some of its nutritional characteristics are taken into account (Senkoylu and Dale, 1999).

Sunflower meal can substitute the soybean meal. It is a good source of protein and B-group vitamins. Dehulled sunflower meal is considered more suiTable - for broiler feeds (Scott *et al*., 1982; Church, 1988). High efficiency in broiler production requires maximizing the feed utilization and minimizing the losses due to mortality and/or growth retardation (Wyatt *et al*. 1997). Many commercial enzymes are being used to accelerate the growth of broiler chickens fed on maize-soybean based diets (Zenella *et al*. 1999; Saleh *et al*. 2003 and Karki, 2007). Alvizyme Plus® one of the commonly used commercial enzymes, which contents several enzymes, viz. *Lactobacillus acidophilus, Saccharomyces cervisiae,* amylase, protease, lipase, cellulose, phytase, α-galactocidase, glucanase, pectinase and xylanase. The effect of Alvizyme Plus® supplementation on the performance of broiler fed diets improves weight gain, feed efficiency, carcass yield and reduces the per unit production cost (Sapcota and Ranjan, 1994; Adam, 2000; Karki, 2007).

Soybean meal is one of the most suiTable - protein source of poultry diets, the availability of soybean meal for animal feed use in Asia is low (APO, 1990). Moreover, absolute amount of the soybean meal utilized by feed industries in Nepal is imported, (Lohani and Amatya, 2000). Furthermore, soybean meal used as protein source for feeding animals and birds cost high price in the international market, and also directly competes for human food (Gifford, 1971). The soybean meal is expensive than other oil cake sources. Taking into consideration of aforementioned problems, an experiment was designed to find out the effect of sunflower meal substituted for soybean meal with or without enzyme on the performance of broiler chicken.

MATERIALS AND METHODS

To investigate the effects of substitution level of soybean meal by sunflower meal with or without enzyme on growth performance and economics of broiler chickens was conducted in livestock farm, IAAS, Rampur, Chitwan, Nepal from 19th March to 1st May, 2008. For this purpose, two hundred and fifty two, day old, unsexed Vencobb-100 broiler chicks were purchased from commercial hatchery and reared in 18 different floor pens. Each of six treatments was organized by complete randomized design. i.e., T1= 0% SFM without enzyme supplementation, T2= 0% SFM with enzyme supplementation, T3= 25% SBM substitution with SFM without enzyme supplementation, T4= 25% SBM substitution with SFM with enzyme supplementation, T5= 50% SBM substitution with SFM without enzyme supplementation, T6= 50% SBM substitution with SFM with enzyme supplementation. Two types of rations, broiler starter (2 to 4th weeks) and finisher (5th to 6th weeks) were fed. Each diet was adequately fortified with the required vitamins, mineral premixes. The birds were fed *ad libitum* in all treatments up to the 6 weeks of age. The birds were vaccinated as per vaccination schedule. The different parameters during experiment such as body weight, weight gain, and carcass characteristics (dressing percentage and sharing of different

organs) of broilers were measured. Likewise economics parameter of broiler production also recorded. The data were first tabulated in Microsoft Excel and statistically analyzed in complete randomized design (CRD) using MSTAT-C computer software packages. Means were separated by using Least Significant Difference (LSD) at 5% level of significance.

RESULTS AND DISCUSSION

Cumulative weekly body weight

Effect of inclusion of sunflower meal with or without enzyme supplementation for substitution of different levels of soybean meal on cumulative weekly body weight of broiler chickens in different weeks is presented in Table - 1.

Accordingly, the body weights of the birds under different treatments were non-significant ($P>0.05$) for first and second week. The highest and the lowest values ranged from 199.0g to 196.9g and 340.6g to 320.0g for respective weeks. However, weekly body weight for third week of age was found significantly different ($P<0.05$). The highest and the lowest body weight was found 663.3g and 568.3g respectively for T1 and T3 and this value was at par with and the values of T4 (657.0g), T5 (620.7g), and T2 (608.5g). Considering the values for body weight in fourth week, a significant difference ($P<0.05$) was observed among treatments. The highest body weight was recorded in T4 (1103.3g) and the lowest was observed in T3 (983.7g). Similarly, the values of T1, T2 and T5 were at par with the value of T6 (1033.4g). In the same context cumulative body weight was found significantly different ($P<0.05$) in fifth week of the experiment. In this week the highest body weight was found in T4 (1558.0g) and the lowest body weight was found in T3 (1338.0g). And the values of T1, T2, T5 and T6 were almost similar. The cumulative body weight in the sixth week were also found significantly different ($P<0.05$) among the treatments in which the highest cumulative body weight was found in T4 (1958.0g) and the lowest in T5 (1667.0g). The values of T1, T3 and T6 were almost similar.

Table - 1: Effect of inclusion of sunflower meal with or without enzyme supplementation for substitution of different levels of soybean meal on cumulative weight gain of broiler chickens in different weeks

Treatments	Period (week) and cumulative body weight (g)					
	1	2	3	4	5	6
T_1=0% SBM substitution WOE	197.1	320.0	663.3^{ab}	1050.0^{ab}	1447.0^{b}	1750.0^{bc}
T_2=0% SBM substitution with E	198.6	338.1	608.5^{ab}	1025.0^{bc}	1417.0^{b}	1817.0^{b}
T_3=25% SBM substitution WOE	197.1	323.8	568.3^{b}	983.7^{c}	1338.0^{b}	1751.0^{bc}
T_4=25% SBM substitution with E	197.3	340.6	657.0^{a}	1103.3^{a}	1558.0^{a}	1958.0^{a}
T_5 =50% SBM substitution WOE	196.9	336.9	620.7^{ab}	1033.3^{bc}	1375.0^{b}	1667.0^{c}
T_6=50% SBM substitution with E	199.0	328.6	611.7^{b}	1033.4^{bc}	1437.0^{b}	1733.0^{bc}
Mean	197.7	331.3	30.2	1038.1	85.1	1779.1
LSD	Ns	Ns	6.31	85.1	3.4	134.3
CV %	1.89	4.82	10.5	3.4	24.4	4.38
SEm $\pm$	3.1	25.5	10.5	10.9	24.4	26.98

The results of this study indicated that commercial enzyme products had some effects in diets containing high concentrations of SFM. Kocher *et al*. (2000) had also reported similar findings that the addition of enzymes to the higher SFM-level diets had little effects on growth performance and AME. The body weight of the birds in every treatment was increased in the slower rate in earlier weeks and increased in the faster rate in the fifth week onward. This might be related to the genetic contributions of the birds and the trend of feed intake. The body weight of the birds in every treatment was increased in the slower rate in earlier weeks and increased in the faster rate in the fifth week onward. This might be related to the genetic contributions of the birds and the trend of feed intake.

Weekly Body weight gain

Table - 2: Effect of different levels of soybean meal substitution with sunflower meal with or without enzyme supplementation on weekly weight gain (g week^{-1} bird^{-1}) of broiler chickens

Treatments	**Period (week) and body weight gain (g)**				
	2	**3**	**4**	**5**	**6**
T_1=0% SBM substitution WOE	122.5	313.3	416.7	396.7^{ab}	303.0^{ab}
T_2=0% SBM substitution with E	139.4	270.4	416.5	391.7^{ab}	400.0^{a}
T_3=25% SBM substitution WOE	126.4	244.5	415.3	394.7^{ab}	371.0^{ab}
T_4=25% SBM substitution with E	143.4	316.4	446.3	455.0^{a}	400.0^{a}
T_5=50% SBM substitution WOE	139.6	283.1	413.3	341.7^{b}	291.6^{b}
T_6=50% SBM substitution with E	129.6	254.7	450.0	403.3^{ab}	296.6^{b}
Mean	133.6	254	426.0	397.1	342.8
LSD	Ns	Ns	Ns	67.71	86.3
CV %	10.3	10.1	7.6	9.9	10.6
SEm $\pm$	3.3	10.25	7.1	11.1	15.4

Effect of different levels of soybean meal substitution with sunflower meal and with or without enzyme supplementation on weekly weight gain (g week^{-1} bird^{-1}) of broiler chickens in different weeks is presented in Table - 2. The result of weekly body weight gain was found statistically similar ($P>0.05$) for second, third and fourth week of experiment. Almost similar body weight gain was observed in each treatment which ranged from 316.4g to 244.5g. But, the results of weekly body weight gain was found significantly different ($P<0.05$) in fifth and sixth week of experiment period. The highest and the lowest body weight gain were 455.0g and 341.7g and 400.0g and 291.6g, respectively for fifth and sixth week period. The values for other treatments were found almost similar. The highest cumulative weight was observed in 25% sunflower inclusion levels with enzyme. This might be due to the promotion of microbes by the addition of enzyme to certain extent (25%) sunflower inclusion levels.

The result showed that the body weight gain of the birds at lower levels of substitutions (0 and 25% SBM substitutions) had yielded higher body weight gain than higher level of substitution (50% SBM substitution levels) in almost every week. Similar result was reported

by (Rajesh *et al*., 2006). Although, the broilers fed SFM diet up to 66 percent soybean replacement did not affect the body weight gain, apparently higher body weight gain was noticed in 33 percent soybean replacement by SFM when compared to control diet during 0-4 weeks of age. Whereas, the lower body weight gain was observed in broilers fed with 100 percent soybean replacement by SFM in the diets. However, the weight gain was in favor of control diet compared to SFM diets during 5-6 weeks of age. It could be due to the high fiber content in SFM diets that reduced the digestibility of the nutrients which ultimately decreased the weight gain (Rajesh *et al*., 2006).

Carcass characteristics

When considering the results of different meat traits, it is evident that though some variation is observed but they were not influenced significantly. The most important trait dressing percentage ranged from 68.2 to 72.7 which did not differ significantly ($p>0.05$). However, in totality T4 gave the highest (72.7%) dressing percentage over others. The mean weight of giblet, empty gizzard and abdominal fat of broiler chicken at the end of the experiment under different treatment is depicted in Table - 3. Highest weight of giblet and abdominal fat were in T6 (100.43g) and T2 (20.5g), respectively whereas the lowest values were observed in T2 (92.13g) and T5 (10.5g) which were statistically non-significant. Similarly, Table - 3 indicates the mean weight of offal (feather, head, shank and viscera) of broiler chicken at the end of experiment under different treatments. The highest and the lowest weight of feather, head, shank and viscera ranged 187.10 (T5) to 104.20 (T4), 47.80 (T6) to 43.90 (T5), 70.70 (T1, T2) to 66.5 (T5) and 217.80 (T3) and 191.80 (T4). The values were statistically non-significant ($P>0.05$). Likewise, the highest offal weight was observed in T5 (498.7g) and lowest in T4 (407.4g). Similarly the offal percentage over live weight was observed highest in T5 (29.91%) and lowest in T4 (20.80%). It can be inferred from the data related to different carcass traits that substitution of SBM by SFM up to 50% with or without enzyme did not have any significant influence.

Table - 3: The mean dressing percentages and offal percentage over live weight of broiler chickens

Treatment	Live Wt.	Dressed %	Giblet	Offal	Offal %
T_1=0% SBM substitution WOE	1750.0	71.60	100.3	450.9	25.76
T_2=0% SBM substitution with E	1817.0	71.30	92.13	453.6	24.96
T_3=25% SBM substitution WOE	1751.0	70.60	93.50	460.9	26.32
T_4=25% SBM substitution with E	1958.0	72.70	96.27	438.3	22.38
T_5=50% SBM substitution WOE	1667.0	68.20	96.13	498.7	29.91
T_6=50% SBM substitution with E	1733.0	70.60	100.43	490.4	28.29
SEM	26.98	3.02	12.87		
$LSD_{0.05}$	ns	ns	ns		
% C.V.	4.38	7.40	18.80		

Almost similar result was obtained by Wagan (2001), the edible internal parts were not affected significantly by different levels of sunflower meal; but liver and heart weight of

broilers were influenced by different levels of sunflower meal. The dressing percent, giblet weight and offal's weights were not affected by 15-20 % of soybean meal substitution by sunflower meal (Sah, 2002). In another study, the weight of the breast, back, wing, thigh and the drumstick were not affected significantly (P>0.05) by the SBM substitution levels and exogenous enzyme (Lyayi and Yahaya, 1999).

Economic analysis

Expenditure, income and variable cost by output ratio of the experimental birds under different treatment combinations are presented in Table - 4. This Table - presents the total variable expenditure, income, change in net profit and income by variable cost ratio for different treatment combinations for the one production cycle of broiler chicks. The total variable cost bird^{-1} was increased with the higher levels of soybean meal and with enzyme supplementation. It ranged from NRs 116.65 (50% replacement level without enzyme) to NRs 122.02 (0% substitution with enzyme) bird^{-1}. Accordingly, the highest income (NRs 208.21) was obtained from dietary treatment (25% SBM substitution with enzyme) followed by T3 and T2 (NRs 190.13 and 188.04, respectively). The lowest income was obtained from T5 (NRs 148.56). Likewise, the net surplus over variable cost and change in surplus due to feed change were also found highest for T4 treatment (NRs 88.47 and +33.94 bird^{-1}). Similarly, the output to variable cost ratio was observed higher for T4 and T3 treatments (1.73 and 1.60, respectively).

The similar economic results were reported by (Rajesh *et al.* 2006) in an Indian research. The author had reported that replacement of soybean meal by SFM at 0, 33%, 66%and 100% with or without enzyme had shown the cost of production per kg live weight over feed cost of 19.57, 18.59, 18.63, 18.02, 19.14, 18.44, 19.13, and 19.07 (in Indian Rupees) which was significantly different (P<0.05). The author further reported that inclusion of SFM with 33 per cent and 66 per cent soybean replacement with enzymes decreased the cost of production significantly (P<0.05) by 8 percent and 5.70 per cent respectively. Similar finding was reported by Sah (2002), he had stated that 15-20% substitution of sunflower seed oil meal for soybean oil meal in diet reduces the gross expenditure resulted highest net income.

Table - 4: Expenditure, income and variable cost by output ratio of the experimental birds under different treatment combinations

	Dietary treatments					
	T_1	T_2	T_3	T_4	T_5	T_6
Expenditure (variable costs, in NRs bird^{-1})						
Day old chicks	30.00	30.00	30.00	30.00	30.00	30.00
Feed	81.32	82.02	78.53	79.74	76.65	77.88
Labor	3.33	3.33	3.33	3.33	3.33	3.33
Water and electricity	0.83	0.83	0.83	0.83	0.83	0.83
Litter	0.83	0.83	0.83	0.83	0.83	0.83
Vehicle fuel/lubricants	0.83	0.83	0.83	0.83	0.83	0.83
Drugs (vaccine and medicine)	1.67	1.67	1.67	1.67	1.67	1.67
Veterinary consultancy	0.50	0.50	0.50	0.50	0.50	0.50
Disinfectants	0.33	0.33	0.33	0.33	0.33	0.33
Miscellaneous	1.67	1.67	1.67	1.67	1.67	1.67
Total variable cost	121.32	122.02	118.53	119.74	116.65	117.88
Income (in NRs bird^{-1})						
Live bird	175.02	187.21	189.30	207.38	147.73	181.76
Manure	0.83	0.83	0.83	0.83	0.83	0.83
Total income	175.85	188.04	190.13	208.21	148.56	182.59
Net surplus over variable costs (NRs bird^{-1})	54.53	66.02	71.60	88.47	31.91	64.71
Change in surplus due to feed change (in NRS bird^{-1})	Control	+11.49	+17.07	+33.94	-22.62	+10.18
Output: Variable cost ratio	1.45	1.54	1.60	1.73	1.27	1.54

CONCLUSION

The result of the study revealed that the 0% and 25% soybean meal substitutions with sunflower meal were better for the production performance of the broiler chickens. Likewise, the birds with enzyme (Alvizyme Plus®) supplementation had performed better than non-supplemented birds. The best production performance of the birds without deteriorating the carcass characters was obtained from the 25% soybean meal substitution by sunflower meal with enzyme supplementation; and it was found the highest economic returning treatment.

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ANISE OIL (*PIMPINELLA ANISUM L.*) AS A NATURAL FEED SUPPLEMENT FOR GROWTH IN BROILER CHICKEN

Besh Bahadur Bhandari[1] and Jagat Lal Yadav[2]
[1]Pakhribas Agriculture Research Station, Pakhribas, Dhankuta Nepal
[2]Institute of Agriculture and Animal Science, Rampur Nepal
Email: bhandari_bhesh@yahoo.com

ABSTRACT

This study examined the usage of anise oil in broiler nutrition for growth promoting substance. The experiment was laid in a completely randomized design with 240 seven day-old Hubbard broiler chicks randomly assigned to six groups containing 10 chicks in each and replicated four times. Different levels of anise oil were added to a standard ration to determine its effect on feed intake, body weight gain, feed conversion ratio and economics of broiler production compared to the control and antibiotic groups. Anise oil was supplemented to the basal diet at 0.0 (control), 100, 200, 400, 600 mg/kg diet and antibiotic 0.5g/kg diet (group 1-6), respectively for experimental period for 6 weeks. The highest final live weight gain (1882.60 g) was observed on 400 anise oil group followed by 600 anise oil group (1847.40 g), antibiotic group (1835.30 g), 200 anise oil group (1824.97 g), 100 anise oil group (1808.85 g) and control group (1795.50 g). Thus, addition of 400 mg/kg anise oil to the diets improved live wt. gain by approximately 5% compared to the control group and approximately 3% over the antibiotic group. Feed consumption revealed no significant difference between treatment groups, however, the feed conversions of birds received 400 mg anise oil was the best (1.91) as compared to control (1.94), antibiotic (1.94) and other treated groups. Moreover the net income per bird was significantly higher in 400 mg anise oil group when compared with other treatment groups. It can be concluded that the use of anise oil as feed additive at a level of 400 mg/kg diet enhance the performance of broiler chickens and could be considered as potential natural growth promoter for poultry.

Keywords: Broilers, Anise oil, Essential oils, Antibiotics

INTRODUCTION

Antibiotic feed additives have been used for improving animal and poultry performance for many years (Younis, 1987). Use of antimicrobial agents in food- producing animals has recently been an important public issue (Jafari *et al*., 2007). It has been reported that the usage of antibiotics as a growth promoter in chicken diets might be questionable (Moser *et al*., 2003). As a result, the ban of antibiotic growth promoters (AGPs) by many countries has led to alternative substances, which can be used in animal nutrition on a safe basis. Therefore, aromatic plants and essential oils extracted from plants have been more important due to antimicrobial and stimulating effects on animal digestive systems (Langhout, 2000). Aromatic plants have been used traditionally in the therapy of some diseases as medicine and in food (Williams and Losa, 2001). Many spices, preservatives and essential oils are used to inhibit bacterial growth (Hirasa and Takemasa, 1998). All essential oils are possessing antioxidative, fungicidal and antimicrobial activity (Dorman and Deans,

2000). Therefore, recently, essential herbs and aromatic plants have been given attention to substitute antibiotics growth promoters.

Anise (*Pimpinella anisum L.*) is an aromatic annual herb containing anothole (85 %) as active ingredient along with *eugenol, methylchavicol, anisaldehyde* and *estragole*. anise has been used as a stimulating effect of digestion and antiparasitic (Cabuk *et al.,* 2003) antibacterial (Singh *et al.* 2002), antifungal (Soliman and Badea, 2002), antipyretic (Afifi *et al.* 1994), seizures and epilepsy (Abdul-Ghani *et al.,* 1987 anticonvulsant for treatment of constipation (Pourgholam *et al.,* 1999). muscle relaxantants (Albuquerque *et al*. 1995; Alçiçek *et al*., 2003; Bassett, 2000). The anise oil has rarely been evaluated in animal feed. Therefore, the present study initiates to examine the effect of anise oil on overall performance of broiler chicks as alternatives to antibiotics.

MATERIALS AND METHODS

The experiment was conducted in the Livestock Farm of Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan from March 29, 2009 to 10th May, 2009. The experiment was set on completely randomized design (CRD). The trial was laid on experiment after one week of brooding on 240 unsexed, day old Hubbard Classic broiler chicks of similar weight. There were altogether six treatments and four replications with 10 birds in each experimental unit. All the chicks were provided with uniform floor, standard management conditions throughout the experimental period of six weeks.

Experimental diets

The experimental diet was formulated according to the standard perceived by Hubbard Broiler Guide (http://www.hubbardbreeders.com/broilermanagementguide.php). Requirement for all nutrients, were met using primarily maize, soybean meal, rice polish and smaller amounts of de-oiled cake, soya oil, minerals and vitamins. The presence and levels of anise oil and antibiotic in the diets were the main factors tested. A basal diet was formulated for each treatment and then three different levels of anise oil (87.5-90% purity; Özdrog Co., Hatay, TURKEY) or an antibiotic (CTC) were added to the standard diets to generate the other four treatment groups.

Table - 1: Experimental diets

Treatments	Experimental diets
1	Basal diet
2	Basal diet + Antibiotic (Chlorotétracycline- 5 mg/kg)
3	Basal diet + Anise oïl (100 mg/kg)
4	Basal diet + Anise oïl (200 mg/kg)
5	Basal diet + Anise oïl (400 mg/kg)
6	Basal diet + Anise oïl (600 mg/kg)

Antibiotic were mixed in a carefully to the standard diet. Anise oil was dissolved in soybean oil and then gently mixed with the standard diets. Due to volatile nature of anise oil the

diets were airtight in the plastic bags required for seven days. Feed and water were provided *ad libitum* during the entire experimental period. Birds were fed using 2 phase system, first phase starting from first week to fourth week and second phase from fifth week to sixth week.

The diets were subjected to proximate analysis as per AOAC (1995). The ingredients and nutrient composition of the experimental broiler starter and finisher diet are presented in Table -- 2.

Table - 2: Ingredients and nutrient composition (% DM) of experimental diets

Ingredients	**Starter (0-4) wks (B1)%**	**Finisher (5-6) wks (B2)%**
Mix maize	50.40	55.00
Rice polish	8.00	7.00
De-oiled cake	5.00	4.50
Soya cake	32.0	28.20
Bone meal	2.00	2.00
Soya oil	1.00	2.00
Limestone	0.80	0.60
Lysine	0.10	0.05
Methionine	0.20	0.15
Salt	0.30	0.30
Vitamin and minerals	0.15	0.15
DOT	0.05	0.05
Total Nutrients		
ME , kcal/kg	3001	3150.93
CP	21.04	19.51
CF	3.31	4.36
Ca	1.02	0.90
P	0.46	0.39
Lysine	1.18	1.03
Linoleic acid	1.44	1.82

Collection of data

Data on body weight, feed consumption were recorded at weekly intervals and mortality was recorded at occurrence. From the above data, body weight gain and feed efficiency were calculated.

Return over feed cost

Return over feed cost of broilers reared under different inclusion levels of anise oil and antibiotics were worked out by using the prevailing market rates.

Statistical analysis

The data collected on various parameters were subjected to statistical analysis using statistical programme MSTAT for the analysis of variance and Duncan's Multiple Range Test (DMRT) was used to measure the difference between treatments at 5% level of significance (Duncan, 1955) as modified by Kramer (1957).

RESULT AND DISCUSSION

Body weight gain

Mean live body weight (LBG) of chick (Table -- 2) fed diets mixed with different level of anise oil and antibiotic supplementation differ significantly higher ($P < 0.01$) among the treatments at 4th and 5th weeks of age. Addition of 400 mg/kg anise oil in diet showed significant difference with all other treatments; improved live weight gain by approximately 5 percent compared to the control group and 3 percent over the antibiotic group. While higher level of anise oil 600 mg/kg in diet significantly decreased LBG of chicks. Similarly significant results among the treatments were observed on weekly body weight gain of birds (Table - 3).

Table - 3: Average cumulative weekly live body weight (g) of Hubbard broiler fed diet mixed with different levels of Anise oil and Antibiotic supplementation

Weeks	Control	Anise oil (mg/kg)				Antibiotics	P
		100	200	400	600		
1	323.08^{b}	327.75^{b}	333.05^{ab}	338.62^{a}	331.37^{ab}	329.95^{ab}	NS
2	653.62^{c}	659.42^{bc}	667.52^{bc}	686.25^{a}	672.47^{ab}	667.65^{bc}	*
3	1008.47^{c}	1015.45^{bc}	1026.22^{bc}	1057.45^{a}	1037.90^{ab}	1031.2^{bc}	*
4	1408.42^{d}	1417.9^{cd}	1431.45^{bcd}	1474.90^{a}	1448.17^{b}	1440.15^{bc}	**
5	1795.50^{d}	1808.85^{cd}	1824.97^{bcd}	1882.60^{a}	1847.40^{b}	1835.30^{bc}	**

NS: Non Significant, Means within the row followed by the different superscript are significantly different ($P< 0.05$) by DMRT

Table - 4: Average weekly weight gain (g) of Hubbard broiler fed diet mixed with different levels of Anise oil and Antibiotic supplementation

Weeks	Control	Anise oil (mg/kg)				Antibiotics	P
		100	200	400	600		
1	208.73^{c}	215.20^{b}	217.27^{ab}	223.42^{a}	218.32^{ab}	218.97^{ab}	**
2	330.54^{c}	331.67^{c}	334.47^{bc}	347.62^{a}	341.10^{ab}	337.70^{bc}	**
3	354.85^{c}	356.02^{bc}	358.70^{bc}	371.20^{a}	365.42^{ab}	363.60^{abc}	**
4	399.95^{b}	402.52^{b}	405.22^{b}	417.45^{a}	410.27^{ab}	408.90^{ab}	*
5	387.07^{c}	390.87^{bc}	393.52^{bc}	407.70^{a}	399.22^{ab}	395.15^{bc}	*

Means within the row followed by the different superscript are significantly different (P <0.05) by DMRT

As shown, Anise oil supplementation at 400 mg/kg diet significantly improved body weight gain when compared with the control, antibiotic and with both lower (100 and 200 mg/kg) and higher (600 mg/kg) levels of anise oil. These differences among groups may be due to active ingredient such as anothole, eugenol, methylchavicol, anisaldehyde and estragole in anise. It was reported that anothole and eugenol have digestive stimulating effects and showed positive effect on live weight gain and feed conversion (Cabuk *et al*., 2003). The present result is agreement with the finding of (Ciftci *et al*., 2005), who reported that addition of anise oil (400mg/kg) significantly improved live body weight and FCR than the lower supplementation levels (100 or 200 mg/kg) and when compared with the control. The reason of reducing body weight in 100 mg anise oil group may be due to low essential oil concentration in digestive system and high essential oil concentration in 600 mg group could be affected negatively digestive system.

Feed consumption

The mean weekly feed consumption (g/bird) of broiler as influenced by dietary inclusion of anise oil and antibiotic is furnished in Table - 3. Feed consumption revealed no significant difference between treatment groups from 1st to fifth week which might be due to isocaloric and isonitrogenous diet fed throughout the experiment. This was similar to the findings of Ciftci *et al*. (2005) who observed no difference in feed intake in broilers fed with anise oil and antibiotic. The scent of certain essential oils can stimulate areas of the brain influencing emotions and the nervous system and may act in defense against physiological and environmental stress (Biomin, 2005). Higher supplementation of anise oil in feed may be due to their potent nature reduced feed intake of birds and the results agreed with the (Gauthier 2005) who reported that high level of essential oil lead to feed intake reduction and gastrointestinal micro-flora disturbance.

Table - 5: Average weekly feed consumption (g) of Hubbard broiler fed diet mixed with different levels of Anise oil and Antibiotics

Weeks	Control	Anise oil (mg/kg)				Antibiotics	P
		100	200	400	600		
1	343.38	346.13	349.21	354.27	348.17	351.26	NS
2	569.30	573.29	575.08	587.99	584.11	581.70	NS
3	708.21	701.14	699.61	710.96	716.03	712.89	NS
4	883.36	884.58	890.93	900.70	897.03	894.03	NS
5	889.87	902.76	897.61	917.21	904.82	896.89	NS

NS: Non Significant

Table - 6: Average weekly Feed Conversion Ratio of Hubbard broiler fed diet mixed with different levels of Anise oil and Antibiotic supplementation

Weeks	Control	Anise oil (mg/kg)				Antibiotics	P
		100	200	400	600		
1	1.645^{a}	1.608^{ab}	1.607^{ab}	1.585^{b}	1.594^{ab}	1.604^{ab}	NS
2	1.728	1.722	1.719	1.691	1.712	1.722	NS
3	1.995^{a}	1.969^{a}	1.950^{ab}	1.915^{b}	1.959^{ab}	1.960^{ab}	*
4	2.208	2.197	2.198	2.157	2.186	2.186	NS
5	2.298	2.309	2.280	2.249	2.266	2.269	NS

Means within the row followed by the different superscript are significantly different ($P< 0.05$) by DMRT

Feed Conversion Ratio (FCR)

The mean feed conversion ratio (Table - 6) of broilers fed with different level of anise oil and antibiotic only differ significantly at third week of age. The feed conversions of birds received 400 mg anise oil in the diets were the best (1.91) as compared to control (1.94), antibiotic (1.94) and other treated groups. The improved feed utilization with 400 mg/kg anise oil could be due to these positive effects of anise oil on the digestive system and digestibility of nutrient. Studies showed that, essential oils increased digestion of protein, cellulose and fat (Jamroz and Kamel, 2002), improved apparent whole-tract and illegal digestibility of the nutrients (Hernandez *et al.,* 2004), increased effects of pancreatic lipase and amylase (Ramakrishna *et al.,* 2003) and improve utilization of digestive products through enhanced liver functions (Langhout, 2000; Williams and Losa, 2001 and Hernandez *et al*., 2004). The results in this study are in agreement with results of studies in which different essential oils were added to poultry diets. In these studies reported that essential oils derived from different aromatic plants have improved feed intake, feed conversion, and carcass yield (Hertrampt, 2001; Williams and Losa, 2001; Tucker, 2002 and Bassett, 2000). On the other hand, a high FCR is associated with low digestibility of the diet, as shown in un supplemented group and same results obtained in high level of anise oil supplemented

group. In this line Bayram *et al*. (2007) reported the negative effects on feed intake and feed conversion ratio when anise seed mixed at 5 percent level in diet of quails.

Return over feed cost

The gross expenditure, gross income, net income per bird and gross income over gross expenditure, with diet containing different levels of anise oil and antibiotic is presented in Table - 7. The average cost of production per bird was significantly higher on the 600mg anise oil supplied diet but net income per bird showed significant difference ($P < 0.01$) in bird fed diet supplied with the 400mg anise oil.

Table - 7: The income and expenditure of Hubbard broilers fed diet mixed with different levels of anise oil and antibiotic supplementation

Economics of production				
Treatments	**Gross expenditure, NRs**	**Gross income (NRs)**	**Net income per bird (NRs)**	**B/C ratio**
T1	163.273^{c}	243.735^{c}	80.462^{b}	1.493
T2	164.605^{bc}	245.464^{bc}	80.859^{b}	1.491
T3	165.737^{abc}	247.592^{bc}	81.855^{b}	1.494
T4	169.205^{ab}	255.306^{a}	86.101^{a}	1.509
T5	170.770^{a}	250.651^{ab}	79.881^{b}	1.468
T6	165.965^{abc}	249.055^{bc}	83.090^{b}	1.500

Means within the column followed by the different superscript are significantly different ($P < 0.05$) by DMRT

As shown, addition of anise oil (400mg/kg diet) proved to be economical in broiler production while lower and higher levels decreased the economic efficiency in production which was in agreement with Soltan *et al.* (2008) who stated that addition of anise seed at 0.5g/kg had stimulatory immune effect and improve the economical efficiency of production while the higher level may had negative effect. This result agree with those of Abd El- Latif, *et al.* (2002) who reported that the inclusion of herbal feed additives in Japanese quail diet resulted in the least feed cost/kg gain and the highest percentage of economical efficiency compared with the control diet. In this respect, vegeTable -, herbs, spices and edible plants were suggested a non-traditional feed additive or growth promoters in broiler diets to improve the growth feed conversion efficiency and reduce the cost of feed (Gill, 1999). Hassan, *et al.* (2004) also reported that economic efficiency of feed was improved in chicks fed diets supplemented with the herbal feed additives as compared with the un-supplemented one.

CONCLUSION

It can be concluded that adding Anise oil as supplementation in the ration of broiler at 400 mg/kg showed relatively increase on feed intake, total body weight gain and feed conversion and on economic return. Thus, Anise oil could be considered as a potential

natural growth promoter for poultry. Further works are recommended for specific studies on Anise oil on poultry industry.

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TREE FODDER BASED FATTENING OF CASTRATED AND INTACT MALE GOATS IN SPRING SEASON

Ram Prasad Ghimire[1], Devi Prasad Adhikari[1], Shiva Hari Ghimire[1] and Megh Raj Tiwari[2]
[1]Agriculture Research Station (Goat), Bandipur
[2]National Animal Science Research Institute, Khumaltar
Email: ramghimire.narc.gmail.com

ABSTRACT

Tree fodders are the mainstay of the goat production systems in the mid hills of Nepal. The tree fodders become vital during the most critical fodder shortage during the spring season. However, there are certain tree fodder species which have been recommended to lop in spring seasons for feeding animals. Here, we thus aimed to compare the fattening potentials of tree fodder species which are fed in spring on castrated and uncastrated goats. The experiment was conducted at Agriculture Research Station (Goat) for 12 weeks in Randomized Complete Block Design (RCBD) with 2×5 factorial arrangement. The castrated and uncastrated bucks were used as two levels of first factor; and species of fodder were used as second factor having five levels, viz. Raikhanayo (Ficus semicordata), Pakhuri (Ficus glaberrima), Kavro (Ficus lacor), Sal (Shorea robusta) and mixed fodders. The nutrient content of the fodders were determined in the laboratory. Observations were taken for feed intake and weight gain attributes. The result showed that the voluntary intake of fodders was higher ($p<0.001$) for castrated male goats in comparison to intact males. Likely, Pakhuri and Kavro had higher voluntary intake (g DM day^{-1}) than in the case of other fodders. Interaction effects were also significant ($p<0.001$). Similarly, castrated male goats had higher ($p<0.001$) weight gain compared to intact ones. Likely, Kavro and Pakhuri had yielded higher average daily gain, although, other fodders were found at par. The interaction effect had shown that fattening the castrated goats by using Kavro and Pakhuri had resulted better ($p<0.001$) body weight gain of Khari goat. The results of the study revealed that castration could increase the fattening potential of the male goats and Kavro and Pakhuri are the better fodders for fattening the goats in spring season. The findings of the experiment could be useful to the goat entrepreneurs of the mid hills of the country.

Keywords: Tree fodders, castrated, uncasrated, Khari goat, average daily gain (ADG)

INTRODUCTION

Goat is economically, socially and culturally important livestock commodity in Nepal. It plays a major role in the farming system as they provide a potential source of animal protein, household cash income and several other advantages for significant national economy (Rajwar, 2013). Goat farming has got attention to be commercialized further in mid hill regions wheretree fodders are abundantly available as feed resources (Ghimire, 1992). However, sufficient nutrients have been still a problem for goats rising for meat purpose. Therefore, supply of nutrient rich fodder supply for goats during their different life stages must be evaluated. In general, winter and spring seasons have been found to be most critical for goat raising as green fodder becomes scare in these periods (Pariyar, 2008).

The defoliation calendar of tree fodders of mid hills of Nepal constructed has been developed by Nepal Agricultural Research Council. The calendar recommends lopping of fodder trees in spring seasons, such as Rai khanayo (*Ficus semicordata*), Sal (*Shorea rubusta*), Pakhuri (*Ficus glaberrima*), Kavro (*Ficus lacor*) (Ghimire *et al.,* 2012). However, among these recommended species it has yet to identify the fodder species for fattening of the castrated and intact male goats during spring season.

Thus, the present study examined how some of these recommended fodder species might interact among castrated and uncastrated males for fattening purpose in the lean period.

MATERIALS AND METHODS

The present experiment was carried out in the premise of Agriculture Research Station (Goat), Chhap, Bandipur, Tanahun at an altitude of 1250 masl and 27.94N and 84.38E. The experiment was conducted from June 2012 to September 2012 for 90 days. An adaptation period of 14 days was followed by the experiment. The experimental animals were drenched with anthelmintics before 15 days of the onset of the experiment. Randomized Complete Block Design (RCBD) with 2×5 Factorial arrangement and replicated three times. The first factor was castration and had two levels, viz. castrated and intact male goats. Similarly, second factor was tree fodder species with five levels, viz. Rai khanayo (*Ficus semicordata*), Sal (*Shorea rubusta*), Pakhuri (*Ficus glaberrima*), Kavro (*Ficus lacor*), and mixed fodders (control). The treatment of mixed fodders was used as the conventional feeding practices to the goat during spring season. The mixed fodder comprised of; Thin Napier, Khari, *Artemesia*, Kans (*Vetiveria zizanioides*), Banso (*Setaria pallidesesca*), *Imparata*, Dubo (*Cynodon dactylon*), Phurke (*Pittosporum napaulense*), Signal (*Brachiaria documbens*) and Greenleaf Desmodium. Khari breed aged (5-6 months) male goats having similar weight w taken as an experimental unit. All the experimental animals were provided similar concentrate ration (13% CP and 65% TDN) at the rate of 1 percent of their body weight day^{-1} and experimental tree fodders were provided *ad-libitum*.

Daily feed, fodder offered and, refused were recorded for calculation of daily fodder intake. Similarly, the experimental animals were weighed in every two weeks for weight gain measurement. The fodder samples were analyzed in the laboratory of Animal Nutrition Division, Khumaltar, Lalitpur for nutrient composition.

Table - 1: Nutrient contents of the different tree fodders used in the experiment, %

Tree fodders	DM	CP	TA	OM	NDF	ADF	ADL	HC	Cellulose
Mixed fodder	26.3	9.86	8.47	91.53	61.58	48.49	26.25	13.09	22.23
Rai Khanayo	34.5	10.02	13.90	86.10	61.22	54.33	36.53	6.89	17.81
Sal	31.22	10.27	3.05	96.95	65.92	55.91	32.83	10.00	23.08
Pakhuri	32.03	10.85	12.09	87.91	40.59	30.38	18.32	10.20	12.07
Kavro	32.79	12.5	13.96	86.04	55.14	44.51	26.19	10.62	18.32

DM= Dry matter, CP=Crude protein, T. Ash= Total ash, OM= Organic matter, NDF= Neutral detergent fiber, ADF= Acid detergent fiber, ADL= Acid detergent lignin, HC= Hemicellulose

Data analysis was done by using GenStat Discovery Edition 4 (2011) and the statistical model was;

$Y_{ijk} = \mu + a_i + b_j + axb_{ij} + r_k + e_{ijk}$

RESULTS AND DISCUSSION

Feed Intake

The effect of the castration was found prominent during the study. Mean daily feed intake was found higher ($p<0.001$) for castrated bucks (469.23 g DM day^{-1}) in comparison to intact ones (427.02 g DM day^{-1}). Likewise, the effect of different fodder species was also found significantly different in the fattening of the male goats during spring season ($P<0.001$). Feed intake was higher in the case of Pakhuri followed by Kavro, Sal and Rai khanayo. The treatment of mixed fodders which was used as control in the experiment had lowest daily dried fodder intake ($P<0.001$).

The interaction effect of different tree fodder species with the castrated and intact male goats on daily dry matter intake was obtained significantly different ($p<0.001$). Pakhuri had shown higher dry matter intake for both castrated and intact male goats (Table - 2). Except in the case of Pakhuri, all the fodders had shown higher dry matter intake in the case of castrated than in the case of intact male goats. Kavro, Rai Khanayo and Sal had higher fodder dry matter intake to castrated male goats in comparison to others.

Table - 2: Mean daily fodder dry matter intake of castrated and intact male goats fed with different tree fodder species

Fodders	Castrated	Intact
Mixed	321.54	286.52
Rai khanayo	430.68	358.22
Sal	422.91	383.38
Pakhuri	693.99	736.00
Kavro	477.10	371.27

Standard Error of Mean= 7.76, F-probability=<0.001, Least Significant Difference at 5%= 15.35

Daily fodder DM intake on different weeks had shown similar trend with the mean daily fodder intake (Table - 2). Pakhuri had shown higher fodder dry matter intake for both castrated and intact male goats in every week. Kavro and Raikhanayo to castrated male goats had followed it in almost similar trend in every week. Mixed fodders to both castrated and intact male goats had shown lesser fodder dry matter intake than other treatments.

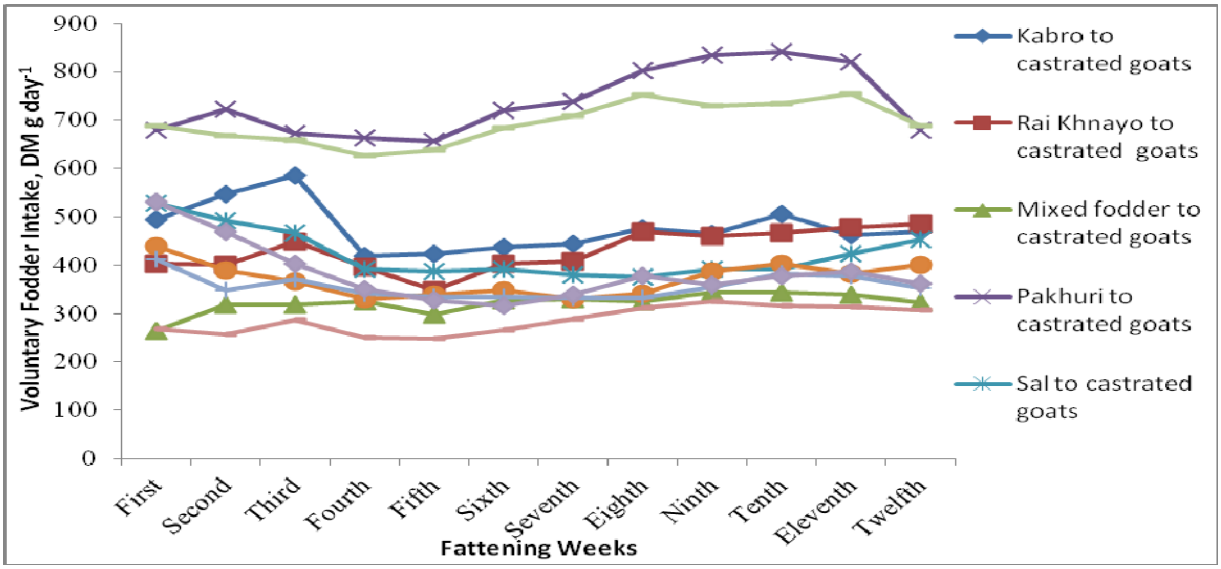

Fig:- 1: Daily fodder dry matter intake by castrated and uncastrated male goats in different weeks of fattening period.

Growth performance

The growth performance of castrated male goats were significantly ($p<0.001$) higher comparing to uncastrated goats. Castrated goats had obtained higher body weight gain (7.51 kg) than uncastrated (5.68 kg) during the 12 weeks fattening period. Accordingly, average daily gain (ADG) was 83.4 g and 63.1 g day^{-1} for castrated and uncastrated goats, respectively. Likewise, the castrated goats fed with Kavro and Pakhuri fodders had obtained higher ($p<0.01$) body weight gain (7.76 and 7.43 kg, respectively) compared to Sal, mixed fodders and Raikhanayo fed ones (5.65, 5.60 and 5.41 kg, respectively). Accordingly, ADG of the castrated goats fed with Kavro and Pakhuri were higher than the ADG of the uncastrated goats fed with Sal, mixed fodders and Raikhanayo.

Table - 3 showed that the interaction effect of castration and fodder species on mean body weight gain of the male goats were also obtained significant ($p<0.001$). In the case of fattening with Kavro and Pakhuri fodders to the castrated male goats had attained higher body weight gain (9.50 and 8.42 kg, respectively) than other treatment combinations. They were followed by the intact male goats fed with same fodders, Kavro and Pakhuri (7.91 and 7.35 kg, respectively). Raikhanayo, Sal and Mixed fodders had resulted lower body weight gain than Kavro and Pakhuri in both castrated and intact male goats. Accordingly, the calculated average daily gain (ADG) had revealed similar result of the experiment.

Table - 3: Mean body weight gain of castrated and uncastrated goats fed with different tree fodder species

Fodders	Body weight gain*		Average daily gain** (ADG, g day^{-1})	
	Castrated	Intact	Castrated	Intact
Mixed	5.05	6.15	56.19	68.32
Rai Khanayo	5.82	5.01	64.74	55.73
Sal	5.63	5.57	62.62	61.95
Pakhuri	8.42	7.35	93.66	81.74
Kavro	9.50	7.91	98.61	87.99

*Standard Error of Mean= 0.59, F-probability=<0.001, Least Significant Difference$_{0.05}$= 1.32

** Standard Error of Mean = 12.46, F-probability =<0.001, Least Significant Difference$_{0.05}$= 31.83

The ADG of the different treatments in different weeks are presented in Fig:- 2. The castrated goats fed with Kavro had shown higher ADG in every week of 12 week fattening period. The treatment of Pakhuri to castrated goats had followed it and showed almost similar trend, except in fourth and sixth weeks. Those treatments were followed by Kavro and Pakhuri to uncastrated goats in every week. Raikhanayo and mixed fodders to uncastrated goats had resulted lower ADG than all other treatment combinations in every week of the 12 weeks fattening period.

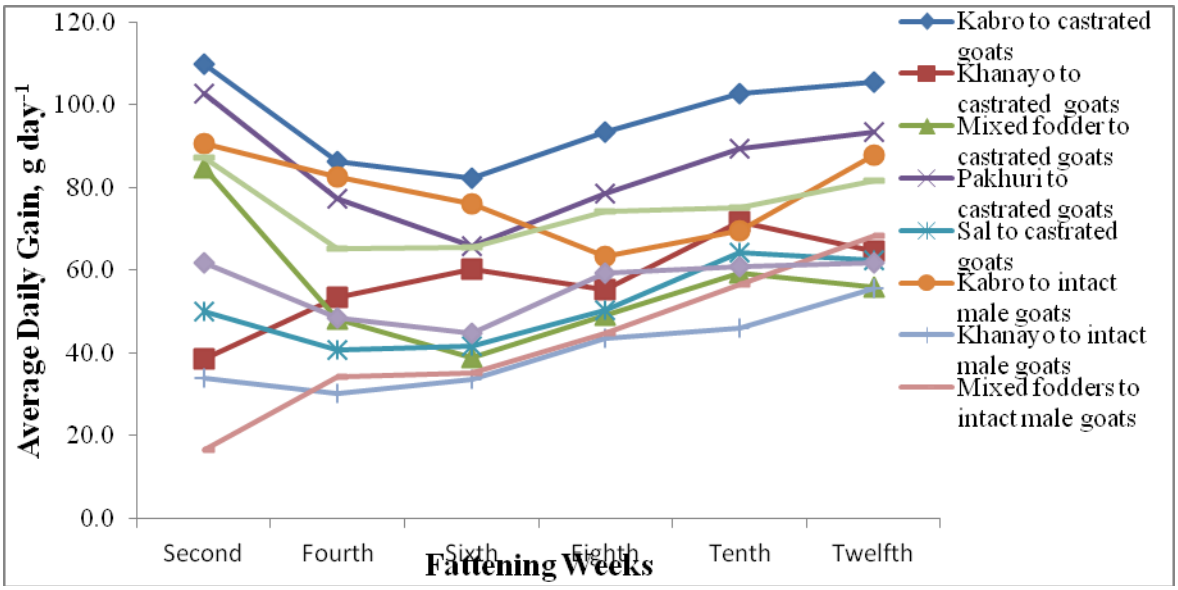

Fig:- 2: Average Daily Gain of the castrated and intact male Khari goats in different weeks fed with different tree fodders.

DISCUSSION

The voluntary fodder intake was higher (P<0.001) for the castrated in comparison to uncastrated goats. Similarly, all goats fed with Pakhuri fodders had higher fodder dry

matter intake than Kavro, Raikhanayo, Sal and mixed fodders. Accordingly, higher voluntary fodder dry matter intake (P<0.001) than any other treatment combinations the treatment of feeding Pakhuri fodder to castrated goats and intact male goats, and were followed by Kavro fodder to castrated goats.

The experiment was carried out in spring season which is one of the breeding seasons of the native Khari goats. As the experimental animals were 5-6 months aged, the uncastrated goats were observed restless and spending their time and energy on insistently teasing and breeding related activities rather than feeding, although they were kept in the individual metabolic crates. But, castrated goats were more docile. This could have adversely affected the voluntary fodder dry matter intake on uncastrated goats. Likewise, Pakhuri and Kavro had comparatively lower content of NDF, ADF and ADL than Raikhanayo, Sal and mixed fodders (Table - 1). These higher levels of lignin portion of fiber content of Raikhanayo, Sal and mixed fodders could have prolonged the retention time of fodders in the rumen and in lower gut, which might have decreased voluntary intake of these fodders. Furthermore, Pakhuri and Kavro are more palaTable - fodders for spring season (Ghimire *et al.,* 2012) and better palatability might have positively influenced the voluntary intake of these fodders.

Castrated goats had attained larger body weight gain than uncastrated. Likewise, the goats fed with Kavro and Pakhuri had obtained higher ADG than other fodders. The castrated goats fed with Kavro and Pakhuri fodders had yielded higher (p<0.001) ADG than any other treatment combinations, and were followed by the uncastrated goats fed with same fodders. In this case too, higher fodder intake of Kavro and Pakhuri by castrated goats (Table - 2) might have resulted higher ADG. Furthermore, some vital nutrients (like, crude protein, minerals and digestible portion of the fiber) content were better in Kavro and Pakhuri fodders in comparison to Raikhanayo, Sal and mixed fodders (Table -1). It might be another factor that had contributed the heavier body weight gain of the goat fed with Kavro and Pakhuri fodders.

Several authors have stated that uncastrated bucks gained higher weight than castrated goats (Murray *et al.*, 2001; Assia *et al.,* 2011 and Solaiman *et al,* 2011). The process of castration might causes stresses to lower ADG (Mahgoub and Lodge, 1996). Contrarily this study revealed that the castrated goats had higher (P<0.01) ADG than uncastrated ones. In this case, higher fodder dry matter intake by the castrated goats could have resulted higher ADG than uncastrated ones. Yami (2008) had stated that the castration of goats retard growth and quantity of lean meat if done late (after 6 months age). It was supported by another study (Kebede *et al.*, 2008); castration within 3 months had not shown effect on body weight gain, but after 3 months castration reduced body weight gain. The male goats used in the present experiment were castrated within their age of two months. So, the adverse effect of castration might not have apparent on the body weight gain of male goats. Likewise, the results are further supported by another study where it was shown that metabolism had not been affected by castration (Assia *et al.*, 2011). Because of the early castration of the experimental animals in the present study and no adverse effect on metabolism due to castration, the treatments having higher voluntary fodder intake had shown apparent effect

on the body weight gain of male goats. Among the fodders used in the study, Pakhuri and Kavro were more nutritive fodders and also had higher voluntary intake for castrated male goats which might have yielded higher body weight gain of them.

Castration of goat produces carcass with more fat and higher SFAs. Fatty acid contents of body tissue of goats affected by nutrition; grazing on pasture having more unsaturated fat than those fed grain (Rhee *et al.,* 2000). But, in the present study, the quality of the carcass was not taken into consideration, and is the area of investigation in future.

CONCLUSION

Goat husbandry is getting popularity as an enterprise in Nepal. In fattening the goats, tree fodders are the major resources in mid hills especially during fodder deficit in late winter and spring. Present study had shown that the early castrated goats had higher fattening potential than uncastrated ones. Similarly, among the tree fodders that are recommended to be lopped in spring season, Kavro and Pakhuri are more productive compared to Raikhanayo, Sal and mixed fodders in fattening the male goats.

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EFFECT OF DIFFERENT LEVELS OF CRUDE PROTEIN ON THE GROWTH RATE OF BROILER CHICKEN

Ram Bali Sah[1], Ram Deo Pandit[2], Md. Sah Nawaj Ali[1] and Bishnu Prasad Kushbaha[1]
[1]National Buffalo Research Program, Tarahara, Sunsari
[2]Regional Agricultural Research Station, Tarahara, Sunsari
Email:nbrp.tarahara69@gmail.com

ABSTRACT

This study was conducted to evaluate the effect of different levels of crude protein on the performance of broiler at poultry research farm of RARS, Tarahara, Sunsari. An experiment involving 120 Arbor-Acre (Breed) one day chick was used lasting a period of 6-weeks to ascertain the impact of crude protein on the performance of broilers. Chicks of similar body weights (n=120) were randomly distributed to 4 treatment groups with 3 replications. The experimental chicks were kept under a standard management condition for 42 days. The four treatments group birds T1, T2, T3 and T4 were supplied with level of crude protein 19%, 20%, 21% and 22%, respectively. Performance parameters were recorded and analyzed. The supplementation of 22 percent of crude protein significantly (P<0.01%) increased the weight and increase in feed conversion efficiency.

Keywords: Broilers, crude protein, growth, FCR

INTRODUCTION

Broiler chickens are most efficient converters of feed into animal protein in comparison to all other domestic animals and birds. The broiler farming need less capital, less space and give quick and early returns because of shorter generation intervals and higher demand of broiler meat due to low price and remunerative value in comparison to other type of meats.

Reduction in harvesting days for marketing increases the profitability in the broiler production (Wijtten et al, 2004). The best way to increase growth rate in poultry is to make appropriate dietary changes (Wijtten et al, 2004). During days 0 to 21, chicks are fed by 17% dietary protein, which resulted in smaller weight gain and poorer feed conversion than chicks fed 19, 21 or 23% crude protein (Nguyen *et al*., 2005). According to NRC (1994) the requirement for 0-2 week old broilers is to feed 23% crude protein containing feed. An adequate level of crude protein is required to make sure there is enough nitrogen to allow the body to synthesize non-essential amino acids (BOA, 2004). Rezaei *et al*. (2004) experimented with feeding broilers 208.4 g/kg and 178.4 g/kg crude protein. Birds fed 178.4 g/kg of crude protein had decreased weight gain and daily feed consumption compared to birds fed 208.4 g/kg crude protein (Rezaei *et al*. 2004). In addition, dietary crude protein fed at 120% of the recommended crude protein levels in starter diets increased body weight gain in the starter phase and in the consecutive grower phase (Wijtten, 2004). Moreover, it was shown that a delay in body weight gain due to suboptimal crude protein levels in the starter

diet decreased growth rate in the growing phase of broilers (Wijtten, 2004). Therefore, the objective of this experiment was to evaluate the effects of higher dietary protein levels on body weight gain.

MATERIALS AND METHODS

The experiment was conducted with 120 commercial broiler chicks (Arbor-Acre) in deep litter system at the poultry farm of RARS, Tarahara from 01 Mar. to 7 April 2010. A house pen was selected having good ventilation facilities. House was also white washed and kept for drying for 7 days and disinfection was done with phenyl solution before commencing of the experiment. The brooder was also cleaned and disinfected.

Experimental birds

The selected chicks were weighed individual and divided randomly into four treatments by using completely randomized design (CRD) having 3 replications in each. The number of birds for treatment was 30 chicks. Feeding trials were conducted for 6 week. Following feeding regimes were followed during experimental period.

Treatment groups (T1) Broiler feed 19% CP
(T2) Broiler feed 20% CP
(T3) Broiler feed 21% CP
(T4) Broiler feed 22% CP

Management practices

The chicks were reared in deep litter brooder. The brooder temperature was maintained by electrically adjusted properly 35°C before the chicks were kept for experimentation. The window of the brooder room were kept open daily on the day hours to ensure proper ventilation. The light of each compartment kept open during the night. The experimental broilers were kept on different ration in different chamber of brooder in well ventilated and in clean house. Same amount of feed was fed daily to the chicks in the morning and evening at fixed hours (i.e. 9 am and 4 pm.). Every day morning before feeding the residue left was recorded to find out the actual feed consumption in each group.

Concentrate mixture composition is presented in Table - 1.

Table - 1: Composition of concentrate mixture

Ingredient	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Maize	60	58	55	51.5
Wheat bran	2	0	.2	0
Ground nut cake	12	12	18	21
Fish meal	10	10	12	13
Sesame meal	8	9	5.5	4
Soya bean meal	7.5	10.5	9	10
Salts	0.5	0.5	0.5	0.5
Mineral mixture	0.5	0.5	0.5	0.5
Total	**100.5**	**100.5**	**100.5**	**100.5**
Crude protein content of concentrate mixture (%)	19	20	21	22
ME Kcal	2874	2870	2861	2855

RESULTS AND DISCUSSION

Growth rate

The data regarding body weight of broilers of different treatments are presented in Table - 2. By the end of first the highest body weight of broiler was recorded in T4 (101.76 g) followed by T3 (99.76 g), T2 (98.16 g), and T1 (94.4 g). The body weight gain was not significant among the treatments.

Table - 2: Body gain trend of broilers

Weeks	T1	T2	T3	T4	F-value
1st	94.4	98.16	99.76	101.76	Ns
2nd	200.76	217.33	215.5	233.46	*
3rd	361.20	390.6	384.86	406.53	*
4th	642.6	664.43	667.63	688.46	Ns
5th	926.23	1007.53	996.66	1039.83	**
6th	1260.7	1343.66	1365.6	1401.83	***

The effect of crude protein level on weight gain in the first week was similar to Rezaei *et al*. (2004) and Nguyen and Bunchasak (2005). By the end of second week the highest body weight of broiler was recorded in T4 (233.46 g) followed by T2 (217.33 g), T3 (215.5 g) and lowest by T1 (200.76 g). The differences in body weight were significantly ($p < 0.05$) among the treatments. The birds fed with 22% CP were heavier than birds fed with 20% and 21% CP diets. This finding was corresponding to Nguyen and Bunchasak (2005). In their study, they observed that higher CP levels resulted in faster gain in broiler chicks.

By the end of third and fourth week the highest body weight of broiler was recorded in T4 (406.53 and g) followed by T2 (390.6 g), T3 (384.86 g) and lowest by T1 (361.20 g). The difference in body weight was significant ($p < 0.05$) among the treatments.

By the end of fourth week the highest body weight of broiler was recorded in T4 (688.46 g) followed by T3 (667.63 g), T2 (664.43 g) and lowest by T1 (642.6 g). The differences in body weight were not significantly differences among the treatments.

By the end of fifth and sixth week highest body weight of broiler was recorded in T4 (1039.83 and 1401.83 g) followed by T2 (1007.53 and 1342.66 g), T3 (996.66 and 1365.6 g) and lowest by T1 (926.23 and 1260.7g). The differences in body weight were highly significant ($p < 0.01$) among the treatments in fifth week whereas it was highly significant ($p < 0.001$) among the treatments in the sixth week of experiment.

Feed consumption

Feed consumption was calculated by subtracting the amount of feed residue from the amount of feed offered in a week and was expressed in term of average feed intake /bird.

Table - 3: Feed consumption of broiler

Week	T1	T2	T3	T4	F-value
1st	102.86	114.23	109.9	113.6	Ns
2nd	267.23	278.23	270.26	284.1	Ns
3rd	395.33	396	403	403	Ns
4th	525.9	539.66	537.03	539.53	Ns
5th	744.93	716.46	705.86	735.86	Ns
6th	880.36	864.46	857.76	887.43	Ns
Total	2915.75	2909.18	2832.58	2962.98	Ns

Table - 3 showed that the weekly feed consumption of broiler slightly different among groups. However, in group slightly higher by T4 group, followed by group T1, T2 and T3, respectively up to six week of age. The feed consumption was not significantly different among the treatments.

Feed conversion efficiency

Table - 4: Feed conversion efficiency of broiler

Treatment	Final body weight	Total feed consumed	FCR
T1	1206.7	2915.75	2.3
T2	1343.66	2909.18	2.2
T3	1365.6	2832.58	2.1
T4	1401.83	2962.98	2.1

Table - 4 showed that the highest feed conversion efficiency was recorded in T3 and T4 group and lowest by T1 and T2 groups. The feed consumption was significantly different among the treatments.

CONCLUSION

On the basis of present study the supplementation of crude protein 21 and 22% was found much beneficial in the term of growth rate, feed consumption and feed conversion efficiency. This experiment clearly indicated that feed supplementation of high level of crude protein is profiTable - in broiler production.

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Pasture and Fodder

PERFORMANCE OF DIFFERENT VARIETIES OF OAT FODDERSON HIGH HILL OF RASUWA DISTRICT

Birendra Khanal[1], Bodh Raj Baral[1] and Kishor Kumar Shrestha[2]
[1]Agriculture Research Station, (Pasture), Dhunche, Rasuwa
[2]Pasture and Fodder Division, Khumaltar, Lalitpur
Email: arspasture@live.com

ABSTRACT

This study was conducted at high hills of Chandanbari, Syaphru VDC (3250masl) and Kyanging, Langtang VDC (3750 masl) to find out the most promising varieties of oat for high hill region. Fifteen different varieties of oat were cultivated in RCBD design with three replications at each site. First cutting was done at two month after date of sowing and subsequent cutting was done at each month interval. Significantly difference ($p<0.05$) was observed on Green matter (GM) and Dry matter (DM) production. The highest total GM was produced from Awapuni (27.85 t/ha) followed by Stampede (23.78 t/ha). GM from 83INC19G3, CDA1001 and PDLV65 produced 21.92 t/ha, 21.76 t/ha and 21.15 t/ha respectively. The least GM (16.82 t/ha) was obtained from 92176, 03. Similarly significantly the highest DM was produced from Awapuni (5.35 t/ha) followed by Stampede (4.41 t/ha), 83INC19G3 (4.20 t/ha), CDA1001 (4.19 t/ha) and PDLV65 (4.02 t/ha). The least DM (3.23 t/ha) was produced from 92176, 03. It was found that plant height, leaf length, leaf number/plant and tiller number/plant is directly related to GM and DM production. This study indicates that Awapuni, Stampede, 83INC19G3, CDA1001 and PDLV65 were the most promising oat varieties for higher GM and DM production at high hill.

Keywords: Oat, high hill, green matter, dry matter

INTRODUCTION

Livestock is the mainstay of livelihood of the high hill farmers of Rasuwa district. The dominated livestock species in high hill are yak, nak, chauries, sheep, goat and equines. The farmers raise their livestock under transhumance system in high hill of Rasuwa district. For livestock keeping inadequate quality feed has always been a challenge in high hills. Crop residues such as rice straw, maize stover and other fibrous crop by-product are very poor in quality and are important food in winter season (Gatenby*et al*., 1989). Oats (*Avena sativa* L.) are commonly called Jai in most parts of Nepal. Fodder oats are an important animal feed for all categories of livestock and the grains are used as concentrate feed. It is most widely cultivated by dairy farmers and can be fed in any form, i.e. as green forage, silage, or hay during scarcity periods of the year. Oat cultivars have been identified and recommended for different domains and its capability of fodder production have helped in alleviating fodder problem of dry winter sustainability animal production (Pariyar, 2004). Its multicut ability, acceptability to all categories of livestock, utilization in different feeding form (green, hay, straw, grain) and its availability during dry winter has helped in the development of a commercial industry. The area under oats in Nepal has been estimated to be 10000 ha and the productivity of green fodders 12 t/ha in two cut (Pariyar, 2005).Oat forages comprise the

largest component of the supplementary forage markets and play an important role in achieving animal production targets. Oats are quick growing, palaTable -, succulent and nutritious. In the hills and the terai, animals are in semi-starved for seven months. Malnutrition over two-thirds of the year drastically reduces their condition and adversely affects production. There has always been a need to find a source of green forage for winter (Kshatri*et al*., 1993). At very high hill cultivation of oat at winter is not possible because of heavy snow fall. Oat can be cultivated at the month of April and hay can be made at appropriate time, which can be offered better feed source in scarce period. This study was therefore conducted to identify high green fodder yielding varieties of oats at high hill.

MATERIALS AND METHODS

The study was conducted at high hills at Chandanbari, Shyaphru VDC (3250 masl) and Kyanging, Langtang VDC (3750 masl). Fifteen different oat cultivars were cultivated in RCBD design in plot size 4 m^2 with 3 replications in each site. The Seed rate was 120 kg/ha. Farm yard manure (FYM) was applied @ 5t/ha. The chemical fertilizer NPK was used @ 120:60:40 kg/ha. Full dose of phosphorus and potash and half dose of nitrogen were applied as basal dose and the remaining dose of nitrogen was applied in split doses. Half of the nitrogen was applied after 1st cut and the remaining half after 2nd cut. Sowing was done in line with 25 cm spacing at the mid of April month. Irrigation was applied at each 15 days interval. The different parameters on plant height, leaf length, leaf breadth, number of leaf/tiller and number of tiller/plant was taken by selecting five plants at random from each treatment. GM production and DM production were recorded. The leaf area at each cut was calculated by multiplying leaf length and leaf breadth. Dry matter of sample was calculated by keeping 100 gmsample in oven during 24 hour.The weight of dry sample was used to find out the DM percent/ha. Cutting was done in three times. First cut was done at two month after date of sowing and subsequent cutting was done at each month interval. The average data in each site was used for data analysis. The data recorded was statistically analyzed using the analysis of variance technique.

RESULTS

Plant height

Table - 1 indicates the plant height of oat at different cut. There was no significant (<0.05) difference between the treatments on plant height at different cut except 3rd cut. At 1st cut the highest plant height (42.10 cm) was found in Awapuni followed by stampede (41.57 cm). The lowest (30.45 cm) plant height was found in Croa 118.At second cut the highest plant height (39.67 cm) was obtained from stampede and lowest (31.18 cm) was found in 92169, 01. At third cut it was found that significantly the highest plant height (41.45 cm) was obtained from Stampede followed by Awapuni (39.67 cm) and least (28.50 cm) was obtained from 92169, 01.The average plant height of different cut was found non significant (<0.05) between the treatments. The average plant height of three cut was found the highest (40.90 cm) in stampedefollowed by Awapuni (40.41cm) and the lowest (30.47 cm) was observed in 92169,01.

Table - 1: Plant height at different cut

Oat	Plant height (cm)			
	1st cut	2nd cut	3rd cut	Average
NZ Saia	35.83	37.18	35.70	36.23
Awapuni	42.10	39.45	39.67	40.41
92173,02	41.53	35.41	31.20	36.05
CDA 1001	36.49	36.52	35.57	36.19
Kamadhenu	32.18	34.07	32.53	32.93
83 INC 19 G3	36.97	36.63	37.25	36.95
Netra	32.40	32.59	29.61	31.53
346/2	33.63	32.25	29.18	31.69
Stampede	41.57	39.67	41.45	40.90
92169,01	31.72	31.18	28.50	30.47
Swan (Pak)	32.18	32.40	31.23	31.94
Bundel 851	32.60	33.15	31.38	32.38
Croa 118	30.45	31.72	31.37	31.18
92176,03	34.20	31.62	33.72	33.18
PDLV65	38.70	37.10	37.02	37.61
Overall mean	35.50	34.73	33.69	34.64
SE mean	0.807	0.697	0.730	0.656
St dev	7.658	6.613	6.928	6.224
Variance	18.647	13.73	18.007	16.794
F value between treatments	NS	NS	*	NS

Tiller number per plant

Table - 2 indicates the tiller number/plant at different cut. There was no significant (<0.05) difference between the treatments on tiller number/plant at different cut. Tiller number per plant was found more or less equal among the varieties at each cut. However the average tiller number of three cut was found in between 5.4 in swan (pak) and 6.2 in Awapuni, CDA 1001, 83 INC 19 G3 and PDLV65.

Table - 2: Tiller number/plant at different cut

Oat	Tiller number/plant			
	1st cut	2nd cut	3rd cut	Average
NZ Saia	5.0	5.7	6.0	5.6
Awapuni	6.3	6.2	6.0	6.2
92173,02	5.5	6.0	6.3	5.9
CDA 1001	6.0	6.7	6.0	6.2
Kamadhenu	5.3	6.2	6.3	5.9
83 INC 19 G3	6.3	6.0	6.3	6.2
Netra	5.8	5.7	5.8	5.8
346/2	5.0	6.0	6.4	5.8
Stampede	6.0	6.2	6.1	6.1
92169,01	5.8	5.7	5.0	5.5
Swan (Pak)	6.0	5.0	5.3	5.4
Bundel 851	5.8	6.2	5.0	5.7
Croa 118	6.0	5.7	5.3	5.7
92176,03	5.0	6.0	6.0	5.7

PDLV65	6.2	6.2	6.2	6.2
Overall mean	5.73	5.96	5.86	5.86
SE mean	0.44	0.072	0.0823	0.198
St dev	0.502	0.687	0.529	0.572
Variance	0.254	0.473	0.672	0.466
F value between treatments	NS	NS	NS	NS

Leaf number per tiller

Table - 3 indicates the leaf number/tiller at different cut. There was no significant (<0.05) difference between the treatments on leaf number/tiller at different cut. The average number of leaf in each variety was found more or less equal i.e 5 at each cut. Average leaf number/tiller of three cut was in ranges between4.8 (346/2, 92169, 01 and 92176,03) to 5.3 (83 INC 19 G3).

Table - 3: Leaf number/tiller at different cut

Oat	**Leaf number/tiller**			
	1st cut	**2nd cut**	**3rd cut**	**Average**
NZ Saia	5.0	5.0	5.0	5.0
Awapuni	5.2	5.2	5.2	5.2
92173,02	4.8	5.0	5.0	4.9
CDA 1001	4.7	4.8	5.4	5.0
Kamadhenu	5.3	5.0	5.2	5.2
83 INC 19 G3	5.0	5.8	5.2	5.3
Netra	5.0	5.2	5.2	5.1
346/2	4.8	4.7	4.7	4.8
Stampede	4.8	4.7	5.5	5.0
92169,01	5.0	4.7	4.7	4.8
Swan (Pak)	5.0	5.0	4.6	4.9
Bundel 851	5.0	4.7	5.6	5.1
Croa 118	4.7	5.0	5.2	5.0
92176,03	5.0	4.8	4.7	4.8
PDLV65	5.0	5.0	5.0	5.0
Overall mean	4.95	4.97	5.08	5.00
SE mean	0.532	0.063	0.869	0.488
St dev	0.505	0.672	0.824	0.667
Variance	0.255	0.47	0.679	0.468
F value between treatments	NS	NS	NS	NS

Leaf area

Table - 4 indicates the leaf area at different cut. There was no significant (<0.05) difference between the treatments on leaf area at different cut. At first cut the highest leaf area(20.55 cm^2) was found in CDA 1001 and lowest in (13.73 cm^2) in 92176,03. At second cut the highest leaf area (22.19 cm^2) was found in Awapuni and the lowest (15.55 cm^2)in swan (Pak). At third cut the highest leaf area (17.01 cm^2)was observed in PDLV 65 and lowest (14.04 cm^2) in

NZ saia. The average leaf area of three cuts was found the highest (18.97 cm^2) in CDA 1001 and lowest(14.71 cm^2) in NZ saia.

Table - 4: Leaf area (cm^2) at different cut

Oat	Leaf area (cm^2)			
	1st cut	2nd cut	3rd cut	Average
NZ Saia	13.74	16.35	14.04	14.71
Awapuni	17.77	22.19	16.64	18.87
92173,02	13.85	18.31	14.86	15.67
CDA 1001	20.55	20.06	16.30	18.97
Kamadhenu	14.48	17.54	17.00	16.34
83 INC 19 G3	16.03	19.96	15.35	17.11
Netra	15.38	16.93	16.06	16.12
346/2	17.22	18.43	16.67	17.44
Stampede	18.00	16.64	16.10	16.91
92169,01	16.68	16.76	16.40	16.61
Swan (Pak)	16.37	15.55	15.11	15.68
Bundel 851	15.54	17.42	16.19	16.38
Croa 118	16.53	16.49	15.58	16.20
92176,03	13.73	16.38	14.58	14.89
PDLV65	18.67	17.79	17.01	17.82
Overall mean	16.30	17.79	15.86	16.65
SE mean	0.13	0.119	0.106	0.176
St dev	1.248	1.138	1.01	0.729
Variance	2.688	2.361	1.751	2.212
F value between treatments	NS	NS	NS	NS

Green matter and dry matter production

Table - 5 and 6 indicates green matter and dry matter production per ha up to three cut respectively. There was no significant (<0.05) difference between the treatments on GM production at 1st cut. The highest GM (10.65 t/ha) was obtained from stampede followed by PDLV65 (9.13 t/ha) and the least (6.18 t/ha) was obtained from 92176,03. The highest DM (2.03 t/ha) was obtained from stampede and lowest (1.07 t/ha) from NZ saia. It was found that significantly difference (<0.05) between the treatments on GM and DM production at 2nd cut. Significantly the highest GM (11.19 t/ha) was obtained from Awapuni followed by 83INC19G3 (8.92 t/ha) and the least (5.56 t/ha) was obtained from Croa, 118. Similar pattern was obtained in dry matter production. The highest DM (2.19 t/ha) was obtained from Awapuni and the least (1.08 t/ha) from Croa, 118. At 3rd cut significantly the highest (7.61t/ha) GM was obtained from Awapuni followed by Stampede (5.30 t/ha). In other varieties green matter production ranging from 4.10 to 4.69 t/ha was obtained. Significantly

the highest dry matter production (1.45 t/ha) was obtained from Awapuni and the least (0.78t/ha) was obtained from 346/2.

It was found that significantly difference (<0.05) on total GM and DM production of three cut. Significantly the highest GM (27.85 t/ha) was produced from Awapuni followed by Stampede (23.78 t/ha). The green matter production from 83INC19G3, CDA 1001 and PDLV65was obtained 21.92 t/ha, 21.76 t/ha and 21.15 t/ha respectively. The least GM (16.82 t/ha) was produced from 92176, 03. Significantly the highest DM (5.53 t/ha) was obtained from Awapunifollowed by stampede (4.41t/ha) and least (3.23 t/ha) was obtained from 92176, 03.

Table - 5: Green matter production (t/ha)

Oat	**Green matter production (t/ha)**			
	1st cut	**2nd cut**	**3rd cut**	**Total**
NZ Saia	6.68	5.82	4.52	17.02
Awapuni	9.05	11.19	7.61	27.85
92173,02	7.57	5.72	4.51	17.80
CDA 1001	8.54	8.75	4.47	21.76
Kamadhenu	8.37	6.74	4.40	19.51
83 INC 19 G3	8.73	8.92	4.27	21.92
Netra	7.70	6.24	4.23	18.17
346/2	8.17	5.83	4.10	18.10
Stampede	10.65	7.83	5.30	23.78
92169,01	7.20	5.73	4.16	17.10
Swan (Pak)	8.19	5.99	4.46	18.64
Bundel 851	7.97	6.62	4.22	18.81
Croa 118	8.19	5.56	4.69	18.44
92176,03	6.18	6.14	4.50	16.82
PDLV65	9.13	7.47	4.55	21.15
Overall mean	8.15	6.97	4.67	19.74
SE mean	0.47	0.271	0.159	0.524
St dev	4.41	2.572	1.509	5.633
Variance	19.52	6.615	2.278	28.411
F value between treatments	NS	*	*	*

Table - 6: Dry matter production (t/ha)

Oat	Dry matter production (t/ha)			
	1st cut	2nd cut	3rd cut	Total
NZ Saia	1.07	1.14	0.86	3.07
Awapuni	1.71	2.19	1.45	5.35
92173,02	1.43	1.12	0.86	3.41
CDA 1001	1.62	1.71	0.85	4.19
Kamadhenu	1.59	1.32	0.84	3.74
83 INC 19 G3	1.66	1.74	0.81	4.20
Netra	1.46	1.21	0.81	3.49
346/2	1.55	1.13	0.78	3.48
Stampede	2.03	1.38	1.00	4.41
92169,01	1.37	1.11	0.79	3.27
Swan (Pak)	1.55	1.16	0.85	3.56
Bundel 851	1.51	1.30	0.80	3.61
Croa 118	1.55	1.08	0.89	3.52
92176,03	1.17	1.20	0.86	3.23
PDLV65	1.73	1.43	0.86	4.02
Overall mean	1.53	1.35	0.88	3.77
SE mean	0.088	0.053	0.030	0.113
St dev	0.839	0.501	0.286	1.077
Variance	0.704	0.251	0.082	1.160
F value between treatments	NS	*	*	*

Discussion

Variation of plant height in different varieties of oat could be due to genetic makeup of the varieties. Zaman*et al* (2006) explained that plant height may differ in varieties due to environmental condition which in turn variation in hormonal balance and cell division rate. Kim and Seo (1988) observed that high yielding varieties of oats tended to gain more plant height than low yielding varieties which agreed with our study. The reasons behind our finding of more or less equal number of leaf per tiller may be due to cut at equal time and at equal height in different time. Ahamad*et al* (2008) explained that leaf area in different varieties at different locations may also be attributed to varying genetic make-up, soil and environmental adaptability. Hussain*et al* (1993) reported that fresh forage yield differ due to difference in leaves per tiller and plant height. Mufti *et al* (1996) tested ten promising cultivars of oats and found that plant height, number of tillers per plant per meter, number of leaves per tiller and leaf area directly affected the green fodder yield, which agreed with our findings. In our finding, though some variety had higher leaf area, the GM and DM production was found low, the reasons behind this may be due to thin steam. Amanullah*et al* (2004) stated that higher yields of fodder oat cultivars possibly attributed to their greater leaf area, responsible for more photosynthetic activities, having high capacity to store assimilative product. Pariyar*et al* (1999) found that under fertilizer the highest green matter production by 83 INC 19G3 (45.5 t/ha) in Rupandehi, but our study found 83 INC 19G3 was

3rd higher yielding variety at high hill. The cultivar Awapuni and kent were most suiTable - for lumle site as they produced a significantly higher amount of biomass (11.7t/ha and 8.9 t/ha) in 141 and 135 days (Paudel and Suwal, 1996). This finding supported our finding that Awapuni was the higher yielding variety at high hill, sown at mid of April.

CONCLUSION

Among fifteen oat varieties cultivated at high hills of Rasuwa district, significantly highest green matter (27.85 t/ha) and DM (5.35 t/ha) was obtained from Awapuni. The least green matter (16.82 t/ha) and DM (3.23 t/ha) was obtained from 92176, 03. From this study we can be concluded that Awapuni, Stampede, 83INC19G3, CDA 1001, and PDLV65 were the most promising oat varieties for higher green matter and dry matter production at high hill.

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EVALUATION OF APPROPRIATE FORAGE SPECIES IN THE SUMMER AND WINTER SEASON FOR SUPPLYING GREEN FORAGE TO LIVESTOCK

Buddhi Ram Acharya, Manoj Kumar Shah, Yamuna Kumar Shrestha and Keshab Prashad Dhungana
Regional Agricultural Research Station, Lumle, Kaski
E-mail: bracharya.lumle@gmail.com

ABSTRACT

Availability of green forage throughout the year for livestock production is a major constraint. Some of the main winter and summer forage species cultivar are Oat, Teosinte, Sorghum and Bajra etc. The agro-ecological conditions of western hill region are one of the most potential areas of livestock production, however, to support the sustainability of livestock production from western hills only limited forage and fodder works has been carried out. To foster the livestock of western hills, the present study was carried out to evaluate appropriate forage species in the summer and winter season for supplying green forage to livestock in the western hills of Nepal. Three sites Lumle, Syangja and Parbat district in the western hills were purposively selected and the evaluation trial was conducted since 2010 to 2012, by applying RCBD. Winter and summer forage species like different cultivar of Oat, Teosinte, Sorghum and Bajra were collected for winter and summer cultivation. The maximum biomass was obtained from cultivars Netra (50.49 ton/ha) followed by Kamdhenu (49.23 ton/ha) and Kent (48.99 ton/ha) in winter forage cultivation. However, it was statically non-significant (P>0.05) among treatment whereas significantly differed (P>0.05) among locations. In case of summer forages, Sorghum produced the highest green matter (65.4 ton/ha) followed by Bajra (61.5 ton/ha) and Teosinte (42.3 ton/ha). The experiment revealed that Netra and Kent oat varieties are best suited for winter season and Sorghum species are suiTable - for summer season cultivation in the western hills.

Key words: Forage, winter and summer season, livestock, Nepal

INTRODUCTION

Green forage availability and supply throughout the year has been always been a major constraint in most parts of the world. Several complex factors govern the availability and supply of green forage. This causes insufficient feed and nutrition and substantial underfeeding especially in dry winter period has been common. Quality feed and forage has become a crucial problem for livestock feed in the hills of Nepal. 70% of the total livestock units exist in the hills, where the feed situation is even poorer, with a deficit of 18.2 %, 37.6%, 56.2%, for total dry matter (DM), total digestible nutrients (TDN) and crud protein (CP) requirement for the ruminants (Rajbhandari and Pradhan, 1991). Consequently, this is reflected in poor livestock performance in the country as a whole. In addition, the increasing human and unproductive animal's pressure and the deterioration of grazing and forestland are also affecting the availability of forage (Yazman, 1990).

About Concentrate based feeding system could be options, but becomes expensive and would take much time to adopt by the most resource poor farmers. Therefore, to sustain the

livestock production developing options for year round forage production can be possible alternatives. However, there are only limited studies on highlighting guidance on year round forage production by identification of appropriate forage species, optimum combination, methods of production, sowing seasons, productivity, nutritional aspects of forage.

MATERIALS AND METHODS

Sites and farmers selection

A total of three sites in the western hills were purposively selected. First site was in Regional Agricultural Research Station, Lumle, Kaski; second in Walling, Syangja; and third in Devisthan and Maghaphat, area of Parbat district. A total of five farmers were selected in each site in Syangja and Parbat districts.

Collection of different forage species

Winter and summer forage species like oat of different cultivar, Teosinte, Sorghum and Bajra were collected mostly from Pasture and Forage Research Division, Khumaltar, Lalitpur and other available resource center**.**

Division of different forage cultivars according to season

Selected forage germplasm were divided into summer and winter season of cultivation so that it was easy to production of forage crops in different months of the season. Accordingly in the summer season Teosinte, Sorghum and Bajra were selected while different oat cultivars were selected for winter season.

Sowing of different forage cultivars in different sites

The winter forage species like oat cultivars (Kamadhenu, Netra, Kent) was sown in three locations comprising of farmers as a replication and variety as a treatment as per RCBD design similarly summer forage species like Teosinte, Sorghum and Bajra were sown in three locations comprising of farmers as a replication and species as a treatment as per RCBD design.

Experimental design

Evaluation of winter forage crops

- Treatments: 3 (Oat cultivars- Kamdhenu, Kent and Netra)
- Replications: 5 (farmers)
- Plot size: 10 sqm
- Seed rate 100 kg/ha
- Fertilizer 80:60:40 NPK kg/ha)
- FYM 10 ton/ha
- Locations: 3 (Syangja, Parbat and Lumle)
- Design: RCBD

Evaluation of summer forage crops

- Treatments: 3 (Bajra, Sorghum and Teosinte)
- Replications: 5 (farmers)
- Plot size: 10 sqm
- Seed rate 40 kg/ha
- Fertilizer 80:60:40 NPK kg/ha
- FYM 10 ton/ha
- Locations: 3 (Syangja, Parbat and Lumle)
- Design: RCBD

Sample collection and dry matter analysis

Samples were randomly collected in 1 square meter area. Information was collected by taking plant height, leaf length, number of tiller per hill, number of leaf per tiller, weight of 1 square meter green biomass and collected samples were subjected to nutrition lab for dry matter analysis.

Data analysis

Data and information collected during evaluation was entered into the MS excel and analyzed using GENSTAT and MINITAB statistical computer software.

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RESULTS AND DISCUSSION

Winter forage production

There was found statically non-significant different on biomass production within treatment (Table --1).The biomass of Netra (50.49 ton/ha) was found highest than Kamdhenu (49.23 ton/ha) and Kent (48.99 ton/ha). Likewise, parameters such as DM yield, Leaf length, No. of leaf/tiller, No. of tiller/hill, plant height, showed statically non-significant within treatment. Rajbhandari *et* al. (2011) reported similar result on oat cultivars Netra and Kamdhenu production. In farmers perception Netra variety of oat was found better than other winter forage. The green forage production of Netra was found better and this variety has multi cutting character and high yielder than other variety of oat.

Table -1: Productive performance of winter forage (oat cultivar) in different location

Variety	Plant height (cm)	Leaf length (cm)	No. of leaf/ tiller	No. of tiller /hill	Biomass (t/ha)	DM Yield (t/ha)
Kamdhenu	50.9	29.07	4.19	3.07	49.23	5.55
Netra	51.3	30.17	4.24	2.8	50.49	5.55
Kent	45.4	29.13	4.32	2.64	48.99	5.61
Average	49.9	29.46	4.25	2.84	49.56	5.57
F-test treatment	NS	NS	NS	NS	NS	NS

Summer forage production

The highest biomass (65.4 ton/ha) was found from Sorghum followed by Bajra (61.5 ton/ha) and Teosinte (42.3 ton/ha) among different summer forages but statically non-significant within treatment. Similarly, a non significant different were observed on plant height, leaf length and leaf breadth but was significant different on number of tillers per hill within a treatment (Table --2). In the farmers perception sorghum was found better species for summer forage production.

Table - 2: Productive performances of summer forages

Summer forage	Plant height (cm)	Leaf length (cm)	leaf breath (cm)	No. of leaf/ tiller	No. of tiller /hill	Biomass (t/ha)	DM Yield (t/ha)
Bajra	108.8	55.1	1.64	6.6	4.93	61.5	
Sorghum	114.7	53.8	2.27	6.04	3.19	65.4	
Teosinte	91.5	53.5	2.45	5.13	3.33	42.3	
Average	105	54.2	2.12	5.92	3.82	56.4	
F-test Between treatment LSD(0.05)	NS	NS	NS	** 0.877	** 18.66	NS	NS

CONCLUSION

In scarcity period of green forage winter and dry summer season, farmers facing problem for green forage all that time all the farmers used mostly dry crop by product, due to that productivity of animal going to decrease. To increase the productivity of animal, the year round forage production calendar was developed. In the winter season different oat cultivar was cultivated and evaluated among them Netra and Kent was found better for production. In dry summer season different species of summer forage was cultivated and evaluated among them Sorghum was found better for production. So, we are recommended for winter season Netra and Kent variety of oat whereas dry summer season sorghum was suiTable - for hill area of western region.

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INTEGRATION OF FORAGES IN BANANA ALLEY CROPPING SYSTEM

Dina Nath Tiwari[1] and Kishor Kumar Shrestha[2]
[1]Regional Agricultural Research Station, Khajura, Banke,
[2]Pasture and Fodder Division, Khumaltar, Lalitpur

ABSTRACT

Alley farming is an agro forestry system, in which food and forage crops are grown in the alleys between hedgerows of trees or shrubs. Banana is an emerging cash crop cultivated as a sole crop and similarly Berseem is one of the major forage crop cultivated in the Terai regions of Nepal. An experiment consisting Berseem, saftal, oat and common vetch forage crops was implemented on a designed Banana and forage crop Alley cultivation model (DV3.5 x 1.5 M) during 2007 to 2009 crop season at RARS Nepalgunj for selection of suiTable - forage crops for Alley cultivation with Banana in the aspect to accesses green fodder on the residual area of banana through integrated use of resources. Dwarf variety of Banana (William hybrid) was planted in 3.5 meter line to line and 1.5 meter plant to-plant distance. The forage crops were sown between the lines of banana plants. All tested forage crops showed its optimum vegetative growth and fodder yield. The highest forage yield was obtained from Berseem and saftal. The average green fodder yield 59 ton/ha each was obtained from Berseem and Saftal compared to the 43 ton and 24 ton /ha from Oat and common vetch, respectively. Being Leguminous and high productive the Berseem/Saftal was recommended as suitable forage with Banana Alley cropping. Average 10.5 kg / plant fruiting yield was produced from the William hybrid. No any negative effect on banana was observed with alley cultivation of the forage crops.

Keywords: Banana alley cropping, leguminous forages and green fodder

INTRODUCTION

Increasing human as well as livestock, population is placing heavy demands on land. Sole cultivation of forage crops has not yet been practised due to major priority to food crops on small land size farm whereas a lot of possibility for food and fodder crop production has been realized through relay and alley cultivation practices on the small land size farm. Different technologies have been recommended and applied under different agro forestry systems for intensive forage cultivation. Alley cropping is an agro forestry practice for efficient land use management system to obtain food, fodder, wood and other benefits established on arable lands. Banana alley cropping is one agro forestry model practised in which bananas are planted or established on rows and annual forage crops are cultivated in between the rows of bananas or in the alleys on the same piece of arable land at same time. They are managed to be complementary rather than competitive to maximize the product per unit of land over time. Though it requires more labour inputs it is good where land is scarce.

The banana cultivation as a cash crop is very popular in mid and far -western terai. Similarly the complex farming with crops and small size animal husbandry (5-10 goats or either 1-2 cattle/buffalos) are common in the socio economic of small land size farm in mid

and far -western terai. The year round fodder supply to their livestock using proper technology is possible from the limited cultivated land. Further the Oat, Berseem and winter vetch forage crop combination is very adopted for long time fodder supply (December to April) during dry winter season in the same place. Banana alley cropping practice was studied at RARS, Nepalgung for probable package of year round fodder supply through forage cultivation allied with banana on small size livestock -crop farming system.

MATERIALS AND METHODS

The experiment consisting of 4 winter forage crops was implemented in RCBD design allayed with banana under 4 replications at RARS Nepalgunj. The Banana genotype William hybrid was planted during post monsoon period (September 3rd week) spacing plant to plant 2 meters and row to row 3.5 meters. The forage crops Berseem, saftal, vetch and oat were sown in November 1st week. The chemical fertilizers @ 100 g DAP, 50 g MOP and 150 g urea / plant was applied 3 times a year in ring application. And the yield was taken during November to June in banana crop. The fertilizers were applied @ 60:30:30 kg NPK kg/ha for forage crops. Irrigation and all other cultivation practices were provided according to recommendation for both crops. Parameters like plant population, plant growth and green fodder yield were recorded for both banana and forage crops.

RESULT AND DISCUSSION

Plant height

Highly significant ($P<0.01$) different was found on plant height among tested winter forage crops as sown in Table --1. The maximum plant height was obtained from Saftal (160 cm) followed by Berseem (145 cm), vetch (104 cm) and oat (99cm).

Green matter production

The first cutting of green fodder was taken in 60 DAS and subsequent cuttings were done in 30 days intervals. Total 2 cut was taken from each winter vetch and Oat whereas 3 cuttings were taken from Berseem and saftal crops each. The production performance of introduced forage species was highly significantly ($P<0.01$) different during study periods. The production performance of alley cultivated forge crops was seen more or less similar to sole intensive forage cultivation (Anon, 2007/08 and Anon, 2003/04)). Berseem produced the maximum green matter (59.3 ton/ha) in alley cultivation followed by saftal (58.8 ton/ha) and oat (42.9 ton/ha). The least production was found from vetch (24.3 ton/ha) Table --1. More fodder production was obtained in second year compared to first year. The differences of yield, plant population and plant height between Berseem, saftal, winter vetch and oat was found due to their different seed rate, specific characteristic and yield potential. The green fodder yield of all tested forage crops alleyed with banana was seen more or less similar to the yield of sole crop cultivation compared to secondary data observed from different trails conducted at RARS Nepalgung (Anon, 1996/97). The causes of same forage yield in the alley experiment compared to sole cultivation was mentioned due to no shade effect of banana crops on forage being dwarf type variety (William hybrid) plus initial

growth maintaining stage in banana. The proper combination in other different cultivation practices in forage and banana was also realized as positive factor in the yield increasing of both crops such as same irrigation and manuring frequencies, tolerant to high water intensity and easy to maintain the crops by frequent cuttings by the forage crop.

Table - 1: Production performance of different forage crops in banana alley cropping (2007-2009)

Forage crop	Plant height (cm)			Green fodder yield (ton/ha)		Av	Plant population (num/m²)		
	Y-1	Y-2	Av	Y-1	Y-2		y-1	Y-2	Av
Berseem	140	150	145	50.5	68	59.3	383	285	334.0
Saftal	153	167	160	47.5	70	58.8	53	202	127.5
vetch	100	109	104.5	21.5	27	24.3	-	71	71
Oat	81	117	99.0	35.7	50	42.9	125	117	121
G Mean	118.2	136.1		38.7	53.9		-	169	
CV %	6.3	9.0		12.4	10.1		5.8	8.0	
F test	**	**		**	**		**	**	
LSD	11.9	17.2		7.6	8.5		15.7	19.4	

CONCLUSION

The green fodder yield of all tested winter forage crops allayed with banana meet its specific average yield of sole crop cultivation. Berseem as well as Saftal produced comparatively higher green fodder yield and long time fodder supply (up to 3 cuttings). Due to forage legume crops, banana also benefitted for the maintenance of soil organic nitrogen.

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INITIAL EVALUATION OF TROPICAL AND TEMPERATE FORAGE SPECIES

Kishor Kumar Shrestha, Sunita Sanjyal and Rishi Shrestha
Pasture and Fodder Division, Khumaltar, Lalitpur

ABSTRACT

Fourteen different tropical and temperate perennial forage species were evaluated at Khumaltar for their production performance during 2009 to 2010. The growth and production performance on plant height, tillers, green matter and dry matter yields of introduced forage species were taken separately to find out the suiTable - forage species for adaptability and advanced improvement. There was found highly significant (P<0.001) different on plant height, tillers, green matter and dry matter production among tropical forage species. Sumba Setaria attained the maximum plant height (155.34 cm) followed by Paspalum atratum (112.67 cm) and Molasses (65.0 cm). The maximum green matter production was obtained from Sumba Setaria (99.3 Mt/ha) followed by Paspalum atrotum (51.7 Mt/ha) and Erect Forage peanut (46.7 Mt/ha). Similarly Sumba Setaria produced the maximum dry matter (25.3 Mt/ha) followed by Paspalum atratum (13.0 Mt/ha) and erect Forage peanut (10.7 Mt/ha). The highest numbers of tillers 60, 49 and 31 were obtained from Sumba Setaria, Paspalum atratum and Mulato, respectively. Among temperate forage species there was found statistically significant different on tillers (P<0.001), green matter (P<0.05) and dry matter (P<0.05) production and a non significant different was found on plant height. The maximum green matter (GM) production was obtained from Tall fescue (29.0 Mt/ha) followed by Red clover (28.5 Mt/ha) and Lucerne (26.5 Mt/ha) producing with dry matter (DM) of 8.5 Mt/ha. More numbers of tillers were found from rye grass (46), followed by Phalaris (44) and tall fescue (38).

Keywords: Tropical, temperate forages, green matter and dry matter production

NTRODUCTION

Shortage of fodder is the major constraints for livestock production in all agro ecological zones in Nepal. Pariyar (1993) reported that the feed deficit percentage in Terai, Mid hills and High Mountains is 17.54%, 50.20% and 26.50%, respectively. The major supply of feed for ruminants is from forest and crop residues. The availability of green fodder is abundant for 3-4 months only in monsoon season and rest of the month's animals are under- fed. In the country as a whole, crop byproducts and crop residues contribute 47% of the total available TDN while forest, shrub lands, non cultivated inclusions and grass land contribute 3 %, 11%, 7% and 5% of the total available TDN, respectively (Pariyar, 1998). It is estimated that animal production can be increased by 2-3 times by improving feed resources. The Agriculture Perspective Plan (APP, 1995) has also given highest priority in the improvement of forages and estimated around 238,600 MT of additional dry matter to be produced annually. Forages are not only cheap source of livestock feeding but also play important roles in meeting the requirement of various nutrients (protein, energy, minerals, vitamins and fiber).

Feed resources near by the villages are under constant heavy pressure and the pressure is now being transferred to the nearby forest. If this pressure continues, there will be further

degradation in the already degraded environmental condition of the hills. Livestock are generally underfed by about one third (Pariyar, 1993) and this is directly associated with the low productivity of the animals. In the hills, forest and marginal lands and road sides are the main grazing sites available and many areas are grazed all the year round without any rest period. Due to continuous and heavy grazing pressure, regeneration of palaTable - species is very much suppressed. Under these circumstances grazing lands have deteriorated severely and much of them have been invaded by noxious weeds like *Eupatorium* spp.

Various forage species have been introduced at different time periods and tested at different research farms and farmers' field's conditions in Nepal. There is an urgent need to evaluate the production potential, suiTable - methods of establishment and management of different introduced forage and pasture species for disseminating technology package of practices of forage cultivation under farmers' field's conditions. An initial evaluation of some tropical and temperate forage pasture species has being done at Khumaltar since 2008.

MATERIALS AND METHOD

Total fourteen tropical and temperate forage species and cultivars were studied in this experiment and were conducted in a RCB design with 3 replications. The trial was shown on October 3rd week in 2008. The planting materials were received from CLDP, DLS and PFR, New Zealand. The rooted slips and seeds were used as availability of planting materials. Sowing was done in line keeping 40 cm apart maintaining. The major observations were taken on establishment, plant height, tillers, fodder production and fodder supply period from the experiment. The different forages used were as follows:

Tropical forage	**Temperate forage**
Sumba Setaria (*Setaria sphacelata*)	Rye grass cv Raunui (*Lolium perenne*)
Peanut Spread type (*Arachis pintoi*)	Cocksfoot Rasuwa (*Dactylis glomerata*)
Paspalum (*Paspalum atatum*)	Red clover cv Hamua (*Trifolium pratanse*)
Comfrey	Lucerne cv Wairau (M*edicago sativa*)
Mulato (*Brachiaria spp*.)	Tall fescue cv Demeter (*Fescue*
Peanut erect type (*Arachis pintoi*)	Phalaris cv Maru (*Phalaris aquatic*a)
Molasses (Melinis minutiflora)	
Desmodium silverleaf (*Desmodium uncinatum)*	

RESULT AND DISCUSSION

Plant height

There was found highly significant different on plant height among tropical forage species. The highest plant height (155.3 cm) was found from Sumba Setaria followed by *Paspalum atratum* (112.67 cm) and Molasses (65 cm). The least plant height (36.67 cm) was found from Comfrey Table --1. In case of temperate forage species a non significant different was observed on growth pattern. Red clover attained maximum plant height (61.5 cm) followed by Phalaris (55.5 cm) and Tall fescue (49.0 cm) Table --2. On average tropical forage obtained maximum plant height compare to tropical forages.

Tillers/Plant

The maximum tillers per plant were obtained from Sumba Setaria (60) which was highly significant different among tested tropical forage species. The second highest more tillers was found from *Paspalum atratum* (49) and followed by Mulato (31) Table --1. In temperate forage species Rye grass, Phalaris and Tall fescue were found first, second and third highest producing more numbers of tillers per plant 46, 44 and 38, respectively Table --2. More tillers were found in temperate forages than tropical forages.

Green matter production

A highly significant different on green matter (GM) production was found among tropical forage pasture species. The maximum GM (99.3 Mt/ha) was obtained from Sumba Setaria followed by *Paspalum atratum* (51.7 Mt/ha), Peanut erect (46.7 Mt/ha) and Peanut spread (39.3 Mt/ha) among tropical forage species Table --1. Similarly, a significant different ($P<0.05$) in case of temperate forages was found on GM production. The maximum GM was obtained from Tall fescue (29 Mt/ha) followed by red clover (28.7 Mt/ha) and Lucerne (26.5 Mt/ha) Table - 1. The least GM in tropical forages was obtained from comfrey (7.3 Mt/ha) while it was obtained from Phalaris (8 Mt/ha) in case of temperate forage species.

Table - 1: Production performance of tropical forage species

Forage species	**Plant Height (cm)**	**Tillers/clump (Nos)**	**Green matter (ton/ha)**	**Dry matter (ton/ha)**
Sumba Setaria	155.34	60	99.3	25.3
Peanut "Spread"	64	14	39.3	9.7
Paspalum atratum	112.67	49	51.7	13
Comfrey	36.67	6	7.3	1.7
Mulato	44.67	31	17	4.7
Peanut "erect"	57.34	25	46.7	10.7
Molasses	65	11	15.7	3.7
Desmodium silverleaf	73	7	14	3.5
Average	**71.09**	**25.4**	**35.1**	**7.0**
F test Between treatment	***	***	***	***
LSD at 5%	30.097	12.970	32.311	8.134

Dry matter production

Dry matter (DM) production is the reflection of green matter production. Similar pattern of DM production was obtained as that of GM production. A highly significant different on dry matter (DM) production was found among tropical forage pasture species. The yield is found influenced by the height of plant and more number of tillers. Pariyar (2007) reported that the taller the plant the more dry matter yield. The maximum DM (25.3 Mt/ha) was obtained from Sumba Setaria followed by *Paspalum atratum* (13 Mt/ha) and forage Peanut erect (10.7 Mt/ha) Table --1. In case of temperate forages the maximum DM was obtained

from Lucerne (9.0 Mt/ha) followed by Rye grass, red clover and Tall fescue producing (8.7 Mt/ha) Table - 2.

Table - 2: Production performance of temperate forage species

Forage species	Pl ant Height (cm)	Tillers/clump (Nos)	Green matter (ton/ha)	Dry matter (ton/ha)
Rye grass	45.5	46	24.5	8.7
Cocksfoot	48	13	17.5	5.7
Red clover	61.5	10	28.5	8.7
Lucerne	53	27	26.5	9.0
Tall fescue	49	38	29	8.7
Phalaris	55.5	44	8	2.7
Average	**52.08**	**29.7**	**22.3**	**6.9**
F test Between treatment LSD at 5%	NS	*** 9.876	* 12.193	* 3.971

CONCLUSION

Sumba Setaria and *Paspalum atratum* was found very much promising for higher fodder and longer green availability while in case of temperate forages tall fescue, red clover, and Lucerne were performed selective at Khumaltar.

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YIELD RESPONSE OF DIFFERENT OAT CULTIVARS

Sunita Sanjyal, Kishor Kumar Shrestha and Chandra Kanta Mishra
Pasture and Fodder Division, Khumaltar, Lalitpur
Email: susaan004@yahoo.com

ABSTRACT

Yield performance of oat cultivars sown on various dates was examined. Altogether, five cultivars of oat namely, Kamadhenu, Netra, Awapuni, Stamped and NZ9217603 were sown in five different dates at nine days interval. The experiment was set in RCBD and replicated thrice. The yield data on green matter, seed and straw were taken for each cultivar at each sowing separately, and analyzed using statistical tool proposed by Harvey 1990. In case of Netra highest green matter was obtained from last date of sowing, however fourth date was best for seed yield and third date for straw yield. Similar, trend followed for Kamadhenu cultivar. For Awapuni straw yield was observed to be best in first date of sowing, green matter and seed yield remaining same as Netra. In case of Stamped and NZ9217603 cultivars, the best date of sowing was 21st of November, whereas seed production was found to be best on second date of sowing. Maximum straw yield was obtained from fourth date of sowing in Stamped and second date of sowing for NZ9217603.

Keywords: Oat, sowing dates, maturity, straw, seed

INTRODUCTION

Oat ranks sixth in terms of world production of cereals. It is one of the most important fodder crops in Nepal for its winter availability. It supplements a good combination of energy, protein, vitamin B_1, phosphorous, iron and other minerals. Oats are grown for grain, forage, fodder, straw, bedding, hay, haylage, silage and chaff. Oats are well adapted to a wide range of soil types and on acid soils can perform better than other small-grain cereals. Winter fodder deficit has been aided by the cultivation of oat crop in Nepal. Oats are mostly grown in cool moist climates and they can be sensitive to hot, dry weather between head emergence and maturity. This crop has been very popular in Nepal due to its ability to produce good-quality fodder when most pastures are dormant. The use of improved varieties and better management practices are the key factors to increasing the level of production in oat crop. It is generally sown within the first week of November. However, the best productivity time of different oat cultivars for grains and seeds is yet to be known. Thus the research was conducted to identify the most appropriate time for sowing for biomass and seed yield.

MATERIALS AND METHODS

The present experiments were performed during 2011-2012, at Research Farm of Pasture and Fodder Division Khumaltar. It consisted of five different sowing dates with five treatments namely Netra, Kamadhenu, Awapuni, Stamped, and NZ9217603. The first sowing of five oat cultivars began from 2068/6/30 followed at an interval of nine days for each sowings. The experiment was laid out on Completely Randomized Block Design with three replications.

The plot size used for the experiment was $4m^2$ (2x2). Seed was sown at the rate of 100 kg per hectare. Fertilizer was used at the rate of 80:60:40 NPK. Farm yard manure (FYM) was applied @ 5t/ha. Half of the plot was taken for green forage biomass and the remaining was left for seed production. First cutting for biomass was taken after 60 days of sowing and second, third and fourth cutting was taken at 30 days interval for each treatment. Information was recorded on various parameters like leaf length, leaf breadth, and number of leaf/tiller, number of tiller/plant, GM production, DM production and straw production. Four cuttings were taken for each cultivar for green biomass. The data was analyzed using statistical package Harvey (1990) and the mean comparison was done by using the program Duncan Multiple Range and Multiple F-Tests (1995).

RESULTS AND DISCUSSION

Effect of sowing dates on biomass, seed and straw yield of Netra variety

The effect of different sowing date of Netra oat showed a significant effect among the date of sowing. Among all date of sowing, last date (21st Nov) of sowing was found to be the best for maximum green matter production for Netra cultivar. This result is very closely similar to the findings of Tiwari (2000). Thus, Netra oat sown during 21st Nov showed the highest green matter of 46.20Mt/ha which was then followed by the oat sown on 4th November with 35.03Mt/ha. This was subsequently followed by the ones sown on 13th November (31.63Mt/ha) and 26th November (27.33Mt/ha) and the least was observed on from the first date of sowing on 6th October. In case of seed yield, maximum yield was observed during the fourth date of sowing, i.e.13th November with 1.55 Mt/ha. This was then subsequently followed by 4th November, 16th November and 26th November with 1.2Mt/ha, 1.16Mt/ha and 0.774Mt/ha, respectively. And the least seed yield was observed on the last date i.e. (21st November) with 0.53 Mt/ha. Straw Yield also had a significant effect on different sowing date. The highest straw yield was observed on 4th November with 20 Mt/ha and then followed by the one sown during 13th November with 17.3Mt/ha, and the least was observed from 5th sowing with 12.1Mt/ha. The sowing date had a considerable effect on the biomass production among all cultivars (Table-1).

Table - 1: Production performance of oat under different sowing dates

Date of Sowing	Performance of Netra oat		
	Green Matter (Mt/Ha)	Seed (Mt/Ha)	Straw Yield (Mt/Ha)
16th October	22.41 d	1.16 bc	15.33 bc
26th October	27.33 cd	0.79 ac	12.58c
4th November	35.03 ab	1.2ab	20.0 a
13th November	31.63 bc	1.5a	17.3 ab
21st November	46.2 a	0.5ac	12.1 d
P- value	0.011	0.026	0.0064
CV	19.59	17.62	18.32

Effect of sowing dates on biomass, seed and straw yield of Kamadhenu

Green Matter showed a non significant different among the five date of sowing. However, the maximum green matter production was observed in fifth date of sowing (21st November) with 43.6Mt/ha. This was then consequently followed by fourth, second and third date of sowing with 34.06 Mt/ha, 33.43Mt/ha and 32.13Mt/ha. And the least was observed from first date of sowing with 24.53Mt/ha. Seed yield also had no significant difference among various date of sowing. The maximum seed yield was obtained from fourth date of sowing with 1.13Mt/ha and the least was observed from last date of sowing. Fourth date of sowing produced 1.66Mt/ha while second and third date of sowing were at par with last date of sowing.

Similarly, in the case of straw yield, it showed a significant difference among the date of sowing with maximum straw yield recorded from third date of sowing with 26.7Mt/ha followed by first date of sowing with 23.56Mt/ha. The lowest straw yield was observed from last date of sowing with 11.93Mt/ha and the treatments 2 and 4 were at par with each other with 16Mt/ha straw yield (Table -2).

Table - 2: Performance of oat, Kamadhenu under different sowing dates

Sowing date	**Performance of Kamadhenu oat (Mt/ha)**		
	Green Matter	**Seed**	**Straw Yield**
16th October	24.53 d	2.1a	23.56 ab
26th October	33.43 bc	1.1 c	16.59 bc
4th November	32.13 cd	1.19 ab	26.7 a
13th November	34.06 ab	1.5 b	16.66 bc
21st November	43.6 a	1.13 d	11.93 c
P- value	0.085	0.08	0.033
CV	20.96	28.84	26.88

Effect of sowing dates on biomass, seed and straw yield of Awapuni variety

It can be clearly seen from the Table -, that the cultivar Awapuni is no significant among the date of sowing in terms of biomass seed yield and straw yield. Biomass yield was found to be non significant among the date of sowing. The maximum green matter yield was obtained from last date of sowing with 40.18Mt/ha followed by fourth date of sowing of 29.70Mt/ha and the least was obtained from first date of sowing with 20.1Mt/ha. Treatment 2 and 3 were at par with each other.

In case of seed yield, the highest production was obtained from Awapuni sown on first date of sowing with 2.89Mt/ha. This was then followed by second date of sowing with 1.24 Mt /ha, third dates of sowing 1.06Mt/ha and the least was obtained from the oat sown during last date of sowing with 0.59Mt/ha.

Straw is equally important from the perspective of livestock feeding in Nepal. A major part of winter feeding component is based on straw by mixing with green grass. Among the treatments, maximum straw yield was observed in fourth date of sowing for Awapuni

(27.83Mt/ha) followed by third date of sowing with 25.5Mt/ha, second date of sowing with 23.33Mt/ha and first date of sowing of 20.08Mt/ha and the least yield was obtained for the last date of sowing with 17.2Mt/ha (Table-3).

Table - 3: Performance of oat, Awapuni under different sowing dates

Sowing date	Performance of Awapuni oat (Mt/ha)		
	Green Matter	Seed	Straw Yield
16th October	20.1^{e}	2.89 ^{a}	20.08 ^{cd}
26th October	27.73 ^{bc}	1.2 ^{b}	23.33 ^{bc}
4th November	26.0 ^{cd}	1.08 ^{c}	25.5 ^{ab}
13th November	29.7 ^{ab}	0.94 ^{d}	27.83 ^{a}
21st November	40.18 ^{a}	0.59 ^{e}	17.2 ^{d}
P- value	0.09	0.32	0.11
CV	26.75	12.7	20.55

Effect of sowing dates on biomass, seed and straw yield of Stamped variety

Green matter yield was highly significant among the date of sowing however seed yield and straw yield showed no significant differences. The green matter production was found to be highly significant among the treatments whereas, seed yield and straw yield was found to be non significant with the treatments. The maximum green matter yield was obtained from last date of sowing with 44.67Mt/ha followed by third, second and fourth date of sowing with 33.51Mt/ha, 30.97Mt/ha,29.99 Mt/ha and the least was produced from first date of sowing with 22.1Mt/ha. Similarly, seed yield is non- significant among the treatments. Maximum seed yield was obtained from second date of sowing (1.54Mt/ha). Third and fourth date of sowing was par with each other. And the last date of sowing produced the least with 0.5Mt/ha. Likewise, straw yield was no significant with different date of sowing, however the highest straw yield was obtained from fourth date of sowing with 32.66Mt/ha. And the least was obtained from fifth date of sowing with 17.72Mt/ha Table-4).

Table - 4: Performance of oat, Stamped under different sowing dates

Date of Sowing	Performance of Stamped oat (Mt/ha)		
	Green Matter	Seed	Straw Yield
16th October	22.1 ^{e}	1.02 ^{cd}	20.85 ^{d}
26th October	30.97 ^{c}	1.54 ^{a}	30.3 ^{b}
4th November	33.51 ^{b}	1.22 ^{bc}	24.46 ^{c}
13th November	29.99 ^{d}	1.2 ^{ab}	32.66 ^{a}
21st November	44.67 ^{a}	0.5^{d}	17.72 ^{e}
P - value	0.008	0.68	0.57
CV	22.39	17.31	24.92

Effect of sowing dates on biomass, seed and straw yield of NZ9217603 variety

The green matter production was found to be highly significant among the treatments whereas, seed yield and straw yield was found to be non significant with the treatments. The

maximum green matter yield was obtained from last date of sowing with 41.7Mt/ha followed by fourth, third and second date of sowing with 32.58Mt/ha, 30.97Mt/ha,29.05 Mt/ha and 27.07Mt/ha the least was produced from first date of sowing with 15.42Mt/ha.

In case of seed yield, maximum yield was obtained from second date of sowing (1.54Mt/ha). Fourth date of sowing was at par with third date of sowing with 1.3 Mt/ha. And the least was observed from last date of sowing with 0.68Mt/ha. Similarly, maximum straw yield was obtained from second date of sowing (26.5Mt) followed by third date of sowing with 20.33Mt/ha. And the least straw yield was obtained from first and fourth date of sowing with (17.7Mt/ha) and 17.33Mt/ha, respectively (Table-5).

Table - 5: Performance of oat, NZ9217603 under different sowing dates

Date of sowing	Performance of NZ9217603 oat		
	Green Matter	Seed Yield	Straw Yield
16th October	15.42 d	0.9 ac	17.7cd
26th October	27.07 bc	1.54 a	26.5a
4th November	29.05 bc	1.30 ab	20.33 ab
13th November	32.58 ab	1.37 ab	17.33 c
21st November	41.7a	0.6 d	18.38 c
P- value	0.008	0.06	0.57
CV	22.39	30	37

CONCLUSION

Thus we can conclude that the biomass and seed production are highly sensitive to the date of sowing. In all the five tested cultivars of oat at Khumaltar, the best date of sowing for green biomass is found to be the last week of November. And in case of seed production, last week of October is found to be the best date of sowing. However, detailed and multi location research is recommended for this kind of study.

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FODDER AND PASTURE DEVELOPMENT IN NEPAL: PRESENT STATUS AND FUTURE PROSPECTS

Devendra Prasad Yadav and Shankar Pandey
National Pasture and Animal Feed Development Centre, Harihar Bhawan, Lalitpur
Email:drspvet@gmail.com

ABSTRACT

Livestock is an integral component of Nepalese agriculture system contributing about 26% to the Agricultural GDP and 15% to National GDP. In Nepal, there are about 78% farmers are small-holders and marginal. 50% of the total grasslands are found in the high mountains, 29% in the high hills, 16.7% in the mid-hills, and about 4% in the Siwaliks and Terai. It is estimated that about one-third of the Nepalese livestock are underfed. The feed deficit is severe in hills (-56%) followed by the Terai (-42 %). The mountain region is at surplus (+26%). Rangelands provide 34 percent of the total feed requirements for livestock in the country. The economics of milk production is heavily dependent on the quantity of nutritious forage fed to milch animals; however, the overall annual feed deficit in the country is estimated at 34.7 percent on TDN basis. On the other hand, there is forage seed deficit of 28.42 % against national demand in which maximum deficit of forage seed is in eastern region (48.22%) followed by far western region (42.30%). Though diverse geography, agro-climate, biodiversity, landscapes and transhumant pastoralism are beauty of Nepalese mountain ecosystem, there are challenges to manage, conserve and utilize communal rangelands. This paper discusses the prime strategies to be taken into consideration for forage production, forage improvement, forage-based development research and rangeland management.

Keywords: TDN, DM, Rangeland, Pastoralism

PRESENT STATUS

Nepalese economy is agriculture dependent where 67% population is engaged in agriculture. Actually, crops and livestock are important component of Nepalese farming system and are inter-connected to each other. Livestock contributes about 31% to the agricultural GDP of the country among which the largest amount is derived from the hills (53%) followed by terai (38%) and the least from the mountains (9%) (APP, 1995). Milk and milk products are a major source of animal protein in the Nepalese diet, and livestock and livestock products are an important source of household cash income (about 20% of total income) especially in the hills and mountains (Nepal Rastra Bank, 1988).

Livestock serves as major means in the livelihood of Nepalese farmers since traditional period till date. Traditionally livestock were reared on agricultural by-products such as rice straw and maize stover and grazing on community pastureland. Forage availability is much inter-related with the productivity of animal. With subsequent introduction of high producing animals and technology, their corresponding requirement of feeds and fodders

has also been changed. It is reported that about 65% of the cost of production is being invested in animal feeds.

The total DM availability in the year 1995/96 is 15.2 Million ton, but the requirement was 20.9 Million ton which is 24.5 % deficit and it can be forecasted that the deficit will certainly increase to 29.7% in the year 2014/15 according to the high DM requirement which is 25.6 Million ton (APP, 1995). The productivity and profitability of animal is directly related with its production potentials. The average production of animals in terms of milk, meat, power, wool and other products are very low in Nepal. Low animal output is mainly attributed by the shortage of feeds. It is estimated that the feed deficit is up to 40 percent (Pande, 1994).

Livestock production supported through the pasture and rangeland area is providing the major support for livelihood in high-hills and mountain regions. It is evident that livestock sector contributes almost half of the total agriculture income i.e. 47.3% in the mountain livelihood whereas contribution of livestock sector is comparatively less in other eco-zones.

LAND USE STATISTICS

Fig:-s in Table - 1 show that among the three eco-zones, mountain has the highest share with 79 % of the total grassland (1.08 million ha), followed by hills 17 % (0.545 million ha) and *Terai* 4 % (0.074 million ha). From the land utilization pattern, the non-cultivated agricultural land, Pasture land and Shrub land comprise altogether 4356000 ha of land potential for grass cultivation which is 29.6 % of total land of the country. By physiographic regions, about 50% of the total grasslands are found in the high mountains, 29% in the high hills, 16.7% in the mid-hills, and about 4% in the *Siwaliks* and *Terai*. Likewise in terms of development regions, almost 50% of the rangelands are in the mid-western region and only about one-fourth is found in the western region.

Table - 1: Distribution of land area (thousand ha)

Physical condition	Agriculture		Pasture	Forest	Other	Total	Percentage
	Cultivated	Non-cultivated					
Himalayas	77	1.7	884.4	221.5	2233.9	3349.2	22.75
Mountain	2448	146.9	509.9	1813.1	244.7	2959.4	20.06
Hills	12223	665.5	292.7	2202.4	60.7	4443.6	30.12
Siwalik	258.9	55.2	20.8	1476.6	74.3	1885.8	12.79
Terai	12342	117.5	49.7	512.9	116	2110.4	14.31
Total	2968	986.8	1757.5	6306.5	2729.6	14748.4	100
Percentage	20.1	6.7	11.9	42.81	18.5	100	

(Source: Shrestha, 2005)

LIVESTOCK IN RURAL ECONOMY

Livestock is a major source of livelihood security for the poor in most of the developing countries. Apart from being an important source of human nutrition, livestock is also a source of crop nutrition, power for agricultural tillage and rural transportation and a

valuable asset, which can be easily encased during emergency monetary need. Livestock has a direct influence on agricultural production. A wide range of products generated from livestock enable farmers to diversify their sources of income and absorb risk. In arid and semi-arid regions, livestock is the only source of livelihood, particularly when agriculture fails to withstand the drought.

In Nepal where about 78% farmers are small and marginal holders, livestock is the main source of livelihood for a majority of the rural population. The contribution of livestock to the National GDP is about 15% and 26% to agricultural GDP. Among different products, milk is the major output contributing to the GDP as well as to food security. In fact, the contribution of milk to GDP (5.86%) is more than the contribution of rice (5.77%). The demand for milk will further increase by 80% by the year 2022. Demand for meat is also likely to increase by several folds.

Among four important species of livestock, goat represents 41.3% of the population followed by cattle (32.5%), buffalo (22.5%) and sheep (3.7%). While cattle and buffaloes are maintained for milk and animal power, sheep and goat are maintained mainly for meat, with milk and wool as secondary sources of income. Cattle and buffaloes, which are considered as milch animals, are large in size, partly stall fed and require substantial quantity of feed and fodder for economic management. However, in case of sheep and goats, most of the population is maintained exclusively on free grazing, although supplementary feeding can significantly benefit their growth, production and reproduction.

Table - 2: Livestock Population and Production of Milk and Meat in 2010/11

Type of Animals	Total population (m)	Milk production (Mt)	Meat production (Mt)
Cattle	7226050	447185	-
Buffalo	4993650	1109325	167868
Sheep	805070	-	2722
Goat	9186440	-	52809
Pigs	1108465	-	17923
Poultry	39530620	-	36303
Total	62850295	1556510	277625

Source: DLS Annual Progress Report (2012)

In spite of the importance of livestock in rural economy in generating sustainable livelihood for small farmers and meeting the growing demand for milk and meat, the productivity of our livestock has been extremely poor. Such low yielders being uneconomical, the owners neither bother to feed them well nor provide necessary health care, resulting in further loss of production. This is a vicious cycle and in the absence of an efficient development programme, livestock, an important asset for generation of gainful self-employment, will continue to serve as a liability.

The economic viability of livestock husbandry is dependent on the genetic potential for production, good health care, balanced feeding of animals and efficient marketing of the

produce. While genetic improvement and health care are the prerequisites for sustainability, efficient feeding and marketing will help in increasing the profitability. However, the profitability is directly dependent on the sources of feed and fodder, as about 65-70% of the total cost of livestock farming is attributed to feeding. Any saving in feed and fodder cost would directly contribute to increase in profitability. Balanced feeding of milch animals is more critical, as the results are reflected within a short span, almost immediately, in the form of milk production. In case of growing stock, bullocks, sheep and goats, quality of feed will reflect on the growth rate, body weight and fertility, which are often unnoticed by the owners. Hence feeding of milch animals has greater significance for farmers, although feed management for other species is equally important.

Over the years, particularly during the last two decades, there have been significant changes in the animal husbandry sector to improve milk production. However the efforts were not adequate to provide the required boost for enhancing the productivity. There were many players involved in livestock development in the country. Each of them had a specific agenda, although the overall goal was to benefit the livestock keepers. In the absence of effective coordination, there have been duplication and missing gaps, which hampered the progress. Among these players, very few were concerned with the development of feed resources, although feed is the most crucial input for enhancing the production. As the value of the milk is more than the value of paddy produced in the country, it was expected that adequate investments on research and development of forage and feeds were made. However forage research could not attract the attention of the policy makers. Thus forage and feed development should be considered as an integral aspect of the dairy and meat value chain for ensuring success.

RANGELAND DISTRIBUTION BY AGRO-ECOLOGICAL ZONES

Available statistics show that forest, shrub land and degraded forest, grassland; uncultivated land occupy about 4.27 million hectares (29.0%), 1.56 million hectares (10.6%), and 1.75 million hectares (12%), 3.0 million hectares of the total land area of the country respectively (Fig:- 2). It has been reported (HMGN-DFRS, 1999) that forest cover in *Terai* and hills during the period between 1978-79 and 1990-91 have decreased at an annual rate of 1.3 and 2.3 %, respectively.

About 50 percent of total range/grassland is found in high mountains, 29 percent in high hills, 16.7 percent in mid hills and 4 percent in Siwalik and terai (Fig.-2.) By developmental regions, almost 50 percent of range land is found in mid western region and about one-fourth in the western region.

The grazing lands except the alpine meadows are under heavy grazing pressure (Pariyar, 1993). The mid-hills and the open grazing lands are stocked by about 13 times more than its carrying capacity and the steppe grazing lands by about 19 times, where as the alpine meadows are under-stocked. The alpine meadows are grazed only for summer three to four months (Table - 2).

FEEDSTUFF AVAILABILITY

Nepalese dairy cattle have traditionally been maintained on roughage based diets. However, supplementing these roughages with concentrates during the production phase is a common practice. The practice of cultivating crops for animal feed in Nepal is not common, and there has been a historical deficit of animal feed (Pariyar, 2005). More than 50% of the total ruminants livestock are found in the hills and about one–third in the plain region i.e. Terai. Only 13 percent of the total population is found in the mountains (Fig:- 3). By the development regions all fours regions keep almost equal number of ruminant livestock, only about 12 percent keeping in the far western development region. Crop residues, farm weeds and forest supplies make up the diet of the livestock in Nepal. Agricultural lands contribute about 60% of the total requirements, mainly in the form of low quality crop residues, and forest grazing lands contribute the remaining 40%. In totality, it is estimated that about one-third of the Nepalese livestock are underfed. The feed deficit is severe in hills (-56%) followed by the Terai (-42 %). The mountain region is at surplus (+26%) (DLS, 2002). Rangelands provide 34 percent of the total feed requirements for livestock in the country (Rajbhandary and Shah, 1981). It clearly indicates that feed particularly in the form of fodder is the major factor for limiting livestock production. The cost of treatment against the diseases and cost of concentrate will eventually lead to higher cost of production. This would have serious implication in the competitiveness of the domestic animal products with the imported products in long run for sustainability of the agriculture system. The data clearly indicates that the overall annual feed deficit in the country is estimated at 34.7 percent on TDN basis.

STATUS OF FORAGE SEED PRODUCTION

Attempts to improve this grassland by the introduction of species have been made since 1940's. Many tons of forage seeds are being introduced annually into Nepal. This study reported the annual demand of forage seed in fiscal year 2067/68 was 208304 kg. Great potential for seed production existed due to availability of useful land in Nepal. However plantings on a significant scale really started only on 1990 decade. Many reasons may be advanced for the lack of grass land improvement in a country due to its topography, however fragile ecology is greatly in need of such development. Lack of adequate quality and quantity of forage seed is adversely affecting the forage production due to which there is production of 149101 kg of forage seed meeting only 71.58 % of national demand.

Table - 3: Forage seed deficit (%) and grass coverage (ha)

Region	Deficit (%)	Grass coverage (ha)
Eastern	-48.22	1888.5
Central	-23.19	3778.5
Western	-3.99	1448.46
Mid Western	-51.34	1136.75
Far Western	-42.30	658.5
Total	-28.42	8960.71

(Source: Questionnaire Survey Report of NPAFC, 2068)

The overall forage seed deficit is 28.42 % against national demand in which maximum deficit of forage seed is in eastern region (48.22%) followed by far western region (42.30%). The study reported 8960.71 hectares coverage by forage cultivation on the basis of annual programmes of fiscal year 2067/68. The annual national demand of forage seed in fiscal year 2067/68 was 208304 kg with 149101 kg domestic production.

SEED PRODUCTION POTENTIAL DISTRICTS OF NEPAL

Some agro-climatically superior potential seed production pockets are identified. Potential suiTable - seed production sites for various forage species are as followings:

Table - 4: Potential suiTable - seed production sites for various forage species

S/N	Forage species	SuiTable - districts
1	Berseem, Teosinte, Sudan, Bajra, Jowar, Cowpea	Dhanusha, Mahottari, Sarlahi, Rautahat, Bara, Parsa, Saptari, Rupandehi, Dang, Banke, Bardiya
2	Oat, Vetch, Stylo, Kudzu, Siratro, Molasses	Whole terai, and hills up to 1500 masl
3	Cocksfoot, Perennial Rye Grass, Tall Fescue and Paspalum	Hills and mountains of Makwanpur, Gorkha, Dolakha, Rasuwa, Ramechhap, Mustang, Manang, Dolpa and Kathmandu Valley
4	White Clover, Red Clover, Lucerne, and Lotus	Mustang, Manang, Dolpa, Jiri, Nuwakot, Jumla and Kathmandu Valley

(Source: Pande, 1995)

RANGELAND AND PASTORALISM IN NEPAL

Rangelands are located to the high mountains and Himalayan regions at 2500-5000 masl. In Nepal, existing pasturelands are almost natural and thus, the terms rangeland and pastureland have been used as synonymous. Approximately 78 percent of the rangelands are located at high altitude regions in the northern belt of Nepal bordering Tibet (LRMP, 1986). Grazing animals and wildlife obtain forage from rangelands and the contribution of such area to environment protection is important as well. Rangelands in Nepal comprise grassland/ pasture, scrubland and degraded forests. At present, about 1.74 m ha, or about 12% of the area of the country, constitutes pasture land. Due to extreme of climate, poor management and constant grazing, these areas have been part of animal rearing systems.

Pasture lands vary from subtropical grassland at lower elevation to alpine meadows on ride in the mid-hills, high mountain valleys of the inner Himalayan range. Pasturelands are mostly located in the hills and only 4 per cent is found in low lying area (LRMP, 1986).

A review of indigenous pasture management systems in different eco-climate zones especially high altitude area of Nepal shows that the systems evolved are effective and accepTable - to communities and groups. The scheduling of the opening or closing time of the pasturelands by a community or group leader or by an assigned person (herder) is fixed. The users have to follow and the defaulters are fined (Basnyat, 1995).

Transhumant pastoralism is the major form higher altitude pasturelands during the livelihood in Nepal's high altitude region summer and gradually move to lower (>2500 masl). The region is characterized by sharp groups. Apart from the seasonal movement climatic variations, temperate to alpine across the altitude, many herders use herds forests, with predominantly indigenous as a means of transport for consumable species, extended shrub lands and pasture, items. These en route pastoralists also face high-value medicinal plants and significant some problems. Biodiversity, and valuable landscapes, transhumant pastoralism makes important including globally significant flora and contributions to Nepal's economy basically fauna. There is high seasonal mobility, in three ways. First, it provides a number of particularly for transhumant herding, trade animal products such as milk, meat, wool and in search of temporary employment.

The animals are moved towards the alpine pasture during monsoon seasons and brought back to the lower altitude forest, shrub-land and croplands for winter grazing. The movement of the animals follows a routine such that seasonal growth of the grasses is best utilized at different altitudes. The animal movement schedule is also synchronized with the harvesting of crops at lower altitude for better utilization of their residues. In general, the movement cycle begins from the highest altitude 5000m alpine rangelands, during summer (monsoon period) to the lowest altitude 1800m subtropical rangelands in winter. The movement cycle is completed in 365 days and the concentration of the animals in a particular area is dependent upon the season and availability of feed resources (Basnyat, 1995).

The pastoralists mostly own 2-6 animals managing traditionally. Due to lack of inadequate knowledge about rangeland value and lack of awareness about its management, the pasturing is beyond the carrying capacity of that rangeland. Nepal is rich in biodiversity with lots of vegetation but prime challenge is on the part of management.

FORAGE PRODUCTION FOR PROFITABILITY

The economics of milk production is heavily dependent on the quantity of nutritious forage fed to milch animals. With feeding of good quality forage, particularly leguminous fodder, feeding of concentrate can be reduced significantly. Animals yielding up to 5-8 kg milk per day can be maintained exclusively on 48-55 kg Lucerne or Berseem greens, as a substitute for 4.5 to 5.0 kg concentrate (Hegde, 2006). With regard to inferior quality animals, in spite of

feeding good quality fodder, the milk yield remains low and the farmers find it uneconomical to feed such animals. As there are no opportunities to sell surplus fodder in local markets, farmers are reluctant to cultivate fodder exclusively on fertile agricultural lands, without owning high yielding animals. Such shortage of feed and fodder resources could be attributed to the growing livestock population, low productivity and less emphasis on forage cultivation by the livestock owners. Because of low productivity, the owners are not keen to feed their low productive animals.

i) Production of annual forages

To meet the animal feed requirement, year round forage production is recently practiced strategy and helpful in attaining green matter production. Annual forage crops are easy to cultivate, fast-grown and nutritious to dairy animals. The ideal annual forages should have more than 40% legumes to provide protein and energy rich feed for ruminants and to fix nitrogen in the soil for following crops and grasses. In winter, Berseem, Lucerne, oat, and vetch are commonly practiced to sow immediately after harvesting of rice. Berseem has shown very good result in zero tillage cultivation. In spring or summer, Teosinte, bajra, Sudan are cultivated. They are helpful to make up nutritional need during monsoon and autumn season as well.

ii) Production of perennial forages

Perennial grasses are less acidifying than annual forages because there is less nitrate leaching. Their long-lived deep root systems take up soil water more effectively reducing soil acidification and the risk of dry land salinity. The most practiced perennial forages are stylo, molasses, Napier, mulato, paspalum, forage peanuts, Setaria, flemengia etc.

iii) Promotion of pasture species

The high altitude region of Nepal is very potential to produce native pasture species like Buki, Phurcha, Kote, Dhimchi etc as well as for exotic species like white clover, cocksfoot, tall fescue, ryegrass etc. The well-managed legume-based pasture can potentially accumulate large amounts of nitrogen (30-200 kg N/ha annually) in the soil.

STRATEGY FOR IMPROVING FORAGE PRODUCTION

While improving the forage resources, it is necessary to address the opportunities related to production and efficient use of crop residues, increasing the fodder yield of cultivated fodder crops on agricultural lands as well as on wastelands and community pastures. The strategy should cover selection and breeding of high yielding and stress tolerant fodder crops and varieties, improving the yields through sustainable production practices, efficient conservation and strengthening the value chain of dairy and meat producers to provide various critical services required to optimize the income.

Efficient use of crop residues

Although about 60% of the fodder needs are met from various crop residues, no serious efforts are presently made to either increase the yield or quality of this fodder. The crop residues had less significant value due to low productivity of livestock. Unable to appreciate the value, farmers in many regions have been wasting the crop residues, either by feeding the stalk without processing or by burning. Subsequently, with the development of dairy husbandry particularly in peri-urban areas, crop residues are now in good demand. The most commonly used crop residues are rice straw, wheat straw, maize stover, mustard hulls and leguminous crops. Among these, rice straw is the most popular as it is more palaTable - and available during feed shortage period.

Timely harvesting of crop residues, proper processing and storage can also enhance the quality of the forage and prevent wastage. Harvesting of stalk before it turns fibrous f**or** direct feeding or converting into silage, can keep the nutritive value high while reducing methane generation by the ruminants. There are various methods of treating the crop residues before feeding, to improve its nutritional value. It has been reported that even chaffing of stalk before feeding, can reduce the emission of methane by 10% while saving the wastage by 25-30%. Further treatment of crop residues by way of soaking in water and treating with steam under pressure, can also improve the nutritive value and palatability. There are other methods like urea treatment in addition to molasses and physico-chemical methods like urea ammonization, by storing the urea treated straw in anaerobic condition which can further improve the quality.

Establishment of a complete feed production unit can also enhance the demand for fodder, as assured supply of complete feed at an affordable price can motivate a large number of small farmers to expand their livestock development activities as a reliable source of livelihood. To operationalise such decentralized feed production units on an economically viable scale, the units can be operated by local livestock keeper groups who have a major stake in procurement, distribution and its viability.

Fodder crops for wastelands

Considering the limitations of traditionally cultivated fodder crops, it is necessary to introduce various non-traditional fodder crops for growing on marginally productive farms and denuded community lands. There are many hardy grasses and legumes like stylo, molasses, lablab, Siratro, etc. which can be grown on wastelands without irrigation. There are many fast growing shrubs and trees which can be lopped regularly as fodder. Such tree species can be established on field bunds, home gardens and along farm boundaries.

The concept of leasehold forest and forage plantation is another scheme for promotion of nutritious exotic forage species adapTable - to the particular climate. There are large stretches of degraded wastelands which are not only lying idle and are underutilized but are also accelerating soil erosion, surface run off of rain water and hosting a wide range of pests and diseases. Development of these lands for forage production will not only ensure

enhanced supply of superior quality forage but also help in conserving the natural resources and recharging ground water, while improving the bio-diversity.

Development of community pastures is another excellent opportunity. Generally, about 5% to 10% of the land area in every village is reserved for community pastures. However, a part of this land is encroached or diverted by the local government for other purposes. Over the years, in the absence of controlled grazing and care, the productivity of these community pastures has been severely eroded. Such lands can be brought under silvipasture development involving local people. In addition to increased grass production, there was a positive improvement in the micro-climate and biodiversity.

There is a need to develop suiTable - fodder shrubs, trees and grasses for development of pasture lands. Fodder species for introduction under agro-forestry need to be shade-tolerant and resistant to pests and diseases. Establishment of leguminous shrubs particularly in fruit orchards can even enhance the fruit production. It is now time to set priority to breed improved varieties of various non-traditional fodder crops suiTable - for watersheds and wastelands.

Increasing forage yields

Dairy farmers who have undertaken forage production are not able to optimize the yields and maximize the returns due to several reasons. These include poor quality soils, inadequate fertilizer application, moisture scarcity, improper timing of sowing and inadequate facilities to transport and store the forage, till it is fed to livestock. Selection of suiTable - forage crops to suit the local agro-climatic conditions, non-availability of good quality certified seeds, lack of knowledge about cultivation practices and lack of marketing opportunities to sell the surplus forage at remunerative prices are also important problems, contributing to the poor response to forage production. Except for a few crops like oat, Berseem, stylo, Teosinte, maize, which are cultivated in a few isolated pockets in different regions, most of the farmers are not aware of other forage crops, which have special advantages under adverse agro-climatic conditions.

Improving profitability

Farmers generally compare the economics of forage with other agricultural crops. Forage cultivation on agricultural lands is least attractive, unless they own superior quality livestock. Hence the return is mainly influenced by the quality of livestock. Thus efforts should be made to promote fodder production in the areas where livestock husbandry is progressing well and the productivity of animals is high. There is also a need for developing a fodder market in the long run, where farmers can sell the surplus forage. A fair market can motivate the farmers to study the price movement and cultivate fodder.

Forage production, particularly the harvesting, requires larger labour force, which is not available during certain critical seasons and is becoming expensive. It is particularly true for organized farms where unionized labour is inefficient and undependable. Hence it is

necessary to develop suiTable - machinery for harvesting fodder, which can be operated by multipurpose power tillers and tractors which can become popular among dairy farmers.

Opportunities for preserving surplus forage into forage pallets, silage and hay, should also be explored by developing suiTable - technologies. Presently, such processing is not very popular due to high cost.

NEED FOR FORAGE-BASED DEVELOPMENT RESEARCH

Significant research has to be carried out to identify suiTable - forage crops, domesticate them, breed new varieties, develop cultivation practices and develop facilities for large scale seed production. There has not been any significant change in the status of forage supply in the country mainly because these research finding are applicable to only a few regions particularly for humid arid and sub humid conditions.

Indeed, it is a matter of serious concern that forage production has not been picking up on a massive scale, in spite of significant progress in dairy development. This calls for an in-depth study, particularly in newly emerging milk sheds, to understand the mechanism to meet the nutritional needs of milch animals. There is good scope to analyze current feeding practices and help them to introduce balanced feeding, using the available fodder resources.

STRATEGIES FOR FORAGE PASTURE DEVELOPMENT

1) Community-based forage production should be encouraged. Some progressive dairy farmers are willing to cultivate forage crops in their private land and fodder trees on their sloppy marginal land. But they are not being considered. So to meet the pace of equiTable - development on fodder/forage production, we should be capable to catch the policy 'public-private partnership' and should incorporate proactive farmers into the program.

2) Capacitating forage pasture experts with recent technical advances

3) Seed certification in most of the countries including Nepal is voluntary, but as per provisions of the amended Seed Act 1988, truthful labeling on seed bag is compulsory. Seed certification and seed testing systems are aimed at providing high quality source seed to seed growers, and also at stimulating the seed industry, farmer use of better seed, and ultimately the national economy. Voluntary seed quality control should be replaced with compulsory seed certification system.

4) The import of forage seeds and their cultivation to our farmland have introduced the species. But the lesson learned is lack of sustainability unless we establish our own forage resource centers and seed production and distribution mechanism.

5) Registered seed growers should be ensured with crop insurance policy.

6) For rangeland management, following strategies are to be taken into consideration:

- Inter-sectoral policy: As rangeland management is multi-sectoral because of its many uses, there is a distinct need of joint cooperation and programmes from the Ministry of

Forestry and Soil Conservation and the Ministry of Agriculture and Cooperatives, in consultation with local communities, rangeland policies and appropriate management strategies that reflect multiple-use.

- Managing high altitude Rangeland/Grassland: Forage-related programs of the past focused on subtropical and temperate rangelands and neglected high altitude rangelands because of their remoteness, harsh climate, and sparse settlements. However, Nepal's high altitude rangelands must be given major focus as they contain valuable biological resources.
- Rangeland Inventory and Classification; rangeland resource ownership, use pattern together with, production and productivity
- Climate change adaptation, drought/natural disaster preparedness, integrated natural resource management programs should be enforced
- Rangeland renovation, rotational grazing, community-based management and benefit sharing mechanism should be developed
- Capacity Development (education and training) of mountain people

CONCLUSION

Potential forage cultivation area in the country is about 4356000 ha including the non-cultivated agricultural land, Pasture land and Shrub land that is assumed to provide forages/fodders for 21.13 million of ruminant livestock population. Annually, the cultivated grass coverage is reported to be about 8960.71 ha of land which is 0.2 % of potential land for grass cultivation. While calculating the animal per hector, 2358 animals get forages from one hector of land which is too low as compared to per animal DM requirement. This shows very low priority and investment for forage development programs in the country.

There is a need to expand the range of species grown to serve a wider range of markets, e.g. high quality forage for dairy production. For this to be realized, country must decide on the most useful and widely adapted forage species. In addition, common seed quality standards, seed certification, storage and marketing guidelines must be developed.

Public private partnership, farmer's cooperatives development and contract farming should be given priority in developing forages and their seeds/seedlings/saplings. Land ownership should be provided to community people for effective management of rangeland in hill areas.

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INITIAL EVALUATION OF LOW ODAP GRASS PEA (*LATHYRUS SPP*) GENOTYPES FOR GRAIN AND FODDER YIELD

Dina Nath Tiwari[1] and Kishor Kumar Shrestha[2]
[1]Regional Agricultural Research Station, Khajura, Banke
[2]Pasture and Fodder Division, Khumaltar, Lalitpur

ABSTRACT

The grass pea (Lathyrus sativus)" Khesari -in Nepali" is generally grown as a relay crops with rice on low land area in the Terai and inner Terai of Nepal. It is used for grain as well as crop by products for animal feeding. The areas of local landrace grass pea has been drastically decreasing since few years due to identification of high ODAP (Oxalyl Diamino-Propionic Acid) content which causes an neuron lathyrism (paralysis of lower limb) disease in long time grass pea products consumers. However; only occasional consumption of the lathyrus products is not harmful in human and does not appear to affect in animals also. The need of the crop is still realized at the local level. Total 12 genotypes of low ODAP lathyrus genotypes from ICARDA accessories were tested for selection of its grain and fodder production during 2009 to 2011 at RARS Nepalgunj.

Genotypes Eth WIR-70, Sel-463, Sel-190 and Sel-289 and were found selective for both green fodder as well as grain yield. The average yield of 38 ton, 32.5 ton, 31 ton, 30.5 ton green fodder and 2 ton, 1.6 ton, 2.3 ton and 1.6 ton grain /ha was produced from these varieties respectively. Green fodder supply period of these varieties was found longer and the infestation of aphids in these varieties was also found nominal compared to other tested varieties. Sel-190, Sel-1942, sel-1976 and Eth WIR-70 were found selective for grain purpose producing 2.3 ton, 2.1 ton, 2 ton and 2 ton, respectively.

Keywords: Grass pea, ODAP, green fodder, grain yield

INTRODUCTION

The grass pea (*Lathyrus sativus*)" *Khesari* -in Nepali" is generally grown as a relay crops with rice on low land area in the Terai and inner Terai of Nepal. In Nepalese socio-economic condition the grass pea products are identified as rich diet of poor people. It is used for grain as well as crop byproducts for animal feeding. The areas of local landrace grass pea has been drastically decreasing since few years due to identification of high ODAP (Oxalyl Diamino-Propionic Acid) content (>2%) which causes an neuron lathyrism (paralysis of lower limb) disease in long time grass pea products consumers. However; only occasional consumption of the *lathyrus* products is not harmful in human and does not appear to affect in animals. The need of the crop is still realized at the local level.

The maximum area of low land rice field in mid and far western Terai remain fallow after rice harvesting due to lack of irrigation facilities. The grass pea is gifted with many advantage that combine to make it an attractive food crop in drought- stricken, rain- fed areas where soil quality is poor and extreme environmental conditions. The grass pea is

resistant to many pests including storage insects. These fallow lands could be utilized through relay cultivation of low ODAP grass pea with rice.

A lot of total 44 accessories of low ODAP contained (less than 0.2% ODAP content) grass pea genotypes of food and feed /fodder purpose was received from ICARDA source during year 2007/08 and 2008/09. The varietal selection process and germplasm maintenance of the selected genotypes have been continued at RARS Nepalgunj with an objective to assess the production performance of different grass pea genotypes at Nepalgunj condition and selection and promotion of suiTable - grass pea genotypes both for grain and fodder purpose.

MATERIALS AND METHODS

The experiment consisting of 12 genotypes and was conducted in a RCB design with 3 replications. The trial was sown on October 3rd week and harvested in April 2nd week. The seed rate was applied @ 60 kg /ha and sowing was done in line keeping 35 cm apart maintaining 12 seeds per meter row length. The basal dose fertilizers @ 20:40:20 NPK /ha was applied during field preparation and 20 kg/ha N was top dressed at 45 DAS after light irrigation. The major observation of green fodder and grain yield with its different supportive parameters plant height, infestation of disease / pests, fodder supply period and crop maturity period was taken from the experiment. The observation of green fodder and grain yield were taken separately in two parts of a plot. A single cut of green fodder was made at flowering stage to cover its optimum vegetative growth. Whereas; the grain yield without fodder cut was taken after maturity of the crop.

RESULTS AND DISCUSSION

Plant height

The plant height of tested grass pea genotypes was found highly significant different during both years. Genotype, Sel-463, Sel-289, Sel- 385 and Sel-111 were observed in the highest vegetative growth varieties in first year which attending 191 cm, 182 cm, 150 cm and 146 cm, respectively (Table --1). Similarly Eth-WIR 70 found maximum plant height (130 cm) followed by Sel-289 (128 cm) and Sel-385 (127 cm) in second year (Table --2).

Grain yield

The finding of grain yield between tested genotypes was found highly significant in both study years. Genotype, Sel-190, Sel-1976, Sel- 1942, Sel-1914 and Sel-1959 were observed in the highest grain yielding varieties in first year. The yield of these varieties was recorded 2.3 ton, 2.2 ton, 2 ton, 1.8 ton, and 1.7 ton /ha, respectively. In second year the highest grain yield (2.5 ton/ha) was observed from Eth WIR-70 followed by Sel- 190 (2.3 ton), Sel-1942 (2.1 ton), Sel- 463 (2 ton) and Sel-289 (1.9 ton) (Table --1). The least grain yield was observed from Sel- 288, Sel-463, Sel-Eth-15, Sel-1928 and Sel-385. The lower grain yield in these varieties was observed due to by hot wind stress in the case of late seed maturation period from April 3rd to 4th week, flower dropping and maximum immature seed percentage at RARS Nepalgunj climatic condition.

Table - 1: Production performance of different Low ODAP lathyrus genotypes (2009-2011)

Genotypes	Origin	Plant Height (cm)		Av	Grain yield (t ha^{-1})		Av	Green fodder yield (t ha-1)		Av
		Y-1	Y-2		Y-1	Y-2		Y-1	Y-2	
Sel- 190	ICARDA	131	100	116	2.3	2.3	2.3	35	27	31
Sel-B111	ICARDA	146	113	130	1.4	1.7	1.6	41	27	34
Sel-Eth-15	Ethiopia	125	112	119	1.2	1.5	1.4	25	30	27.5
Sel-1942	Nepal	101	85	93	2	2.1	2.1	16	25	20.5
Sel-288	ICARDA	132	128	130	1	1.5	1.3	20	31	25.5
Sel-289	ICARDA	182	127	155	1.3	1.9	1.6	30	31	30.5
Sel-385	Ethiopia	150	117	134	1.3	1.5	1.4	35	30	32.5
Sel-463	Ethiopia	191	102	147	1.2	2	1.6	37	28	32.5
Sel-1914	Nepal	102	98	100	1.8	1.6	1.7	16	23	19.5
Sel-1928	Nepal	130	96	113	1.4	1.4	1.4	15	23	19.0
Sel-1976	Nepal	130	130	130	2.2	1.8	2.0	20	29	24.5
Eth-WIR 70	Ethiopia	136	100	118	1.4	2.5	2.0	35	41	38.0
G Mean		138	110		26.9	1.8		26.9	28.8	
CV %		9	5		13.6	13		13.6	10	
F Test		HS	HS		HS	HS		HS	HS	
LSD		18.8	7.53		0.36	0.38		6	5	

Green fodder yield

The green fodder yield of tested genotypes was found highly significant in both years. Sel-B 111, Sel- 463, Eth- WIR 70, Sel- 190, Sel- 385 and Sel- 289 were found the highest green fodder yielding varieties producing 41 ton , 37 ton, 35 ton, 35 ton, 35 ton, and 30 ton/ha, respectively. The least fodder yield was observed from Sel-1928, Sel-1914 and Sel-1942 genotypes. The yield of these varieties was recorded 15 ton, 16 ton, and 16 ton green fodder /ha, respectively (Table - 1). Similarly, Eth- WIR 70 was found the highest green fodder producer (41 ton/ha) followed by Sel- 288 (31 ton/ha), Sel- 289 (31 ton/ha), Sel-Eth-15 (30 ton/ha) and Sel- 385 (30 ton/ha) in second year (Table - 1).

The lower biomass yield in these varieties was observed due to short plant length and less vigorness in its vegetative growth. Whereas, the higher green fodder yielding varieties showed more or less vigorous vegetative growth as well as higher plant height and branching capacity compared which was also found highly significant to other tested varieties.

Fodder supply

The fodder supply period was determined according to the optimum vegetative / flowering starting period which was varied in the tested genotypes. The longer vegetative period was recorded in Sel-B111, Sel-Eth-15, Sel-385, Sel-288, Sel-289, Sel-463 and Eth-WIR 70 genotypes.

Table --2: Production performance of different Low ODAP lathyrus genotypes (2009-2011)

Genotypes	Fodder supply period	Seed Maturity period	Aphid/leaf minor infestation	Wilt Effect	Selection Remark
Sel- 190	*March- 4th*	*Apr-2nd*	1	1	G+F
Sel-B111	April1 -1st	April -3rd	2	3	Fodder
Sel-Eth-15	April1 -1st	April -3rd	2	1	
Sel-1942	March-3rd	Apr-1st	3	1	Grain
Sel-288	*April-2nd*	Apr-4th	1	3	
Sel-289	April -1st	April -3rd	1	1	G+F
Sel-385	Apr-2nd	Apr-4th	1	1	Fodder
Sel-463	April- 1st	April -3rd	1	1	G+F
Sel-1914	March-3rd	Apr-1st	3	1	Grain
Sel-1928	March-3rd	Apr-1st	2	1	
Sel-1976	March-4th	April -2nd	3		Grain
Eth-WIR 70	April -2nd	May -1st	1	1	Both (G+F)

Scoring Remarks:-	Scoring Remarks:-	Selection Remarks:-
Aphid/ Leaf Minor Infestation: 1= No damage 2= Slight damage 3= Heavy damage	Wilt Infestation: 1= High Resist(0% plant infected) 3= Resist (6-10 % plants infected) 5=Moderate Resist (21-40 % plants infected	G = Selected for grain F = Selected for fodder G+F= Selected for grain & fodder

Disease/paste infestation

Infestation of the Aphid/ Leaf minor and wilt are known as the main constraints of the crop. The infestation observations were taken through the crop period of the experiment. In the disease and insect infestation scoring aspect heavy leaf minor infestation was observed in cultivars Sel 1942, Sel 1914 and Sel 1976 during March 1st and 2nd week 2009. Whereas, all tested varieties were found under wilt resist score (Table --2). Except Sel -1976 (Nepal origin) all other tested genotypes were found either free or slight damage from the Aphid infestation during the crop season period of year 2010/11.

CONCLUSION

Out of 12 genotypes tested Sel - 1942, Sel-1914 and Sel-1976 were found suiTable - for grain and Sel-B111, Sel–288 ,Sel ETH 15 and Sel –385 were identified for fodder purpose whereas, Sel 463, Sel 190, Eth WIR-70 genotypes were performed suiTable - for both the grain as well as fodder yield purpose in mid and far western terai climatic condition. Multiplication / participatory selection of these varieties will be implemented for further releasing and recommendation process.

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POTENTIAL OF LOCAL GRASS FORAGES FOR ANIMAL PRODUCTION

Ritesh Prasad Shah[1], Raj Kumar Shah[1], Sanjay Kumar Jha[1] and Kishor Kumar Shrestha[2]
[1]Agriculture Research Station, Pakhribas, Dhankuta
[2]Pasture and Fodder Division, Khumaltar, Lalitpur
E-mail: riteeshshah@gmail.com

ABSTRACT

This study was carried out to identify the adoptability and yield of local fodder in rain fed condition so that the information for Feeding livestock with green or dry fodder could be known for economical enterprises by reducing the cost of concentrate. Fodder, Kharuki (Capioedium assimile), Phurke (Arunduella nepalensis), Salimmo (Chrysopogon gryllus, Baspate (Setaria palimifolia) and Suparipate were transplanted at ARS Pakharibas in 23rd August 2012 and harvested in 12 November 2012. The plot size was 7.5 m2 for each fodder where plant to plant and row to row spacing was 50 cm. Plant heights, tiller number, leaf length and leaf breadth were analyzed by randomized complete block design with 4 replications for each fodder. Plant height of Arunduella nepalensis (95.6±3.43) cm was found highly significant (p<0.001) over Chrysopogan gryllus (47.6±2.98) cm and Capioedium assimile (51±4.38) cm. Similarly mean tiller number/plant of Setaria palmifolia was highly significant (P<0.001) over Arunduella nepalensis (29±4.71), Suparipate (16.8±3.15) and Chrysopogan gryllus (13.4±4.12). likewise Chrysopogan gryllus leaf length (37±3.1)cm was found highly significant (p<0.001) over Arunduella nepalensis (30.8±3.04)cm Suparipate (25±2.30)cm, Setaria palmifolia (16.8±1.5)cm and Capioedium assimile (7.2±0.58)cm. Leaf breadth of Suparipate (4.58±0.19)cm was highly significant (p<0.001) over Setaria palmifolia (1.68±0.05)cm, Arunduella nepalensis (0.6±0.10)cm Capioedium assimile (0.36±0.024)cm and Chrysopogan gryllus (0.16±0.02)cm. Number of leaf/tiller of Capioedium assimile was highly significant P<0.001) over Suparipate (6.40±0.51b), Arunduella nepalensis (5.80±0.49), Setaria palmifolia (5.60±0.51) and Chrysopogan gryllus (5.00±0.71). All fodder start to flower from 2nd week of November and seed were harvested during 2nd week of December. Mean seed yield was found maximum in Suparipate 26.67 kg/ha followed by Arunduella nepalensis 12kg/ha, Chrysopogan gryllus 6.67kg/ha, Setaria palmifolia and Capioedium assimile respectively, 1.33kg/ha . Fodder yield was found higher in Suparipate 2.75ton/ha, and lowest in, Chrysopogan gryllus 1.1ton/ha. Dry matter percent was found maximum 78.18% in (Arunduella nepalensis) and lowest 28.06 in Suparipate Thus, Suparipate found better in term of production and lower in dry matter percent

Keywords: Local grasses, resources, economic animal production adoptability

INTRODUCTION

Feeding livestock with green or dry fodder could be known for economical enterprises by reducing the cost of concentrate. For this, environmentally suiTable - and sustainable fodders which are locally available should be cultivated in baris, and bunds. Some species of native species have higher productivity and quality as well as good for feed value (Kc *et al*., 2009). Therefore, identification of potential native forage species, adaptability, productive performance and nutrient content in different season is important.

MATERIALS AND METHODS

This study was carried out to identify the adoptability and yield of local fodder in rain fed condition at Agriculture Research Station, Pakhribas from 23rd August 2012 to 12 November 2012. For this native species from Dhankuta namely Kharuki (*Capioedium assimile*), Phurke (*Arunduella nepalensis*), Salimmo (*Chrysopogon gryllus*, Baspate (*Setaria palimifolia*) and Supariapate of rooted slips were planted in a plot size of 7.5 m^2. Plant to plant spacing was 50 cm and row to row spacing was 50 cm for each species. Mean Plant heights, tiller number, leaf length and leaf breadth were analyzed by randomized complete block design with 4 replications for each fodder species. Flowering and seed maturity dates were recorded. Dry matter of each fodder was taken by drying at 60°C for 72 hours in an oven.

RESULTS AND DISCUSSION

Comparison of productive parameter of native species in presented in Table - 1.

Table - 1: Comparison of productive parameter of native species

Productive parameter	**Native species**				
	Kharuki (*Capioedium assimile)*	**Phurke Khar (*Arunduella nepalensis)***	**Salimmo (*Chrysopogan gryllus)***	**Baspate (*Setaria palmifolia*)**	**Supariapate**
Plant Height (cm)	51±4.38d	95.6±3.43a	47.6±2.98de	84±5.92ab	74.4±14.33abc
Tiller numbers/plant	34.6±9.04abcd	29±4.71c	13.4±4.12e	51.4±10.29a	16.8±3.15cde
Leaf length (cm)	7.2±0.58e	30.8±3.04b	37±3.10a	16.8±1.5d	25±2.30bc
Leaf Breadth (cm)	0.36±0.024d	0.6±0.1c	0.16±0.02e	1.68±0.05b	4.58±0.19a
No of leaf/tiller	34.60±9.04a	5.80±0.49b	5.00±0.71b	5.60±0.51b	6.40±0.51b
Days of flowering (50%)	84	87	85	84	84
Days of seed maturity	129	128	135	136	136
Days of Harvesting (50%)	140	140	140	140	140
Green Matter yield Ton/ha	1.9	1.8	1.1	1.5	2.75
Seed yield kg/ha	1.33	12.00	6.67	1.33	26.67
Dry matter %	70.18	52.5	52.13	38.87	28.06

It is evident from the Table - 1 that plant height of *Arunduella nepalensis* (95.6±3.43) cm was found highly significant ($p<0.001$) over *Chrysopogan gryllus* (47.6±2.98) cm and *Capioedium assimile* (51±4.38) cm. Similarly, tiller number of *Setaria palmifolia* was highly significant ($P<0.001$) over *Arunduella nepalensis* (29±4.71) cm, Supariapate (16.8±3.15) cm, *Arunduella nepalensis* (29±4.71) cm, Supariapate (16.8±3.15) cm and *Chrysopogan gryllus* (13.4±4.12) cm. Likewise *Chrysopogan gryllus* leaf length (37±3.1) cm was found highly significant ($p<0.001$) over *Arunduella nepalensis* (30.8±3.04) cm, Supariapate (25±2.30) cm, *Setaria palmifolia* (16.8±1.5) cm and *Capioedium assimile* (7.2±0.58) cm. Leaf breadth of Supariapate (4.58±0.19)cm was highly significant ($p<0.001$) over *Setaria palmifolia* (1.68±0.05) cm, *Arunduella nepalensis*

(0.6±0.10) cm *Capioedium assimile* (0.36±0.024) cm and *Chrysopogan gryllus* (0.16±0.02) cm. Number of leaf/tiller of *Capioedium assimile* was highly significant P<0.001) over Suparipate (6.40±0.51), *Arunduella nepalensis* (5.80±0.49), *Setaria palmifolia* (5.60±0.51) and *Chrysopogan gryllus* (5.00±0.71). All fodder start to flower from 2nd week of November and seed were harvested during 2nd week of December. Mean seed yield was found maximum in Suparipate 26.67 kg/ha followed by *Arunduella nepalensis* 12kg/ha, *Chrysopogan gryllus* 6.67kg/ha, *Setaria palmifolia* and *Capioedium assimile,* respectively, 1.33kg/ha . Fodder yield was found higher in Suparipate 2.75ton/ha, and lowest in, *Chrysopogan gryllus* 1.1ton/ha. Dry matter percent was found maximum 78.18% in (*Arunduella nepalensis*) and lowest 28.06% in Suparipate.

CONCLUSION

Suparipate found better in term of green matter yield 2.75 ton/ha and lowest dry matter, 28.06 percent.

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Animal Breeding

ADOPTION OF DAIRY ANIMAL'S ARTIFICIAL INSEMINATION TECHNOLOGY: A CASE OF KASKI AND CHITWAN DISTRICTS OF NEPAL

Sudha Sapkota, Sabita Mohini Amatya Shrestha, Megh Bahadur Nepali and Devendra Gauchan
Socio Economics and Agricultural Research Policy Division, Khumaltar, Lalitpur
Email: sudhanepal@gmail.com

ABSTRACT

Cattle and buffaloes are the main dairy animals of the country. Recently artificial insemination has been used as an important tool to enhance milk yielding capacity of dairy animals. At present, only 8% of the total lactating animals have been covered by artificial insemination (AI) and major coverage is on the cattle. The adoption of AI is more intensive in Kaski and Chitwan districts. Thus, this study was conducted mainly in the milk pocket area and road access VDCs of Kaski and Chitwan district to evaluate the adoptability of AI technology, and recommend suggestions for increasing milk yield in the country. To achieve the goals, primary data was collected by household survey, Participatory Rural Appraisal (PRA) checklist, Key Informant Survey (KIS) and secondary data was collected through literature review. Simple statistical tools such as mean, percentage and adoption index have been used to analyze the data. This study revealed that in the selected sites AI technology have been more practiced and adopted in cattle in comparison to buffaloes. Buffalo contributes about 71% of the total milk production and thus has social economic values. Therefore, it is necessary to improve the AI technology adoption in buffaloes. The major constraints for low adoption of AI in buffaloes are mostly due to the lack of efficient methods for estrus detection, timely insemination and poor conception rate and seasonality of reproduction.

Keywords, Artificial Insemination, dairy animals, adoption, Cattle, Buffalo

INTRODUCTION

Artificial Insemination (AI) in animals is the technique in which semen with living sperms is collected from the male and introduced into female reproductive tract at proper time and place with the help of instruments (Animal Husbandry, 2013). In developed countries, Artificial Insemination (AI) is treated as one of the most important technologies to reduce the cost of animal rearing.

Adoption of AI Technology in animal production is one of the important technologies implemented in Nepal since long back. Artificial insemination (AI) technology reduces the cost of maintaining breeding bull. Moreover, milk and meat production increases. AI technology facilitates to improve the breeds that help in milk and meat production and the average conception rate in buffalo through AI was found to be 32% (Sherchand, 2002). AI program has been an important part of genetic improvement program in the country, 42 districts have been covered with AI and more particularly in cattle and with lesser extent in buffalo. NLBC (2012) reported that some factors namely animal species, breed, farmers' experience and type of insemination are important for conception rate.

Among the breed, local buffalo has the lowest conception rate of 15.4%. In Nepalese context only 8% of the total lactating animals have been covered by AI technology practices (MoAC, 2011). But still the need felt about the technology adoption among buffaloes which fulfills 71% of total milk production. Therefore, this study was conducted mainly in the milk pocket area and road access VDCs of Kaski and Chitwan district to evaluate the adoptability of AI technology, and recommend suggestions for increasing milk yield in the country.

METHODOLOGY

Sisuwa and Bharat Pokhari VDCs from Kaski and Fulbari and Khurkhure VDCs of Chitwan districts were selected for the study. Primary data was collected by conducting household survey, Participatory Rural Appraisal (PRA), Checklist, Focus Group Discussion (FGD) and Key Informant Survey (KIS). A total of 38 and 28 sample households from buffalo pockets of Kaski and Chitwan districts were surveyed, respectively. Secondary data was collected through literature review. Simple statistical tools such as mean, percentage and adoption index have been used for the analysis of data.

RESULTS AND DISCUSSION

Socio economic characteristics of the selected households

Literacy and the characteristics of AI adopting households are summarized to depict the socio economic characteristics of the selected households.

Literacy

Average family size per household was 5.11 in Kaski and 6.29 in Chitwan district. Likewise, only 3-4 % of selected farmers' household head was illiterate with more education level depicted in Kaski as presented in Table - 1.

Table - 1: Education level of respondent farmers

S/N	Educational level	Kaski	Chitwan
1	Illiterate	2.6	3.57
2	Primary	26.3	10.7
3	Higher secondary	31.5	42.85
4	SLC	34.21	39.28
5	Above SLC	5.2	3.57

Characteristics of AI adopting farms

Respondents of Chitwan district (6.18 yr) have been adopting AI practices earlier than Kaski (5.74 yr). Study revealed that average number of dry buffalo and lactating buffalo per household in Kaski district (1) was higher in comparison to Chitwan district (0.93) (Table - 2). The average number of dry buffalo per household was 0.92 and 0.29 in Kaski and Chitwan district, respectively.

Table - 2: Characteristics of AI adopting HHs

S/N	Characteristics of dairy animals raising households	Kaski	Chitwan
1	AI adoption, year	5.74	6.18
2	Average number of dry buffalo per household.	0.92	0.29
3	Average number of lactating buffaloes per household	1.0	0.93

Trend of Artificial Insemination practices in Chitwan and Kaski district

The number of artificially inseminated buffalo buffalo and cattle are shown in Table - 3. It showed that in Chitwan district AI was practiced in only 2,159 buffalo in the fiscal year 2010/2011 which increased by 30.55% in the fiscal year 2011/12. Likewise, in Kaski district, 2476 buffalo was artificially inseminated in the year 2010/11 which increased by 20.09% in the fiscal year 2011/12.

Table - 3: Artificial inseminated cattle and buffalo in Chitwan and Kaski districts

AI adoption trend in dairy animals								
S/N	District	2067/68 (2010-11)			2068/69(2011/12)			Growth
		AI cattle	AI buffalo	Total	AI cattle	AI buffalo	Total	
1	Chitwan	18581	2159	20740	23833	3243	27076	30.55
2	Kaski	4976	2456	7432	5905	3020	8925	20.09

Source: National Livestock Breeding Centre (NLBC), year

Artificial insemination other districts

Artificial insemination status depicted the Chitwan district was in first rank with 27076 AI in 2012 and 20740 in 2011 whereas, Kaski district was ranked in 9th position with 8925 AI in 2012 and 7432 in 2011 as presented in Table - 4.

Table - 4: Status of AI delivery in different districts

S/N	Districts	Annual insemination in 2068/69 (2011/12)		Annual insemination in 2067/68 (2010/11)		% change
		Rank	AI	Rank	AI	
1	Chitwan	1	27076	1	20740	30.55
2	Rupandehi	2	21049	2	18657	12.82
3	Kathmandu	3	18810	3	16341	15.11
4	Morang	4	17954	4	11973	49.95
5	Jhapa	5	14183	5	7422	91.09
6	Nawalparasi	6	13364	6	11894	12.36
7	Sunsari	7	13267	7	8478	56.49
8	Makwanpur	8	10394	8	9267	12.16
9	Kaski	9	8925	9	7432	20.09
10	Mahottari	10	8326	10		100
	Total		153348		112204	36.67

Source: National Livestock Breeding Centre (NLBC, 2012)

In the FY 2011/2012, there were altogether 1218 AI license holders in Nepal (NLBC, 2012), among them, 389 service holders were from private companies and 829 were serving through governmental agencies. Out of 389 private license holders, 113 inseminators were practicing as artificial inseminator and 276 persons were found to be not practicing as inseminator. It depicted all the AI training holders are not working in the market on AI service.

Distribution of animal types in selected sites

Distribution of animal type (Table - 5) depicted the dominance of buffalo raising (69.7 %) than that of cattle (30.3%) in the selected sites.

Table - 5: Category wise distribution of dairy animals in selected sites

S/N	Category	Percent
1	Buffalo	69.7
2	Cow	30.3

Farmer's perception on production through AI

Farmer's perception was taken on effect of AI on milk and meat production. A total of 89.4 percent farmers responded that both on cow and buffalo have the same effect on milk production through AI and 63.4 percent respondents expressed increased buffalo meat production.

Table - 6: Farmers' perception in effect in milk and meat due to conception of animals through AI, %

	Buffalo		Cow	
	Yes	No	Yes	No
Increased milk	89.4	10.6	89.4	10.6
Increased meat	63.4	36.4	-	-

Adoption of AI in dairy animals

Relative advantage, compatibility, trainability/divisibility, visibility and availability were the major factors to adopt the technology, but the major drive to adopt the technology was easy availability, higher comparative advantage in adoption the AI. The study revealed that comparative advantage as well compatibility of AI in cow was higher comparing to buffalo (Table - 7).

Table - 7: Factors affecting the rate of adoption

Factors	Buffalo	Cow
Relative advantage	+	-
Compatibility	-	+
Trainability/divisibility	+	-
Visibility	-	+
Availability	+	+

Note: + sign denotes more affecting factor, - sign denotes less affecting factor

Adoption index has been calculated to find out the adoption status of the dairy animals. The formula used has been given below. Adoption index formula was adapted from Dangol (2004).

Adoption index: $\frac{\text{Total score obtained by an individual case of AI}}{\text{Maximum possible score of AI practice}} * 100$

Adoption percent of AI

Adoption percent depicted 89.1% in buffalo and 93.10 % in cow. It showed that adoption of AI in cow is higher than in buffalo.

Table - 8: percent of AI Adoption in buffalo and cow

Animals	α	β	Adoption
Buffalo	41	46	89.1
Cow	27	29	93.1

Where,
α: total score obtained by an individual animal
β: maximum possible score of AI practice

Existing institutions delivering AI service

In Nepal, 94 percent AI service has been delivering through government organizations, whereas 3 percent of AI is through agro vet workers. It depicted the need of incorporation of public and private partnership to transfer the technicality on private AI practicener's hand.

Constraints in artificial insemination adoption in dairy animals

Relative advantage, compatibility, trainability/divisibility, visibility and availability were the major factors governing the adoptability of the AI technology. The major drive to adopt the technology was easy availability of the technology. But, higher comparative advantage was one of the most important factors on higher rate of adoption of the technology.

The study further revealed that compatibility of AI in cow is higher than buffalo. It was due to silent heat problems in buffalo which is associated with difficulty in detection of the right time of fertilization. Therefore, there remains high chances of AI failure in buffalo (> 3 times) creating compulsion to the farmers to send buffaloes for slaughtering purpose.

CONCLUSION

Comparative advantage as well compatibility of AI in cow was higher in comparison to buffalo most probably due to silent heat problems. Therefore, further research should be focused on methodological development of heat period detection in buffaloes for increasing milk and meat production.

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ON-STATION GROWTH PERFORMANCE EVALUATION OF SAKINI (*GALLUS GALLUS DOMESTICUS*) POULTRY BREEDS

Saroj Sapkota[1], Neena Amatya Gorkhali[1], R. Bhusal[2], R. Dhakal[2] and Bhola Shankar Shrestha[1]

[1]Animal Breeding Division, Khumaltar, Lalitpur

[2]Research Assistants at Animal Breeding Division, Khumaltar, Lalitpur

Email: sarose.sapkota@gmail.com

ABSTRACT

Sakini is the most adapted common breed (covering more than 50%) of poultry of Nepal. On-station study was conducted to determine the growth performance of Sakini in different Agro-Ecological Zones (AEZ) at Swine and Avian Research Program, Khumaltar complex. Fertile eggs from different AEZ of Central Development Regions (CDR) were collected and hatched. The growth evaluation was performed in Rasuwa (representing high mountain zone), Kavre (mid-hill) and Rautahat (Terai region). The number of eggs collected from Rasuwa, Kavre and Rautahat were 150, 157 and 147 with 40.66 %, 27.89 % and 38.85% hatchability, respectively. Moreover, highest mortality was observed in Kavre (36.58%) followed by Rasuwa (36.06%) and slightly lower in Rautahat (34.42%) during the study period. Location has significant effect (P<0.001) on growth performance from the first week to 22nd week with a mean weight of 1264.36 g. The mean weights recorded for 22nd week of Sakini from different AEZ are 1149.43, 1186.10 and 1457.55 g for Terai, mid hills and high-hills, respectively. The weight of chicks from Rasuwa was observed to be higher for all the observations taken from 1st week to 22nd week except for one day old chicks. Similarly, sex has also significant effect (P<0.05) for all weeks expect during the hatching (0 day). The overall mean weight for the males and females during 22nd weeks of age were 1460 and 1130 g, respectively. The result showed that among three lines studied, Sakini lines from Rasuwa showed better performance on-station.

Keywords: On-station, evaluation, Sakini, growth performance, agro-ecological zones

INTRODUCTION

Poultry are an important livestock commodity in the country. There are 39.5 million poultry in the country (MoAC, 2010/11). Twenty five percent of this is exotic (pure or crossbred) and rest is indigenous (Neopane, 2004). They provide food (meat and eggs) to human beings and manure for maintaining soil fertility. The poultry have high cultural and social values among most communities of Nepal. More than 50% of the household (51.9 %) keep poultry. At least three indigenous breeds of poultry have been identified in different parts of the country. Among the indigenous poultry, Sakini, Ghanti Khuile (Naked Neck –NN), Pwankh Ulte (Frizzled Feather –FF) are well known. All these breeds are found throughout the country and are normal by conservation viewpoint. However, NN and FF are found in limited numbers and are critical from conservation viewpoint.

Sakini poultry have a wide range of adaptability from tropical terai to temperate region in high mountains. They are mainly reared for meat and eggs production purpose. Their meat

and egg cost higher price comparing to broilers and layers. The average cost per kg live weight of Sakini chicken is NRs 350 and a single egg is NRs. 12. Their meat is popular and largely consumed along the highways. They are hardy and suiTable - for scavenging conditions, found in colour ranging from white to dark colour (black, brown) with mixed. They have been characterized on phenotypic level.

The total meat production is about 25 thousand Mt in year 2009/2010 and increased to 288 thousand Mt in 2011/12 (MoAC, 2011/12). Chicken meat (7.62%) ranks third in the total meat production of the country after buffalo (64.1%) and goats (19.45%). In Nepal, meat production and consumption has been continuously increasing especially that of chicken has been common more common in most parts. However, still there is huge demand of meat in the market especially that of indigenous breeds of poultry ranks at the top, because the meat is considered delicious and tasty because it offers the variety and quality to consumers. Since the indigenous poultry needs to be conserved and studied for promotion.

Therefore, an experiment was conducted aim to determine the growth performance of different lines of Sakini breed available in high hill, mid hill and terai region of Nepal.

MATERIALS AND METHODS

The growth performance experiment was conducted at poultry unit of Swine and Avian Research Program (SARP), Khumaltar from November 17, 2011 to Jun 15, 2012. Altogether 454 fertilized eggs, 150 from Rasuwa, 147 from Rasuwa and 157 from Kavre were collected from different VDCs of respective districts.

While collecting eggs, it was reconfirmed that eggs belongs to Sakini breed at least up to two generations. From each household one to four eggs were selected randomly and transported carefully to Animal Breeding Division, Khumaltar, Lalitpur. Eggs were hatched in Suwal hatchery, Bhaktapur. All day-old chicks were wing-tagged for the individual identification. These birds were reared from day-old to 22 weeks of age.

The waterers and feeders used were cleaned and disinfected. Floor, interior and exterior of shed was also painted with lime dust. The chicks were raised under deep litter system (5-8 cms of rice husk) and 3-5 birds/m^2 were kept in confinement. The chicks were fed ad-libitum. The composition of feed used and its nutrient content for each stage used in the study is presented in Table - 1. This feed formulation and nutrient content was adapted as per recommendation of SARP, Khumaltar.

Table - 1: Ingredient composition

Composition	**B1**	**B2**
Maize	545	585
Soyamax	310	270
RP	68	61
DORB	0	0
MBM	40	43
calcite	3.7	3.5
Mustard DOC	20	25
Meth	2.6	2.4
Lys	1.9	1.5
Salt	2.8	2.7
Proviguard/ antioxidant	0.125	0.125
B-complex	0.3	0.3
Trace mineral	1	1
Threonine	0.45	0.5
Phytase 2500	0.3	0.3
BMD	0.3	0.3
Diclazuril	0.21	-
Maduramycin	-	0.5
Toxin Binder	1.5	1.5
Vitamin E	0.05	0.05
Lysoforte/Emulsifier	0.5	0.5
Nutrient contents		
ME, kcal ME/kg	2950	2975
Protein, %	22	20.5
Lysine,%	1.1	1
Calcium,%	0.9	0.85
Phosphorus, %	0.42	0.4
Sodium %	0.19	0.17

Source: SARP, Khumaltar

The following vaccination schedule was followed along with other bio-security options (Table - 2).

Table - 2: Vaccination Schedule

Days/Weeks	Vaccines	Dose and route
Day 1	Marek's (CB1)	0.2 ml s/c
Day 5	ND F1	1 drop intraocular
Day 12	IBD intermediate strain	1 drop intraocular
Day 28	IB + ND	1 drop intraocular
Day 35	IBD strain	Drinking water with skim milk power@50gm/10lit
Day 42	Fowl pox	Scarification in the wing
9 weeks	ND R2B vaccines	0.5 ml I/M
12 weeks	Fowl pox	Scarification in the wing

Spray of lime dust around the shed was done regularly and dipping of footwear in lime water before entrance, use of apron, no entrance of other animals in the shed were followed.

Performance recording

Following are the parameters to evaluate the productive performance of Sakini breed recorded on-station:

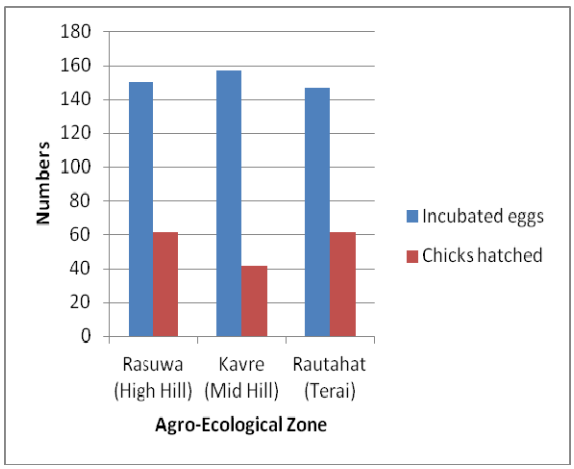
- Weekly weighing (gm)
- Mortality (%)
- Age at 1st laying (wks)
- No of eggs/clutch
- Egg size
- FCR=Total feed consumed (gm) /Total weight gain(gm)
- Morphometric parameters

The data recorded and analyzed using statistical tool prescribed by Harvey (1990), following least squares technique of variance analysis for unequal sub-class number. The pair wise comparison of the least square mean was carried using DMRT (Duncan's Multiple Range Test) (Duncan, 1955).

RESULTS AND DISCUSSIONS

Weight and hatchability of eggs

The hatching performance of eggs collected from three districts is presented in Fig:- 1. The weight of the eggs collected from different cites varied from 37 g to 49 g with highest weight from Rasuwa. The literature showed that the average egg weight of Sakini breed varied from 40 to 45 g (Neopane 2004, 2006; Bhurtel 1996 and Anon, 1997). For the day old



local chicks mean weight was obtained to be 30.96±0.07 g which were similar with Dandarawy local breed in Egypt (31.0 g) (Abdellatif, 1989) and Aardennaise breed in Belgium (30g) (Moula *et al.,* 2009) but higher than that weight of local chicken breed in Cameroon (23-28 g) (Fotsa, 2008) and lower than Tunisian local breed (37.84g) (Raach-moujahed *et al.,* 2011).

The hatchability obtained was 38.85% for Rasuwa, 27.89 % for Kavre and 40.66 % for Rautahat. The lower hatchability might be due to various factors like, storage (time and position) of egg, infertile egg, transportation, weather and etc.

Growth performance of chicks

The growth performance of Sakini chicks from different Agro-ecological Zone (Rautahat, Kavre and Rasuwa) from day old age to 22 weeks with LS mean has been presented in Table - 3. Data revealed that except for body weight after hatching, body weights from first week to 22nd weeks had significant difference. The chicks from Rasuwa had higher body weight from first week up to 22nd weeks. However, the body weight for chicken of Rautahat and Kavre were similar throughout the study period.

Table - 3: Growth performance of chicks, g

Weeks	Overall mean	LS Mean ± SE (g)			LS
		Rautahat	Kavre	Rasuwa	
Day old	30.96±0.07	30.35±0.08(61)	30.40±0.07 (41)	32.12±0.07(61)	NS
1	50.93±0.80	47.35±1.29^{b}(59)	47.27±1.56^{b} (41)	58.17 ±1.25^{a} (60)	**
2	78.67±1.45	65.10±2.35^{b}(57)	67.79±2.84^{b}(40)	103.12 ±2.29^{a} (60)	***
3	117.35±2.30	91.84±3.72^{b}(57)	103.04±4.50^{b}(40)	157.18 ±3.63^{a} (58)	***
4	168.10±3.33	133.42±5.38^{b}(55)	136.26±6.50^{b}(38)	234.64 ±5.25^{a} (56)	***
5	254.14±6.25	192.47±10.10^{b}(54)	197.09±12.19^{b}(38)	372.87 ±9.84^{a} (56)	***
6	329.19±8.15	277.57±13.16^{b}(54)	271.78±15.89^{b}(38)	438.22 ±12.83^{a} (55)	***
7	413.91±9.98	361.42±16.12^{b}(54)	345.88±19.46^{b}(37)	534.42 ±15.71^{a} (54)	***
8	516.13±12.58	451.83±20.32^{b}(52)	439.39±24.54^{b}(35)	657.16 ±19.81^{a} (54)	***
9	604.67±15.24	532.48±24.62^{b}(50)	531.36±29.72^{b}(35)	750.18 ±23.99^{a} (54)	***
10	720.41±21.59	632.46±32.45^{b}(50)	639.85±41.52^{b}(34)	888.9 ±37.22^{a} (52)	***
11	804.64±26.3	736.45±39.54^{b}(48)	717.95±50.58^{b}(34)	959.53±45.35^{a} (51)	***
12	869.14±28.44	810.09±42.76^{b}(48)	810.35±54.70^{b}(34)	986.99±49.04^{a} (51)	***
13	930.01±28.1	873.21±42.25^{b}(47)	852.20±54.05^{b}(33)	1064.61±48.46^{a}49)	***
14	946.65±34.13	833.78±51.32^{b}(32)	852.95±65.65^{b}(24)	1073.24±58.86^{a}(39)	***
15	970.91±37.11	858.95±55.80^{b}(31)	868.00±71.38^{b}(23)	1125.78±63.99^{a}(38)	***
16	1005.18±37.46	903.97±56.32^{b}(31)	918.30±72.05^{b}(23)	1193.27±64.60^{a}(38)	***
17	1049.87±39.14	960.94±58.84^{b}(30)	962.60±75.27^{b}(23)	1226.08±67.49^{a}(37)	***
18	1099.03±40.36	998.06±60.67^{b}(28)	1017.95±77.61^{b}(21)	1281.09±69.58^{a}(35)	***
19	1148.03±42.06	1031.48±63.23^{b}(28)	1063.50±80.89^{b}(21)	1349.58±72.52^{a}(35)	***
20	1195.75±44.65	1080.53±67.13^{b}(28)	1127.25±85.88^{b}(21)	1379.47±76.99^{a}(35)	***
21	1230.04±46.46	1111.11±69.85^{b}(28)	1141.25±89.35^{b}(21)	1437.77±80.11^{a}(35)	***
22	1264.36±45.73	1149.43±68.76^{b}(28)	1186.10±87.96^{b}(21)	1457.55±78.86^{a}(35)	***

*Note: LS: Least square; SE: Standard Error; Numbers in the parenthesis indicates the number of birds from each Agro ecological Zone; Means within the row followed by different superscript are significantly different by DMRT (p<0.05), NS: Non-Significant; **: significant at 1% level of significance; ***: significant at 5% level of significance*

For the first week, the mean weight recorded was 50.93±0.80 g (Table - 4). The LS mean showed the significant difference (Pp<0.001) among the weights of chicken from different AEZ. Sharma (2008) also observed mean weight of local chicken to be 46.1g. Similarly, during the 8th week of age, the mean weight gain was observed as 516.13±12.58 g, which was higher than the study performed at Morang and Sarlahi districts (370.1 g) by Sah *et al.* (2000). However, for the chicken from Rasuwa the weight gain was observed 657.16 g which was higher than all the results. The result obtained was in the range of 400-600 g which was similar to the study of Bhurtel (1996; 1998), Anon (1997) and Neopane (2004; 2006). For 14th week, the mean weight gain of Sakini chicks was recorded 946.65±34.13 g with 1073 g for Rasuwa and about 850 g for Kavre and Rautahat (Table - 3). Sah *et. al,* (2000) also recorded almost similar weight gain for local chickens (865 g). On 16th weeks the mean weight of Sakini chickens were reached 1005.18±37.46 g with 1193.27±64.60 g for Rasuwa which is nearer with the result of Sharma (2008) that was1248.0 g. Average weight gain for 22nd week was recorded as 1264.36±45.73 g with highest weight gain of 1457.55±78.86 g for Rasuwa and similar for both Kavre (1149.43±68.76 g) and Rautahat (1186.10±87.96 g).

The weekly weight gain of male and female chicks from different agro-ecological zone was significantly (P<0.05, 0.01 and 0.001) different for all ages (Table - 4 and 5). Among, the Sakini males and females from Rasuwa were having heavier all ages from day old to 22nd weeks. The weight showed almost similar performance for male and female chicks from Rautahat and Kavre with greater variation from Rasuwa district.

Table - 4: Growth performance of male

Weeks	**LS Mean ± SE of Male Lines (in gm)**			**LS**
	Rautahat	**Kavre**	**Rasuwa**	
Day old	30.66±0.08^{b}	31.69±0.09^{ab}	32.54±0.13^{a}	*
4	136.14±7.75^{b}	135.75±7.10^{b}	258.33±9.02^{a}	**
8	469.35±23.48^{b}	461.91±18.17^{b}	769.33±38.96^{a}	***
12	891.50±60.31^{b}	876.60±52.15^{b}	1230.72±93.73^{a}	***
16	1023.00±64.86^{b}	985.68±55.87^{b}	1491.34±141.07^{a}	***
20	1230.41±78.43^{b}	1242.41±85.87^{b}	1652.36±162.38^{a}	***
22	1295.58±88.86^{b}	1357.66±90.27^{b}	1765.18±156.49^{a}	***

*Note: LS: Least square; SE: Standard Error; Means within the row followed by different superscript are significantly different by DMRT (p<0.05); *: significant at 1% level of significance; **: significant at 1% level of significance; ***: significant at 5% level of significance*

Table - 5: Growth performance of female

Weeks	LS Mean ± SE of Female Lines (in gm)			LS
	Rautahat	Kavre	Rasuwa	
Day old	30.18±0.08	29.12±0.07	31.78±0.11	NS
4	127.32±5.78^{b}	135.21±6.57^{b}	213.36±8.16^{a}	**
8	416.68±17.57^{b}	411.85±16.82^{b}	554.90±35.24^{a}	**
12	706.18±44.54^{b}	744.10±41.32^{a}	767.42±83.08^{a}	*
16	813.24±48.65^{b}	851.00±51.23^{b}	924.42±125.05^{a}	**
20	960.36±62.19^{c}	1037.60±94.06^{b}	1128.07±143.93^{a}	***
22	1047.31±65.63^{c}	1125.70±98.88^{b}	1228.07±138.72^{a}	***

*Note: LS: Least square; SE: Standard Error; Means within the row followed by different superscript are significantly different by DMRT ($p<0.05$); NS: Non-significant; *: significant at 1% level of significance; **: significant at 1% level of significance; ***: significant at 5% level of significance*

The body weight of male for 8th weeks for Rautahat, Kavre and Rasuwa were recorded 469.35, 461.79 and 769.33 g for males, respectively whereas 416.68, 411.85 and 554.9 g for females, respectively. Sharma (2008) observed almost similar results for local chickens for 8th weeks 520 g for males and 438 g for females. But, the males from Rasuwa had higher weight comparing with the literatures. However, Sah *et al.* (2000) under scavenging system observed different results (lower weights for both male - 390.1g and female - 350.1g). Based on growth performance evaluation Sakini chicken from Rasuwa was comparatively superior over from Rautahat and Kavre.

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Livestock Production and Management

MIGRATORY SYSTEM OF BARUWAL SHEEP PRODUCTION IN NEPAL: PROBLEM AND PROSPECT

Dipak Adhikari[1], Devi Prasad Adhikari[1], Mohan Prasad Sharma[2], Dainik Bahadur Nepali[2], Mana Raj Kolachhapati[2], Megh Raj Tiwari[3] and Saroj Sapkota[4]

[1]Agriculture Research Station (Goat), Bandipur, Tanahun

[2]Institute of Agriculture and Animal Science, Rampur, Chitwan

[3]National Animal Science Research Institute, Khumaltar, Lalitpur

[4]Animal Breeding Division, Khumaltar, Lalitpur

Email: dipsagar95@gmail.com

ABSTRACT

To find out the present status of breeding, health care and grazing system and potentiality of migratory management a study was carried out from August 2008 to May 2009 in Lamjung district of Nepal. Two sites were with 10 migratory flocks of each site were selected for study. The breed in this system was Baruwal and Sinhal in case of sheep and goat respectively. The migratory pattern, breeding status, health care, grazing and feeding, problem and potentiality of migratory system were recorded on the basis of field study. The average number of sheep and goats per flock in Lamjung district was 250 ranging from 50 to 500 and the ratio of sheep to goats was 3:2. Most of these flocks were used same breeding buck until 4 to 5 years regularly without considering the inbreeding effect. The castration of buck was done at 344.33±23.25 days and the breedable period of buck was 1144.80±23.25 days. The best ewes and does were used for breeding purpose for 8-9 years of age whereby they gave birth about 5-6 times. The main diseases in migratory system were respiratory diseases, six-month disease, pneumonia, infertility, abortion and parasitic gastroenteritis. The main problems of migratory system were inbreeding, predation and losses of lambs, diseases and abortion, unavailability of sheepherding, restriction for access and grazing due to community forestry.

Keywords*:* Migratory system, Breeding status, Health care, Grazing and feeding

INTRODUCTION

Major livestock species in Nepal are cattle, buffaloes, goat and sheep (MoAC, 2011). Sheep has special importance as they contribute in ensuring food and nutritional security of subsistence food producers. Sheep enterprise is suiTable - to landless, marginal and small farmers as it provides income and employment to the farm family, including women and children. Thus, the sheep industry can play an important role in poverty alleviation.

Total sheep population in Nepal is 805,070 and there are 110,276 in mid-hill of western region. These total numbers of sheep producing annually 2,722 Mt meats and 6 Mt wool (MoAC, 2011). The sheep population has experienced considerable decline of about 11% between 1981 and 1991, 21.8% between 1991 and 2001 and 5.3% between 2001 and 2011. In Nepal there are four breeds of indigenous sheep, among them Baruwal solely comprise 63% (LMP, 1990). Sheep make very effective use of a variety of different grazing lands, including rocky mountain terrain and alpine pastures, which cannot be utilized by other classes of

domestic animals. They can adapt to a variety of climatic conditions and cropping patterns with a range of availability of pasture land, they can be stall-fed, semi-stall-fed, or grazed. Transhumance (Migratory) system of animal keeping is one of the oldest forms of livestock (Owen, 1976). In migratory flocks, sheep and goats are kept together whereby sheep acting as the lead animals (Karki, 1985). Baruwal sheep and Sinhal goats are the principal breeds of this system in Nepal. Karki (1985) recorded the numbers of sheep and goats in 224 migratory flocks of Gandaki Zone (Kaski, Lamjung, Gorkha and Manang Districts). The Fig:-s showed that the ratio of sheep to goat was 3:2. A similar ratio was recorded in the flocks of Kaski and Lamjung Districts by Ghimire *et al*. (1991), but large variations between districts occur. A typical migratory flock consists of 200–250 animals (Karki, 1985), with the range of 50–600 animals (Karki, 1985 and Ghimire *et al*., 1991). The present study was undertaken to reveal the status of breeding, feeding, and grazing and health management of Baruwal sheep production under migratory system.

MATERIALS AND METHODS

This study was carried out from August 2008 to May 2009 in Lamjung district of Nepal. Two VDCs i.e., Yutarkanya and Gharmu were purposively selected with the close coordination of DLSO, Lamjung. These are the pocket areas of sheep production. The migratory flocks having more then 50 sheep were selected and primary information was collected through migratory flock's survey with the help of semi-structured questionnaire techniques from the identified key informants. Besides, secondary information was collected from published literatures of different sources.

All together 20 migratory flocks, 10 from each site were taken under this study. The PRA tools were used to collect the information on sheep production systems. Seasonal calendar was used to collect the information of type and seasonally available pasture for each site. Types of sheds, feeding systems, grazing system, breeding system and health care were recorded through the close observations in each site. Interview with the participants was accomplished using a semi-structured questionnaire. The collected data were analyzed by using descriptive data analysis technique and Harvey, 1990 a statistical package.

RESULTS AND DISCUSSION

Average number of sheep per flock

The average number of sheep per flock in Lamjung district was 250 ranging from 50 to 500, and the average number of sheep/household was 15 ranging from 2 to 200. Likewise the average number of sheep per household was 20, ranging from 2 to 200. Karki (1985) recorded the number of sheep and goats in 224 migratory flocks of Gandaki Zone (Kaski, Lamjung, Gorkha and Manang Districts). The finding showed that the ratio of sheep to goats was 3:2. A similar ratio was recorded in the flocks of Kaski and Lamjung Districts by Ghimire *et al* (1991), but large variations between districts occur. A typical migratory flock consists of 200–250 animals (Karki, 1985), but the flock size can vary within the range of 50–600 animals.

Housing, grazing and feeding system

Migratory sheep were kept in open field. The temporary housing using local materials was made for shepherds only. Extensive grazing of the herd during the day time was a common practice. Generally, the farmers managed to graze their migratory flock on an average of 6 hours per day with the range of 5 to 9 hours. The time and duration of grazing was based on the seasons of a year. In lower belt the common schedule of grazing, was from 11 AM to 5 PM. However, at higher altitudes reasons, sheep were manage to graze early in the morning and come back to shed in the afternoon and manage to graze in evening again. During monsoon, they start grazing before 4 am. Shepherds do not provide additional fodder and forage in the shed.

Any types of concentrate ration usually are not offered to sheep. They survive only by grazing in the forest; during this period they drink water to fulfill their water requirement. In every 15 days interval, flock owners supply salt @ 15 kg/400 sheep (35 g/sheep) for mineral supplement.

Breeding system

Traditionally, there is least care on selection of breeding ewe and ram. The owner retained the ewe and ram in the herd only based on general body appearance. Most farmers are not aware about inbreeding hazards. However, there exist some farmers exchanging breeding ram from other flocks. In general, 4-6 good performing ram for breeding purpose are maintained for 4-5 year regularly in a herd. Such practices prevails high chance of inbreeding. Generally, estrus period are not noted for better chances of conception. Among pregnant shed the problem of abortion reported high due to the trouble created by the breeding ram. The breedable period of ram was 1144.80±23.25 days. The castration was done about one year of age (344.33±23.25 days). The best ewes were used for breeding purpose till 8-9 years of age giving birth with 5.56±0.12 average. If breeding ewes were not performing, they would be culled for meat purpose.

Health condition

The health problems of migratory sheep were common. The health related problems in sheep consisted primarily of parasitic gastroenteritis, liver flukes, mange, external parasites, coccidiosis tape worms and their cysts. Inadequate information on the epidemiology of diseases, control strategies and/or lack of their verification seemed to be the major reasons of ineffective control of these parasitic diseases.

Several other diseases like respiratory diseases, six-month disease, infertility and abortion and high rate of lamb mortality were common disease problems. The disease occurrence pattern is required to be studied. Aconite poisoning was another cause of mortality in the migratory flocks due to abundance of aconite (*Aconitum napellus*) plants in the alpine pastures. Foot-rot had been a chronic problem in the migratory flocks. Malnutrition, nutritional deficiencies associated with metabolic diseases were also contributing poor health

status of sheep. The sheep were beyond the conventional reach of district livestock office and Village Animal Health Worker (VAHW) due to remoteness of the migratory herds. .

These findings resemble with the findings of Karki (1985). The author reported that thirteen diseases were prevalent in the migratory flocks of Gandaki Zone. Of these "six-month" diseases, pneumonia, unspecified diarrhea and foot ailments, parasitic diseases, parasitic gastroenteritis and fascioliasis were the major migratory flock problems. Drenching against parasitic diseases is extremely rare in migratory flocks. Joshi (1991) had revealed the serious effects of parasitic gastroenteritis (PGE) on the productivity of sheep and the prospects for substantial economic benefits.

Migration pattern on 'Kharka'

In general, a single migratory flock was found to manage by 2-5 shepherds accompanied by 4-5 Tibetan mastiff dogs depending on the flock size. Sheep were taken to graze at different ecological regions on based on the seasonality. During mid-July to mid-September, sheep spend on high alpine pastures called "*Bugiyani*". The alpine pastures provide the most nutritious fodder to herds during summer and attain maximum body weight. The flocks after grazing about 2 months start downward migration. The timing was determined chiefly by onset of snowfall period and feed availability in the pasture. From mid September to early November sheep descend through the forest and utilizes fodder and grasses of high altitude pastures.

From early November to April, the flocks reach the villages where they were kept in rice field during the night with the purpose of manuring. During the day, animals are sent for grazing on nearby pastures and rice fields. The flocks remain on one terrace for 1-2 nights, after that moved to another. Likewise from May to mid-July, the flocks ascend steadily upward through the forest. They stay for one to three nights in traditional resting places called *"Kharka"* (open grass field in the forest). During the upward migration, particular route might depend upon the location of the alpine pasture.

Potentials of migratory system

The potential of the migratory system lies with its ability to utilize the extensive alpine pastures present in the northern belt of the country. In addition, the utilization of crop residues and the forest undergrowth around the villages contributes to soil fertility. Thus, these animals convert the unusable resources into the high value products for the betterment of the community.

Constraints of migratory system

Despite the high potential for meat production, which has not been exploited so far commercially, the coverage of the entire migratory system is depleting in the country. The national sheep population has been decreasing at the rate of 2% per annum but in some specific sites the population and flock numbers have decreased drastically during the last 10-15 years (Joshi *et al*. 2004). This decline has serious consequences for the communities living in the highland region of the countries, not only on the their cash income, fibre production,

cottage industries and meat supply but also on the overall fertility of the land for crop production and eventually to the food security situation. The major constraints are as follow.

- **Predation and losses of lambs**

Predation by wildlife especially the leopard, jackals and tiger were found as the main constraint in this region. The study estimated the predation loss of about 5% per flocks. The actual recording in the flocks showed the loss of about 19% the flock population per annum (Karki, 2004) but in some cases it reached up to 30% of the flock strength (Joshi *et al*., 2004). Losses of small lambs during grazing were also the great problem of this system which was 11%.

- **Diseases and abortion**

Diseases constitute another important constraint causing the death and poor viability of the animals in the flock. The actual significance of this problem varies between the accessible and inaccessible areas. We found that 6.75% lambs and 4% adult sheep died due to diseases in every flock. This Fig:- reports a major improvement to earlier report of 26.5% loss in the newborn lamb crop due to diseases in the flocks of Lamjung district (Karki, 2004). In remote flocks of Darchula district 46% of the newborn has been reported (Karki, 2004).

Tiwari and Shrestha (2004) reported that the average mortality of lambs and sheep in migratory system in Karnali zone was 12±9.5 and 6.9±3.2, respectively where average mortalities of lambs and adults of Baruwal sheep were 17.9% and 21%, respectively.

- **Shepherding**

Unavailability of shepherds and the reluctance of young generation to undertake these professions have been reported as the important constraints for migratory system of rearing. May be incentive scheme for shepherds might keep alive this profession and livestock production from most potential viable areas of the country.

- **Restriction to access for grazing in community forests**

With the successful implementation of the community forestry program and its recognition nationally, it was realized rather late that the success of one program could become a major constraint for the other equally to more important sector. It is now evident that closing of traditional grazing areas as part of community forest also stops the access to grazing land for the migratory management system of sheep in Lamjung district. The community forestry has contributed to decline of migratory sheep production.

CONCLUSION

Migratory system is popular and important opportunity for commercial sheep production in highlands which can utilize not only mid-hill pasture in winter but also alpine pasture in summer and rainy season. It is necessary to improve the breeding, feeding, health care, housing system and address the problem to improve productivity in order to keep migratory sheep as an important avenue to sustain the livelihood of farmers in Lamjung district. To

make viable these all improvements the community forestry should be opened without any condition to migratory transhumant livestock production systems.

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PRESENT STATUS, PROBLEMS AND STRATEGIES FOR THE DAIRY SECTOR DEVELOPMENT IN NEPAL

Dinesh Prasad Parajuli and Lok Nath Paudel
Directorate of Livestock Production, Hariharbhawan, Lalitpur
Email: paudeloknath@yahoo.com

ABSTRACT

Dairy sector contributes about 63% to the total livestock-sector gross domestic production (GDP) in Nepal. It is not only recognized as a means for poverty reduction but also taken as an effective sector that minimizes the rural-urban disparities. Nepal Agricultural Perspective Plan (APP) accorded a very high priority to the dairy sector and envisaged to have a potentiality to grow up to at 7% per annum. However, present rate of growth is only about 3.1% per annum.

Food and Agriculture Organization (FAO) of the United Nations (UN) recommends consumption of 250 ml of milk/capita/day but the current availability is about 150ml/capita/day in Nepal. It clearly shows a big gap between the demand and supply of milk. At present, only about 15% of total milk production comes into the formal market and attempt is to be made to increase it at least to 40%, otherwise the import of milk and its products from aboard may reach up to 1.5 million Mt by 2020. So, it is imperative to promote dairy industry in Nepal. Considering these issues, Government of Nepal has already initiated Dairy Cattle and Buffalo Genetic Improvement Programs (DCBGIP), development of infrastructure and laboratory facilities in National Livestock Breeding Center, involvement of private sector in breed improvement programs, national campaign for artificial insemination program (A.I. Mission), initiation of livestock insurance policy, forage mission program, etc. Livestock extension services carried out by the Department of Livestock Services (DLS) have resulted positive changes in farmers' attitude and increased awareness towards the breed improvement and good husbandry practices. All these efforts have resulted into emergence of new dairy cattle and buffalo farms as semi/ commercial enterprises that show the positive trend to increase the milk production and productivity in Nepal.

Key words: Artificial Insemination, dairying, DCBGIP, forage, milk and milk products.

PRESENT STATUS AND PROSPECTS OF DAIRY SECTOR IN NEPAL

Livestock is an integral component of Nepalese agricultural farming system. This component contributes about 9% to the total gross domestic production (GDP) and about 27% to the agricultural gross domestic production (AGDP). A review of livestock statistics of Nepal reveals that over 80% of the country's rural households own livestock and about 20% of the household income comes from livestock (CLDP, 2009). Livestock is an important sub-sector that ensures supply of cash from urban to rural areas. Among the different components of livestock, dairy is the most important sector. Dairy sector contributes about 63% to the total livestock-sector gross domestic production in Nepal. It is not only recognized as a means for poverty reduction but also taken as an effective sector that minimizes the rural-urban disparities. Nepal Agricultural Perspective Plan (APP) accorded a

very high priority to the dairy sector and envisaged to have a potentiality to grow up to at 7% per annum (APP, 1995). However, the present rate of growth is about 3.1% per annum.

According to the available data on livestock statistics, there are 7.2 million cattle, 4.8 million buffaloes, 0.8 million sheep, 8.8 million goats, 1.0 million pigs, 25.7 million chicken and 0.38 million ducks in the country (Fig 1). The trend analysis of the livestock population from 1995 to 2011 reveals that the population of cattle has been increased with a nominal rate (6.8 million in 1995 to 7.2 million in 2011) where as that of the buffalo is increased with higher Fig:- (3.2 million in 1995 to 4.8 million in 2011). Over half of the cattle, buffaloes, goats and sheep are reared in the hills, while one third in the Terai. Transhumant pastoral production is practiced in the temperate, sub-alpine and alpine regions whereas much of the livestock production in Terai and lower-middle hills (<1000m) is sedentary utilizing the available forage in and around the villages.

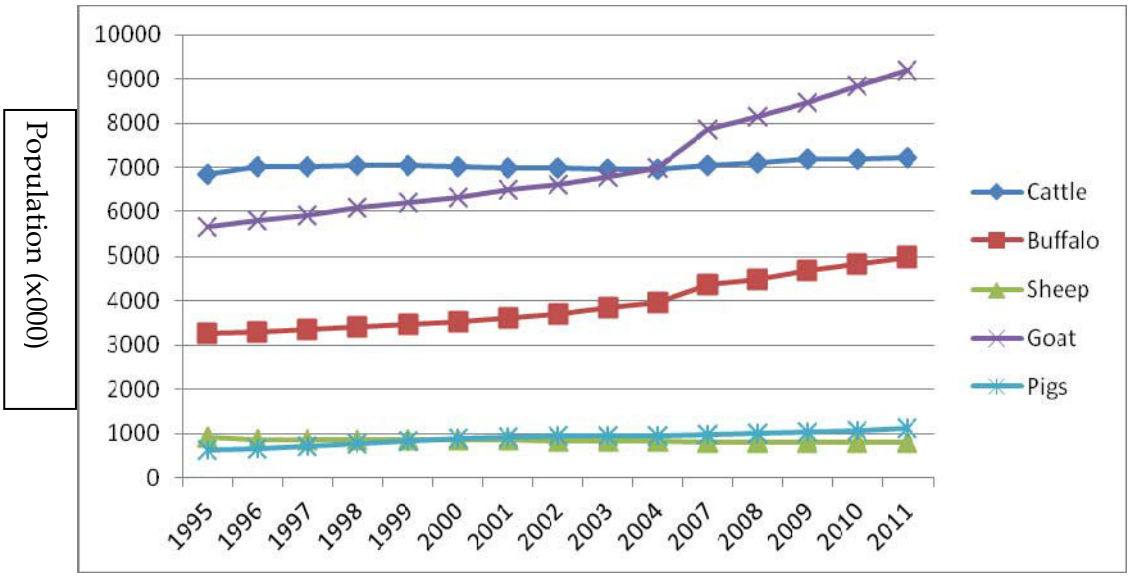

Table - 1: Livestock population in Nepal

Livestock population of Nepal is said as one of the highest per unit land among the Asian countries. Despite a considerable livestock population, per unit productivity of livestock in Nepal is very low as compared to other South Asian Countries (Gurung *et al.*, 2011). It is because of the poor genetic make-up, poor health care and poor feeding and inefficient livestock management. Livestock of Nepal are suffering by 34% feed deficit on dry matter basis which clearly indicates the limitation for the higher production (NASA, 2004).

The livestock production statistics showed that Nepal produces about 1.6 million Mt of milk, 0.277 million Mt meat, 0.586 Mt of wool and 700 million eggs annually.

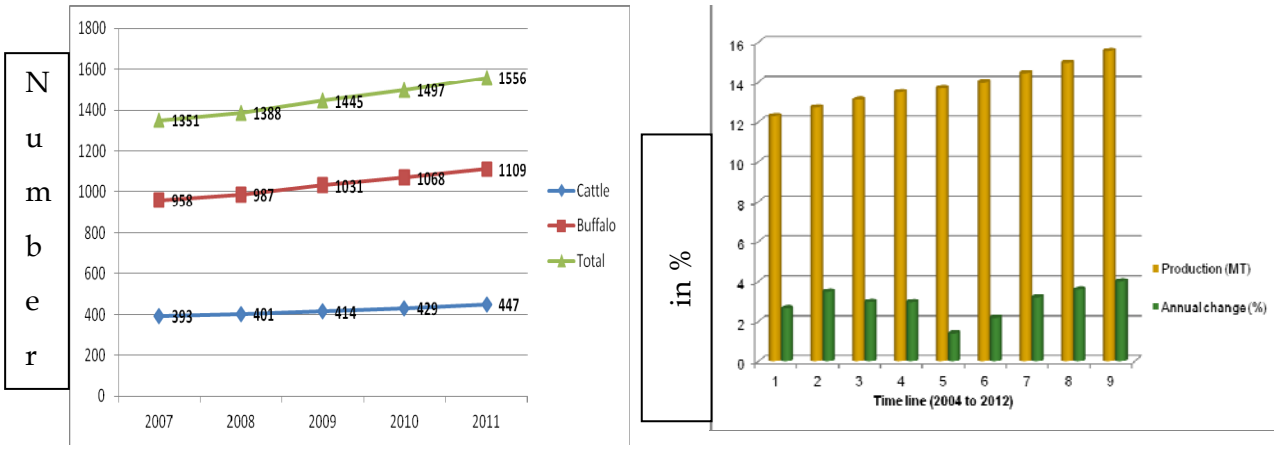

Fig. - 2: Trend of milk yield (A) and annual increase in milk production (in %) in Nepal

The time line analysis of milk production from 2004 to 2012 showed that the annual percentage increase in milk production is always less than 5% (Fig 2). Only about 15% of total milk production comes into the formal processing and marketing. If the dairy sector is not given due attention and at least 40% of the total national production does not come into the formal sector, the import of milk and milk products from aboard may reach up to 1.5 million Mt by 2020 (CLDP, 2009). Food and Agriculture Organization (FAO) of United Nations (UN) recommends consumption of 250 ml of milk/capita/day but the current availability is about 150ml/capita/day in Nepal. It clearly shows a big gap between the demand and supply of milk. So, there is a high scope of dairying and it would continue for some decades in Nepal.

MAJOR CONSTRAINTS IN DAIRY SECTOR DEVELOPMENT

In spite of tremendous scope of the dairy sector it could not take its momentum as per the national expectation. The main constraints in dairy sector development have been listed as below:

1. High percentage of low productive cattle and buffaloes

Out of the total milk production of the country, about 70% comes from buffalo and 30% comes from cattle. Nepal is considered as the second country (after Pakistan) in the world based on the contribution of buffalo in total milk production of the nation. Though the total population of cattle and buffalo is very high there is the dominance of local animals that are very low productive. Only about 12% of cattle and 30% of buffalo are crossbred. Because of the long gestation period and generation interval it takes long time to improve this mass population of the local cattle and buffalo. Therefore, the low productive population of cattle and buffalo is taken as the burden to the country.

2. High cost of milk production

It is the good sign that the traditional farming of cattle and buffalo is changing towards the semi-commercial to commercial farming system. But still the milk production from

cattle and buffalo in such commercial farming systems is basically based on concentrate feeding. Improved forage farming and forage based milk production system are not yet coming up in mass scale. This results on high cost of milk production and ultimately the net return to the farmers goes down which makes farmers reluctant to come to the dairy sector.

3. Shortage of labor in dairy sector

Though milk is almost a balanced diet and easily accepted by the poor to the aristocrats, cattle and buffalo farming is still taken as the dirty business and the job of lower class labors. Majority of the youths are not attracted to the dairy sector rather would like to go to the Gulf countries and elsewhere. This creates shortage of manpower and higher labor charge in dairy farming. This situation will further worsen until the adoption of new technology of farm mechanization becomes common and easily assessable to the dairy farmers of Nepal.

4. Low investment and high interest rate in dairy sector

In spite of government efforts to make easily accessible farm credit to the dairy farmers it is not yet materialized in real field. The financial institutions may easily invest in transportation and other services but are still reluctant for dairy sector investment. Though some lights are coming in the horizon but still the interest rate in dairy sector investment is very high which is becoming as one of the shortfalls for the dairy sector development in Nepal.

5. Lack of assured marketing system

It is a bitter truth for all of us that dairy farmers had been suffered from the unwanted milk holiday in the country till 4-5 years back. Because of the emergence of bigger dairy processing industries like, Chitwan Milk, Sujal Dairy, Sita Ram Dairy, Nepal Dairy, Himalayan Dairy, etc., the milk holiday was mitigated for some years. Because of lack of proper marketing system, only about 15% of the total milk of the country comes to the formal marking channel where as rest of the milk is consumed in its production sites. Farmers are complaining that the pricing system is not scientific and price is fixed without considering the production cost of the milk. In addition, some rumors are again coming up these days advocating that the dairy farmers may suffer from the milk holiday in near future. Therefore, people who are trying to enter in the dairy sector are in a dilemma. If this scenario continues, the dairy sector, which is in a blooming stage now, can be dismantled and the country would bear a very great non-repairable loss for a long time.

6. Institutional constraints and limitations

Department of Livestock Services (DLS) is the main stakeholder for implementation of the dairy programs nationwide. In the same time, Nepal Agricultural Research Council (NARC) has the mandate for the research on dairy sector and the Nepal Dairy Development Board (NDDB) has the role of policy advisory and services. Tribhuwan

University, Institute of Agriculture and Animal Science (TU, IAAS) and Agriculture and Forest University (AFU) have the mandate for appropriate and demand based teaching in the country. But, it seems that there is somewhere gap in conducting teaching, research and extension programs that are based on the demand of the farmers. This inadequate coordination also affects in dairy sector development in Nepal. In addition to this, the number of technical staff with the DLS is very less to address the demand of the farmers. In some districts, a single Junior Technical Assistant (JTA) has been deputed to provide the livestock services for more than five village development committees which are almost not possible in the remote VDCs of the country. In such circumstances, farmers some time face a great loss because of unavailability of the technical services to their dairy animals.

7. **Small farm size and poor infrastructure**

Majority of the dairy farmers are the small holders having less than five lactating animals with them. They are facing the problems because of the poor road, rainfed farming system, inadequate power supply, very limited access to the new technology, etc. These production factors ultimately increase the cost of production and results on low net return to the farmers.

STRATEGIES FOR THE DAIRY SECTOR DEVELOPMENT

Some of the important strategies taken by GoN, DLS for the dairy sector development is as follows:

1. **Selection of the bulls for breed improvement from elite dams based on the pedigree performance recording scheme**

Sire contributes half of the performance of the off-springs. A sire of cattle or buffalo, in one year, may contribute to produce about 200 off-springs by natural service and more than 10,000 doses of semen that contributes to produce more than 5,000 off-springs. Therefore, selection of the best bulls based upon the genetic merit of their parents is the basic and utmost principle for the breed improvement program. In this regard, government of Nepal with the financial and technical cooperation of the Food and Agricultural Organization (FAO) of the United Nations had started the Pedigree Performance Recording Scheme (PPRS) in cattle in the name of Dairy Cattle Genetic Improvement Project (DCIP) under the Technical Co-operation Project (TCP/NEP/3105/D Extension 3204) in July 2008. The program was for the period of two years. It was a very good model where Department of Livestock Services (DLS) and Animal Breeding Division of Nepal Agricultural Research Council (NARC) worked together in partnership with the private sector. Realizing the very important roles of PPRS in breed improvement program, DLS in financial support of United States Agency for International Development (USAID) continued the PPRS in the name of Food Security Promotion Project (FSPP) from the fiscal year 2010/11 for a period of three years. In addition to cattle, this project included buffalo in PPRS and the name of the program was given as Dairy Cattle and Buffalo Genetic Improvement Program

(DCBGIP). In fact, this was the milestone in breed improvement program based upon the PPRS in Nepal.

2. Increase the coverage of artificial insemination (AI) implementing the AI Mission

Breed improvement is the key factor for the dairy sector development. Since about 12% of the cattle and 30% of the buffalo were crossbred and very big mass of the cattle and buffalo is non-descript type having very low productivity it was an utmost need to implement AI Mission in cattle and buffalo. Therefore, Directorate of Livestock Production (DoLP) has initiated AI Mission from fiscal year 2011/12. NLBC is the main implementing agency of AI Mission. Before the initiation of the mission program, only 189156 animals (cattle: 148467 and buffalo: 40689) were inseminated. The AI Mission has targeted to increase the AI coverage by 100000 animals per year. Accordingly, the AI coverage in FY 2011/12 reached to 260166 and in FY 2012/13 and 365779. Now, the AI coverage is 22.86% in cattle and 6.46% in buffalo with the conception rate of 56.12 and 48.04% in cattle and buffalo, respectively (NLBC, 2013).

3. Initiation of livestock insurance policy

Livestock insurance was the highly demanded issue since long back. The Government of Nepal (GoN) has initiated livestock insurance policy in 2012 with the provision of 50% subsidies in the premium. In this connection, GoN has allocated the budget in FY 2013/14 needed for the subsidy in the premium (MoF, 2013). This is a very good start to motivate the farmers to come up with the high inspiration in commercial dairy farming.

4. Provision of soft loan for dairy farming

Farmers have been demanding for the easy access to the financial institutions for the soft loan in dairy enterprises. Realizing the importance of this sector, GoN has announced the provision of the soft loan (in lower interest rate) for the dairy sector. If this is materialized up to the village level, this would be a very good signal for the booming of the dairy enterprise.

5. Initiation of forage mission

Cost of production of milk can only be lowered down if the farming is forage based. It has been said that livestock of Nepal are deficit on feeding by more than 35% on dry matter basis. In addition, forage species grown are predominantly local and indigenous having very poor performance both on quantity and quality. To mitigate these problems, GoN has initiated the Forage Mission from the FY 2013/14. It would e a very supportive program for the dairy farmers of Nepal.

6. Market networking in dairy sector

Milk and milk products are highly perishable. These products are to be sold out as soon as possible. Hence, effective marketing network is a prerequisite for the dairy

sector development. In this connection, initiation to set up the small scale dairies, up to the potential rural areas, from Community Livestock Development Project (CLDP), programs for the formation of marketing cooperatives, distribution of chilling vats, provision of training on milk product diversification, etc. are some of the worth mentioning programs launched by DLS.

7. Programs on sanitation and hygiene

Sanitation and hygiene are very important issues for the success of the dairy industries. Famers need to have the knowledge of bio-security, personal and animal hygiene, minimization/mitigation of adulteration and quality control mechanisms in every steps of the value chain are very critical issues in dairy industries. Therefore, GoN, DLS has given high priority in such issues in recent years.

CONCLUSION

In spite of very high demand along with the substantial scope of dairying, this sector still faces many problems for its full momentum. To mitigate the constraints and to increase the production and productivity of dairy sector effective strategies, e.g. focused dairy production programs, involvement of private sector in breed improvement programs, expansion of private A.I. centers, regular supply of liquid nitrogen, multiplier herd establishment through the distribution of elite bulls from DCBGIP areas, cattle and buffalo resource center development, encouragement of forage based production system, quality services based on value chain approach, effective credit and livestock insurance policy, etc., are taken as the pre-requisites for the dairy sector development in Nepal.

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STUDY ON EXISTING TERAI GOAT KEEPING SYSTEM IN MID WESTERN REGION OF NEPAL

Jagan Natn Banjade, Narayan Paudyal, S. Adhikari and Chet Man GC
Regional Agriculture Research Station, Khajura, Banke
E-mail: banjadej@gmail.com

ABSTRACT

A field survey on existing terai goat keeping system was conducted in Banke, Bardiya and Dang districts in 2011. The selected sites of the districts were the goat production pocket areas of the respective districts. The surveyed sites in the Banke district were Chisapani and Kusum VDCs. Similarly, Satbariya and Rihar VDCs were selected in Dang and Magaragadi and Dhadhabar VDCs in Bardiya district. Altogether 60 households were surveyed randomly (20 households in each site). Sampling survey method and structured questionnaire was used to collect the information in the study sites. The secondary sources of information were gathered from District Livestock Service Offices of respective districts. The survey results showed that majority of the farmers (>70%) highly preferred local goats than improved breeds relying more on forest resources for fodder and grazing of the goats having major forage scarcity period from Chaitra to Jestha, Majority of the farmers were not practicing scientific breeding methods. Income obtained from goat keeping has been used for child's education, medical treatment and livestock health care. The existing goat keeping system revealed tremendous scope and need of research on improved breeding to avoid inbreeding, health management, feeding and incorporation of improved pasture and fodder for increase goat production and enhancing the economic status of the goat keeping farmers.

Keywords: Goat, livelihood, husbandry practices

INTRODUCTION

Goat farming is becoming increasingly popular among smallholder mixed crop-livestock farmers. Goat production is a feasible means to improve the income and nutrition of rural communities to bring them into commercial marketing systems (Braker *et al.*, 2002). With the increasing human population and diminishing land sizes, it is becoming difficult for small-scale farmers (many as small as 0.25 ha, including the homestead) to keep large ruminants. As a result, the goat farming has been very popular in recent years as a pathway to get rid of poverty (Ahuya *et al.*, 2004).

Goat farming is mostly reared in extensive and semi intensive management system in Nepal. In general, goat farmers lack adequate information on goat health, breeding, feeding, housing, fodder and forage production and marketing. The present study attempts to elucidate existing goat farming status mainly focusing on farmers' knowledge on goat breeding, feeding, health management and other major aspects in southern terai districts of mid western development regions of Nepal.

MATERIALS AND METHODS

A structured questionnaire was developed and field survey was done on goat raising pocket areas: Chisapani and Kusum VDCs of Banke district, Dhadhabar and Magaragadi VDCs of Bardiya district, and Satbariya and Rihar VDCs of Dang district of mid western development region. Altogether 60 households, 20 in each district were surveyed in 2011. Goat keeping system was also observed in each household during the survey. The secondary sources of information were gathered from the District Livestock Services Offices of respective districts. Data collected from survey were analyzed by using a Statistical Package for Social Study (SPSS, Version 16.0).

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RESULTS AND DISCUSSION

Birth pattern

In all districts, the farmers were found to be keeping terai local, Jamunapari and crossbreds goats. Majority of the farmer's had crossbred of Jamunapari and terai goats. The farmers were more dependent on complete grazing system and the goat's main kidding season was from Kartik to Magh. The birth pattern of kids is presented in Table - 1.

Table - 1: Birth pattern of kids, %

S/N	District	Single	Twin	Triplet	Total
1	Banke	69.49 (82)	26.27 (31)	4.24 (5)	118 (100)
2	Bardiya	55.1 (27)	40.82 (20)	4.08 (2)	49 (100)
3	Dang	75.47 (80)	24.53 (26)	-	106 (100)

Note: Numbers in pranthesis are number of respondent

Table - 1 showed that single birth was found more in Dang district (75.47 %) followed by Banke (69.49%) and Bardia (55.1%). The twin birth was more in Bardiya district (40.82 %), followed by Banke (26.67 %) and Dang (24.53 %). The triplet birth was found more in Banke district (4.24 %) followed by Bardiya (4.08 %). The triplet birth was not found in Dang district.

Knowledge on inbreeding

Inbreeding is one of the most important causes which were standing behind the low productivity of goats. The knowledge of farmers on inbreeding of goats is given in Table - 2.

Table - 2: Farmers knowledge on inbreeding

S/N	District	Inbreeding	
		Yes	No
1	Banke	65 (13)	35 (7)
2	Bardiya	65 (13)	35 (7)
3	Dang	70 (14)	30 (6)

Note: Numbers in parenthesis are number of respondent

The farmers are still not much acquainted about inbreeding. Awareness of farmers on inbreeding was found equal in Banke and Bardia districts (65 and 65%) while in Dang district it was 70% (Table - 2).

Reproductive performance of goats

Information regarding reproductive performance of goats is given in Table - 3. Table - 3 showed that the age at first service of female was found longer (11.53 months) in Dang district followed by Bardiya (9.35 months) and Banke (8.65 months) district. This indicated that the age at first service was more in Dang district because there were more crossbred goats. The age at first service of male was 9 months which was almost similar for three districts. Similarly, longer kidding interval was observed in Dang (4.25 months) followed by Banke (4.1 months) and Bardiya (3.7 months). The early castration was practiced on Bardiya at 3.85 months than that of in Banke (6.16 month) and Dang (5.75 months).

Table - 3: Reproductive performance of goat

S/N	District	Kidding interval, month	Age at1st service of female, month	Age at first of male, month	Castration age (month)
1	Banke	4.1	8.65	9.05	6.16
2	Bardiya	3.7	9.35	9.94	3.85
3	Dang	4.25	11.53	9.26	5.75
Mean		4.02	9.81	9.39	5.23

Preference of farmers on goat breed

Preference of farmers on different goat breeds is presented in Table - 4.

Table - 4: Preferential goat of farmer, %

S/N	Breed	Distract		
		Banke	Bardiya	Dang
1	Local	85 % (17)	95 % (19)	70 % (14)
2	Jamunapari	10 % (2)	-	15 % (3)
3	Barberi	-	5 % (1)	5 % (1)
4	Cross	5 % (1)	-	10 % (2)

Note: Numbers in parenthesis are number of respondent

The farmer's preference on local goats was 95 % in Bardiya followed by 85% in Banke and 70 % in Dang district. The Jamunapari goats' preference was 15 % in Dang followed by 10 % in Banke district. The Barberi goat was preferred by 5% farmer in each district (Bardiya and Dang). The crossbred goats were more preferred in Dang (10 %) followed by Banke (5 %).

Goat husbandry system

The husbandry practices of goats in three districts in given in Table - 5. Table - 5 revealed that stall feeding system was more proffered in Bardiya district (10%). Partial grazing was

more adopted (90 %) by the farmers of Bardiya district than Banke (45%) and Dang (35%). The complete grazing system was found more adopted in Dang district (60 %) while in Banke it was (50%).

Table - 5: Goat husbandry system, %

S/N	District	Stall feeding	Partial grazing	Complete grazing
1	Banke	5 (1)	45 (9)	50 (10)
2	Bardiya	10 (2)	90 (18)	-
3	Dang	5 (1)	35 (7)	60 (12)

Note: Numbers in parenthesis are number of respondent

Health care

The farmers of Bardiya and Banke districts (93.3%) liked to treat their goats while their goats become sick while it was 84.6 % for Dang district. Farmer's were taking support from JT/JTA's for goats' treatment in all districts. The most prevalent diseases recorded in study districts are presented in Table - 6.

Table - 6: List of prevalent health problem by month

S/N	District	Problem	Month
1	Banke	• Diarrhea, circling of head • Paralysis • Profuse salivation • Eye infection • Diarrhea, weakness • Indigestion, orf, Bloat	Poush Poush Poush Bhadra Bhadra and Aswin Bhadra and Aswin
2	Bardiya	• Cold stress • Tapeworm • Diarrhea • Castration stress • Pneumonia, stomach pain • Diarrhea • Cold stress	Poush Magh Chaitra and Bhadra Baisakh Kartik and Aswin Poush Poush
3	Dang	• Bloat • Posterior Paralysis (Kumri) • Diarrhea • Blockage of urination • Swelling of mouth and fever	Poush and Aswin-Kartik Ashwin-Kartik Baisakh Kartik Poush

Feeds and feeding system

In all study districts farmers were depending on natural resources i.e. forests, communal grazing lands for feeding of goats. The major fodder/ forage deficit period was from Chaitra to Jestha. Farmers used to graze their goats 6-7 hours in a day. The major fodder sources

were forests and farmlands. The farmers were providing grain to the goats in the form of *sani* consisted of wheat straw mixed with fermented crushed grains of barley or wheat. Especially, *sani* was providing to lactating for a limited period in a year (40–100 days/yr). Amount of concentrate varied from 50 to 250 g/head/day.

Goat marketing system

The farmers used to rear castrated bucks for more than 15 months and were selling locally when they get higher price. They used to sale bucks at the age of 12-15 months, does at old age and kids at the age of 6-9 months. Some farmer's sell their castrated bucks on live weight basis while others on bargaining basis rather than on weight basis. This is more practiced on bucks rather than does and kids. There was no market problem of goats however there was no organized marketing system of goats.

Suggestion of farmers

During the survey period all farmer were asked to express their willingness which should be provided by governmental agencies. The expression of farmers is summarized in Table - 7.

Table - 7: Supportive gears for goat husbandry, %

S/N	District	Training	Loan	Improved breed	Treatment	Pasture improvement	Others
1	Banke	21.74 (5)	4.35 (1)	21.74 (5)	21.74 (5)	21.74 (5)	8.69 (2)
2	Bardiya	36.67 (11)	10 (3)	20 % (6)	13.33 (4)	16.66 (5)	3.33 (1)
3	Dang	33.33 (8)	8.33 (2)	29.16 (7)	-	29.16 (7)	-

Note: Numbers in parenthesis are number of respondent

Farmers of Banke district were looking support on training (21.74 %), improved breed (21.74 %) and improvement of pasture lands (21.74 %). Farmers of Bardiya district were looking support for training, improved breed, management of range land by 36.67 %, 20 % and 16.66 %, respectively. Similarly, farmers of Dang district were looking support for training, improved breed, and management of range land by 33.33%, 29.16 %, and 29.16 %, respectively.

CONCLUSION

Farmers were more dependent on forestlands for grazing of the goats. The major fodder scarcity period was found to be from Chaitra to Jestha. The extension of National Park area was also becoming a major problem for grazing of the goats. Farmers are still not practicing scientific breeding methods, only 30-35 % farmers were acquainted that inbreeding practice should not followed. The goat keeping system was found extensive and semi-extensive, only 5-10 % farmers were practicing stall feeding. Similarly, the major health problem found were diarrhea, paralysis, infection, indigestion, orf, bloat, pneumonia, cold stress and internal parasites. For getting better return from goats, awareness program on goat breeding, health

management and nutritional management should be carried out. The farmer's were looking more support on training, improved breed and pasture management. The productivity of goats should be improved through cross breeding and selection.

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STUDY ON DEHYDRATION AND SHELF LIFE OF BUFFALO MEAT

Man Bahadur Shrestha and Achyut Mishra
Food Research Division, Khumaltar, Khumaltar
E-mail: shrestham6@hotmail.com

ABSTRACT

Buffalo's meats are consumed mostly among hilly communities. Among those communities Buffalo meat generally are preserved using traditional methods such as sun and heat darting. There are very few scientific studies showing the dehydration and quality shelf life of such preserved dried meat. Therefore with aim to find out the shelf life of buffalo dried meat by different methods an experiment performed in Food Research Division, Khumaltar. Meat samples from round part were collected from local markets of Lalitpur and were divided into four parts and two of the portions were treated with 10% salt solution for 10 minutes. One of the salts treated and one untreated samples were dried in cabinet (electrical) drier initially at 47^{0}C for 1.5 hours and finally 77^{0}C for 2 hours. Other salt treated and untreated samples were dried in solar drier in sunny days (temperature range 45-51^{0}C) for 2 days. Then all the partially dried meat samples were flaked manually by hammering with heavy iron. Previously cabinet dried flaked meat samples were re-dried at 77^{0}C till its brittle texture. The completion of drying for salted samples was occurred in 8 hours but non salted samples were occurred in 12.5 hours. Similarly, previously solar dried flaked meat samples were re-dried in solar drier till to achieve brittle in texture and they took next 2 days for salt treated and 3 days for non treated samples. The dried meat samples were packed in polythene bags of 25 micron and stored for sensory evaluation, chemical analysis and self life studies. Yield, moisture, protein and ash contents of dried meats prepared from buffalo round by untreated cabinet dried, salt treated cabinet dried, untreated solar dried and salt treated solar dried were evaluated and found to be yielded 24.11, 25.95, 26.28 and 26.88%, moisture; 1.83, 1.99, 3.17 and 3.69%, protein; 74.57, 73.04, 72.54 and 71.96% and ash 5.24, 4.86, 4.25 and 3.84% ?, respectively. For the sensory evaluation, all dried meat samples were seasoned equally and evaluation was carried out between 10 panelists in terms of texture, flavor and taste according to 15 point hedonic rating method and given the mean scores 12.82, 12.55 and 12.82, respectively. From the statistical analysis, it was found that there were no significant differences among the treatments for all sensorial parameters at 95 % level of confidence (P>0.05). From the microbiological study, the mold and yeast counts were found in the range of 4-10 and 2-34 cfu /gram samples. The presence of fungi might be due to the moisture uptake slowly during the storage period. Except the growth of some bacillus sps, the meat samples were found bacteriologically safe for one year.

Keywords: Buffalo meat, nutrient content, durability

INTRODUCTION

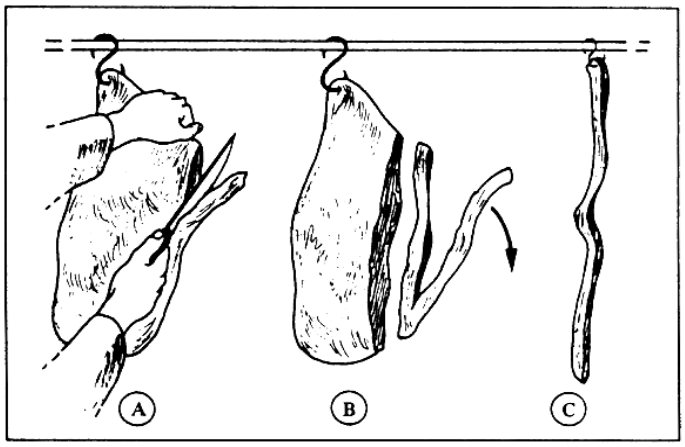
In Nepal, meat and meat products generally include the skeletal muscles of animals such as buffalo, pig, sheep, goat, poultry and fish. In general, large animal meat may not be consumable fresh thus some methods of preservation must have adopted for future use. Among them most common traditional practices are drying meat under natural

temperatures, humidity and circulation of the air, including direct influence of sun rays. In this a gradual dehydration of pieces of meat cut to a specific uniform shape that permits the equal and simultaneous drying of whole batches of meat.

Buffalo is an excellent red meat source low in fat and high in protein and minerals. Research carried out by Dr. Marchello, University of North Dakota has shown that buffalo is a highly nutrient-dense food because of the proportion of protein, fat, minerals and fatty acids to its caloric value along with high concentration of iron and essential fatty acids. The buffalo meat is traditionally dried in household using rural methods. Here, in present study we carried out to assess the meat quality, taste and self life of buffalo meat under different treatment methods at Food Research Division, Khumaltar, Lalitpur in FY 2068/69.

MATERIALS AND METHODS

Buffalo meat samples from round part was collected from local market of Lalitpur. Using a sharpened knife, the covering fat from the external and internal sides of the carcass and the visible connective tissue, such as the big tendons and superficial fasciae, are carefully trimmed off. The muscle was then cut into thin strips. All strips to be dried in one batch were cut to an identical shape as smoothly as possible and care was taken to be the diameter of the strips remains same throughout the length. The meat was then divided into four parts and two of the portions were treated with 10% of salt solution for 10 minutes. Pre-salting not only contributes to a tastier product, but is also desirable from the technological and hygienic standpoint. For salting pure common salt was dissolved in water to make 10%, stirred well to dissolve and meat was dipped in that solution for 10 minutes. Objective of dipping the meat into the salt solution was to inhibit microbiological growth on the meat surfaces and to provide protection against insects during drying. Another function of salt is to impart in taste. The rest two were directly dried.



During drying, one of the salt treated and one untreated samples were dried in cabinet (electrical) drier maintained the temperature initially at 47^{0}C for 1.5 hours and finally 77^{0}C for 2 hours. Next one salt treated and one untreated samples were dried in solar drier in sunny days (temperature ranged 45-51^{0}C) for 2 days. Then all the partially dried meat samples were flaked manually by hammering with heavy iron. Previously cabinet dried flaked meat samples were re-dried at 77^{0}C till its brittle texture. The completion of drying for salted sample was occurred in 8 hours but non salted sample was occurred in 12.5 hours. Similarly, previously solar dried flaked meat samples were re-dried in solar drier till the

texture become brittle and they took next 2 days for salt treated and 3 days for non treated samples. All the dried meat samples were packed in polythene bags of 25 micron and stored for further quality evaluation.

RESULTS AND DISCUSSION

Physicochemical parameters such as yield, moisture, protein and ash contents of dried meats prepared from buffalo round by untreated cabinet dried, salt treated cabinet dried, untreated solar dried and salt treated solar dried were evaluated. The observations were replicated for three times and mean score were taken for the expression as a result average composition of different nutrients are presented in Table - 1.

Table - 1: Nutrient content of buffalo meat, %

Treatment	Yield	Moisture	Protein	Total ash
Untreated cabinet dried	24.11	1.83	74.57	5.24
Salt treated cabinet dried	25.95	1.99	73.04	4.86
Untreated solar dried	26.28	3.17	72.54	4.25
Salt treated solar dried	26.88	3.69	71.96	3.84

The moisture content was found higher (3.69%) in salt treated solar dried meat samples. Nevertheless the drying was effective against controlled drying system, cabinet drier, compare to natural drying (solar) system. Moisture is the key factor for the shelf life and biochemical changes during storage life of dried meat i.e. higher the moisture content lower will be the shelf life. The yield, protein and total ash contents were highly depends on the moisture. Higher the moisture higher will be the yield but the protein and total ash were negatively correlated with moisture.

Microbial testing was observed after one year of storage in packing (25 micron PE bag) condition. From the microbiological study after one year storage, the mold and yeast counts were found in the range of 4-10 and 2-34 cfu /gram samples. The presence of fungi might be due to the moisture uptake slowly during the storage period. Except the growth of some bacillus sps, the meat samples were found bacteriologically safe for one year.

For the sensory evaluation, all dried meat samples were seasoned equally and evaluation was carried out between 10 panelists in terms of texture, flavor and taste according to 15 point hedonic rating method and given the mean scores 12.82, 12.55 and 12.82, respectively. From the statistical analysis, it was found that there were no significant differences among the treatments for all sensorial parameters at 95 % level of confidence ($P>0.05$).

During meat drying, the thickness of the meat strips determines the duration of the drying process. Since thick strips take considerably more time to dry than thin ones, it is important that strips to be placed in the same batch are of the same cross-section, with only the length differing. Insufficiently dried or over dried pieces will be the result if this rule is not followed. Cutting muscles into long, thin and uniformly shaped strips requires experience

and skill. Knives with broad blades are best suited for this purpose (Gracey and Collins, 1994).

In red meat, lean muscle is composed of bundles of hair like muscle fibers. These protein muscle fibers are held together by proteinaceous connective tissue which merges to form a tendon which in turn connects the muscles to a bone. The muscle fibers themselves are elongated cells that contain many smaller highly oriented fibrils. A major protein of muscle fiber is myosin and actins. In well fed animals fat penetrates between the muscle fiber bundles called marbling and makes muscle tendered. The compositions of meat cuts will vary with the relative amounts of fat and lean but a typical cut of beef contain 60% water, 21% protein, 18% fat and 1% ash (Lawrie, 1985).

Warm, dry air of a low humidity of about 30 percent and relatively small temperature differences between day and night are optimal conditions for meat drying (Lawrie, 1985).. However, meat drying can also be carried out with good results under less favorable circumstances when basic hygienic and technological rules are observed. Intensity and duration of the drying process depend on air temperature, humidity and air circulation.

CONCLUSION

- Though the moisture (might be lower shelf life!) content was slightly higher in solar dried meat, the process of drying meat using solar drier is economically viable.
- Though the protein content was slightly higher in untreated dried meat, salt treatment aids in preservation as well as imparts in taste.
- Except the growth of some bacillus sps., the meat samples were found bacteriologically safe up to one year with simple plastic wrapping.

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SOLAR DRYING PROCESSING AND PRESERVATION OF RABBIT MEAT

Damodar Neupane[1], Achyut Mishra[2], Narayan Burma[3] and Subarna Man Pradhan[1]
[1]Swine and Avian Research Program, Khumaltar, Lalitpur
[2] Food Research Division, Khumaltar, Lalitpur
[3]Department of Livestock Services, Harihar, Bhawan, Lalitpur
Email: damodarneupane@yahoo.com

ABSTRACT

This study was conducted to develop a method for improving processing and preservation of rabbit meat using solar drying. For this study, twelve meat rabbits of Soviet Chinchilla and Californian Hyaline breeds maintained on concentrate based diet with forage grass supplementation at Swine and Avian Research Program, Khumaltar, Lalitpur were slaughtered at the age of 18 weeks. Dried meat was prepared by skinning, deboning, salting and drying in temperature of 45 to 50°C for 2 sunny days in Solar drier after cutting the meat into cubes of 1-1.5 cm thickness. Two pre-drying preservation techniques (Control: Dried without any treatment of brine; Treatment 1: 3% brine for 2 days at 4°C and Treatment 2: Dipping in 10% brine for 1 hour at 25°C). The indication of drying was measured by its brittle textures. The dried samples were analyzed by sensory evaluation according to hedonic rating (evaluation of texture, flavor and test) method where 15 panelists were involved. The dried meat was found good in terms of colour and taste but was hard in texture. The result showed that the dried meat treated with 10% Nacl was found significantly superior (overall acceptance 8.07/9) followed by the dried meat treated with 3% Nacl (overall acceptance 7.42/9) and the non-treated meat or control (overall acceptance 7.38/9).

Keywords: Rabbit and meat preservation technology

INTRODUCTION

Over past few years, numbers of farm families in middle hilly region of Nepal have chosen rabbitary as a subsidiary occupation. Farmers have found rabbitary not only environment friendly but also of substantial economic importance. Early maturity age and high prolificacy has established rabbit as an efficient meat producer. Best known for being prolific, rabbits are herbivores that efficiently convert fodder to food. The meat rabbits are easy to rear since major portion of their diet required for the growth can be fulfilled using forages, fodder and crop byproducts. So, high quality rabbit meat can be produced in low cost. Under efficient production system, from the total consumed protein rabbit can convert 20% of the protein to edible meat. The comparable Fig:-s of the same indicator for other species are 20-23 percent for broiler chickens, 16-18 percent for pigs and 8-12 percent for beef cattle. Rabbit meat contains high protein and yet low cholesterol. Therefore, rabbit has been safe and rabbitary has not witnessed any epidemics leading to complete failure of the enterprise or huge economic loss unlike that of avian influenza in poultry birds. With the advancement of information and communication technology, the degree of reluctance in the consumption of rabbit meat has declined sharply. Current market trends therefore suggest

that if it is made available regularly in the market rabbit meat will be a highly demanded item.

In Kathmandu, rabbit meat is being produced and selling at Budanilakanth only. In some villages of Myagdi and Parbat districts of western hills, rabbit meat is the main meat to fulfill the local meet demand. So, the number of consumers for rabbit meat is increasing day by day. Therefore, a study on processing and preservation technology for rabbit meat and skin was conducted at Swine and Avin Research Program, Khumaltar, Lalitpur.

MATERIALS AND METHODS

Twelve meat rabbits belonged to Soviet Chinchilla and Californian Hyaline maintained on concentrate based diet with forage grass supplements were slaughtered at the age of 18 weeks. The slaughtered rabbits were skinned and head, foot and intestine removed. The live weight and dressed weight of rabbit was measured and recorded. The rabbit meat was dried at Food Research Division's laboratory, Khumaltar, Lalitpur by deboning, salting and drying in temperature of 45 to 50°C for 2 sunny days in solar drier after cutting it into cubes with 1-1.5 cm thickness. Salting for two samples by dipping in 10% salt solution for 1 hour at 25°C and in 3% salt solution for 2 days at 4°C and one sample was dried as such without any treatments (control). The indication of drying was measured by its brittle textures. The dried samples were analyzed by sensory evaluation according to hedonic rating method where 15 panelists were involved. The rating scales are presented in Table - 1 and carcass measurement in Table - 2.

Table - 1: Rating scales

	Ranking
Like extremely	9
Like very much	8
Like, moderately	7
Like slightly	6
Neutral	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Table --2: Measurement of pre slaughter weight and dressed weight in kg excluding legs and head

S/N	Rabbit No	Live weight in kg	Dress weight in kg
1	11695	2.5	1.5
2	03275	2.3	1.3
3	03279	2.1	1.2
4	03255	2.4	1.4
5	03277	2.1	1.15
6	03254	2.3	1.25
Total		**13.70**	**7.80 (56.93%)**

RESULTS AND DISCUSSION

Meat quality, taste and texture

The samples of dried meat prepared differently were evaluated on the basis of texture, flavor and taste by the team of 15 panelists. It was found that the overall acceptance including texture, flavor and taste of the dried meat treated with 10% Nacl solution was found superior followed by the dried meat treated with 3% Nacl solution and the not treated (control) dried meat (Table - 3). According to the panelist the dried rabbit meat could have good markets compared with fresh rabbit meat in the markets. The dried rabbit meat was liked by the entire member of the panel. It was also compared with the buff dried meat which was also having sensory evaluation test on the same occasion by the same panel, all of them responded very positive response for dried rabbit meat compared with buff dried meat.

Table - 3: Texture, flavor, taste and overall acceptance

Sample codes	Texture	Flavor	Taste	Overall acceptance
Control dried meat	7.18 II	7.25 II	7.18 III	7.38 III
Dried meat treated with 3 %Nacl	6.81 III	7.25 II	7.37 II	7.42 II
Dried meat treated with 10 %Nacl	7.93 I	8.06 I	8.00 I	8.07 I

CONCLUSION

It is concluded that, the dried rabbit meat treated with 10% Nacl solution could have better market than the dried meat not treated and the fresh rabbit carcass.

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CLIMATE SMART AGRICULTURE (CSA): ROLE OF LIVESTOCK AND FISHERIES IN NEPAL

Ghanshyam Malla, Ananda Kumar Gautam, Alok Sharma and Arjun Prasad Timilsina
Agricultural Environment Research Division, Khumaltar, Lalitpur
Email: ghanashyam_99@hotmail.com

ABSTRACT

Climate Smart Agriculture (CSA) is a way forward for food security in Nepal. It helps communities to adapt and mitigate climate change by adopting appropriate practices whereas livestock and fisheries are important sectors for food and nutrition to people. This paper thus aims to highlight the role of livestock and fisheries in CSA. For the purpose we reviewed published papers to generate concepts and scope of livestock and fisheries in CSA. As an impact of temperature rise by 2.5^{o}C might create high risk of extinction of animal species by 20-30 % and extreme weather could increase disease and pest epidemic in livestock and fisheries in Nepal. Findings showed that CSA is barely possible without livestock practices. Livestock save energy, sequestrate carbon, reduces water demand, increases soil fertility, adapts to extreme weather conditions and converts agricultural byproducts to manure which is crucial for soil health. Therefore, it plays vital role in CSA. Thus, for millions of people in rural areas, especially in dry and infertile areas where other agricultural practices are less practicable, efficient and resilient livestock and fisheries practices such as: agro-forestry, participatory pasture and range land management, multi nutrient block to improve digestibility of fibrous feed, monitoring of environmental performance, rice-fish integrated systems and control of climate induced disease and pest etc. are recommended for adaptability and mitigating climate change in the country.

Keywords: *climate change, CSA, fisheries, GHG, livestock and mitigation*

INTRODUCTION

Climate change and population growth are major threat to global food security. Thus, it's time to move on to Climate Smart Agriculture (CSA) to ensure to feed everyone. CSA is an innovative climate friendly agricultural practice for adaptation, food security and mitigation of climate change. *"It is not business as usual agricultural practice, as there are also many technologies and practices that are not climate-smart, such as: building large irrigation schemes in regions where rivers are likely to dry will do nothing for adaptation over the longer term"* (Campbell, 2010). Therefore, the practice should have characters of adaptability, enhance productivity and climate friendly. Effective implementation of useless lands, water, inputs is necessary for the initiation of the practice to produce more food in the country. To feed everyone, productivity of all sectors should be improved, either by decreasing or keeping constant the Green House Gas emission. Thus, CSA would be the only solution for food security without affecting the environment. Conservational agriculture (CA), integrated nutrient management system (INMS), water harvesting and use, pest and disease control, resilient ecosystems, genetic resources and improvement of social constraint etc. are the practices that should be increased to achieve the objectives of CSA.

Livestock is an integral part of subsistence farming system and it is a close partner of ecosystem and agriculture in Nepal. It contributes 13% of GDP in national economy (Gurung, 2011). It also adds value to resources that would otherwise go waste. The marginal lands that cannot be used and indeed should not be ploughed are used for grazing. Wastes like straw, legumes waste, groundnut, and household wastes, all go to feeding livestock. It provides animal protein and food for all people especially in dry infertile areas where other agricultural practices are less practicable. Thus, to achieve sustainable livestock production for nutritional security, climate smart livestock practice is required (FAO, 2010). For example, improvement of pasture *Brachiaria decumbens*_showed 200 and 170% higher milk/day and live weight kg/day respectively where as methane emission was only 24% higher compared with *Cerrado sps* (Thornton and Herrero, 2007). Agro-forestry, participatory pasture and range land management, multi nutrient block for the improving digestibility of fibrous feed. Monitoring of environmental performance and control of climate induced disease and pest etc. are the practices recommended for Climate Smart Livestock Production.

Fisheries play important role in food and nutrition security of rural and marginal people in Nepal. Presently, the animal protein intake is only about 12%of the total protein requirement, on which fish contributes only 1.4 % with 1.8 Kg per capita/year consumptions. Fisheries and aquaculture employed about 578000 people and 53 % of this population is comprised of women (Mishra and Upadhyaya, 2010). In order to improve the fisheries production and minimize the dependency on the limited and uncertain natural resources, the fish farming should be given high priority in our policies along with efficient implementation. Therefore, efficient and resilient fisheries practices such as: monitoring of environmental performance, rice-fish integrated systems and control of climate induced disease and pest etc. are recommended for improving fish production.

Impacts of climate change on crops, livestock and fisheries

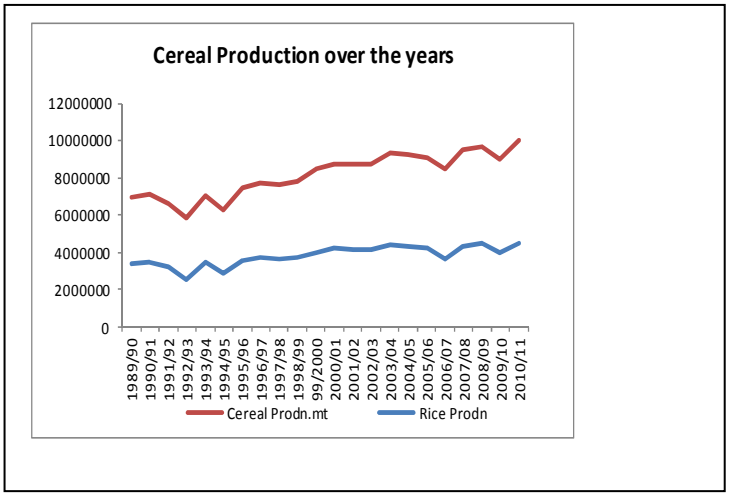
Climate change is an emerging issue that has been posing threat in all sectors, especially in food security. It is expected that, with a 2.5^{o}C rise in global temperature, 20-30% of animal species could face high risk of extinction (Calvosa, 2009). INC (1994/95) showed 65% (527Gg) of total 867Gg methane emission was only from enteric fermentation and now it would be 909.6Gg and also predicted that it would likely be double by 2020. The recent population of livestock has increased by 72.6% in 1994/95AD.

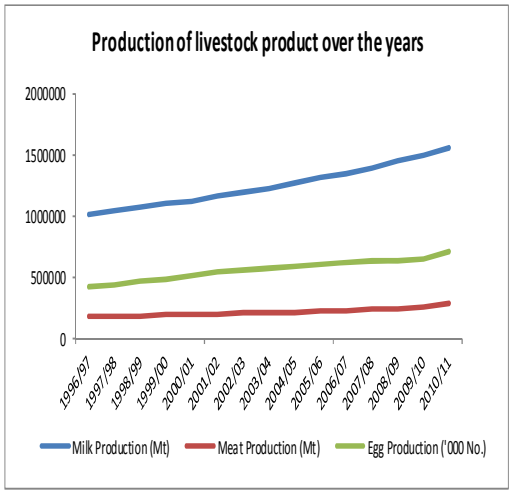
Though livestock in Nepal is a major source of methane and nitrous oxide and has been blamed for high production of GHGs emissions i.e. 18% of the total in the atmosphere its adaptability and economic return is better as compared to crops. The capacity of local communities to adapt climate change and mitigate its impacts might depend on socioeconomic status, environmental condition and resources (Devkota, 2010). However, intensive rearing of pig and chicken might be more sensitive to climate change.

In fisheries climate change has brought challenges, such as over-fishing, poor management, increase in unpredicted storms and extreme weather events (FAO, 2010). Fish products are

perishable and sensitive to moderate temperature rises. Therefore, it requires more energy for processing, sanitation and preservation.

Likewise, the expansion in the range of warmer water species is possible in the context of climate change, whereas the colder water species gets endangered with rise in water temperature. The trout aquaculture in cold water region of the country might have the negative impact. Thus, for food security, nutritional security and better livelihood of millions of people, efficient and resilient climate smart agriculture, livestock and fisheries practices are the most.





The above Fig:-s (Number) shows trend the production trend of cereal, livestock and fisheries products over 15 years of (1966/67-2010/11), the. Increase in temperature and erratic rainfall in past has affected the production of cereal crops and reduced the production as adverse precipitation pattern, whereas, in livestock and fisheries production change in temperature and rain fall has not affected as in cereal crops. Livestock and fisheries production is increasing trend over the years even in adverse climatic condition. It might be due to the sectors having higher adaptability with climate change compared to cereal crops. However, the sector is still uncertain and would be vulnerable with climate impact likes change in breeding pattern and disease outbreaks. Thus, though livestock is green eater and environment polluter, integration of crops with livestock practice in farming system would be helpful for climate smart agriculture and nutritional security of people.

MATERIALS AND METHODS

Livestock and fisheries being an integral part of agriculture in Nepal, reviews were done to collect relevant information from these sectors.This paper is based on review of available literatures in the area of CSA typically for livestock and fisheries. Most of the information has been gathered through review of journals, proceedings, WebPages and articles published in national and internationals journals. The information and ideas are developed based on a series of interaction with key personnel working in the respective areas.

Basic pillars of Climate Smart-Agriculture

In order to achieve climate smart agriculture in the world, climate resilient and efficient farming of crops, livestock and fisheries production has to be enhanced in all levels along with the enhancement of resilient technologies in the sectors. The basic pillars of climate smart agriculture are as follows:

(i) Weather smart

Any eco-friendly practice or technology should be more resistant to weather parameters such as: hailstorm, rain, temperature rise etc. compared with conventional practice is called weather smart. In general livestock and fisheries are more resistant to climate change than the crops. In other words, minor change in temperature and precipitation has negligible impacts in these sectors. Therefore, an integration of these sectors is believed to provide better food security compared to stand alone crop cultivation or livestock keeping.

(ii) Water smart

The wise use of water during production can help to conserve precious water resources. Any CSA practice should bear the minimum quality of consuming less water. Although livestock and fisheries are water and energy intensive for processing, they can be adapted for their higher economic return. Livestock plays vital role to save water as it increases water holding capacity of the soil by improving physical properties of soil.

(iii) Carbon smart

The technology developed to increase agricultural productivity that emits less GHG as compared to conventional practice is called carbon smart. Agro forestry and management of pasture and rangeland for livestock production will help in mitigation of climate change by sequestration of carbon.

(iv) Nutrient smart

The ability to transform nutrient in soil through biological process and minimize the use of fertilizers can help to reduce GHGs emission is called nutrient smart. Recycling appropriate materials and composting agricultural waste by livestock farming reduces the impact of landfills as well as the demand of chemical fertilizers for cultivation.

(v) Energy smart

Innovative technology should require less energy compared to conventional practice. In order to make the practice energy smart, we should consider ways to improve personal energy efficiency and decrease use of machinery in farm. Livestock can also be utilized for land preparation, transportation and producing biogas energy. This can be termed as energy smart.

Potential GHG reducing CSA practices in crops

Agriculture is a large source of N_2O, accounting 58% of the total emissions mostly due to use of fertilizer in soil and of CH_4 accounting for 47% of total emission essentially from livestock and rice cultivation. Those emissions are depending on natural process and agricultural practices, which make them more difficult to control (FAO - CSA- module 1). But there are CSA practices that are capable of reducing GHGs in the country.

Examples of CSA practices are:

- Mitigating methane emissions through new Irrigation Schemes (Bohol, Philippines), where, alternate wetting and drying in rice field is done to reduce N_2O and CH_4 emission. It reduces methane emissions by 48 % compared to continuous flooding of rice fields and increases productivity.
- Urea Deep Placement (UDP) is applied for reducing loss of fertilizers from field and it enhances efficiency of fertilizer use in the soil. This practice decreases nitrogen losses by 40 %, increases urea efficiency up to 50% & increases yield by 25% (Bangladesh 0.5 million ha).
- Mitigating GHGs emission through new Zero Tillage practice (Western Nepal), where wheat sowing is done to reduce carbon by 26% compared to conventional tillage and increases productivity by 16%. It also saves moisture loss from field, labor cost as well as improves soil health.
- Save and Grow system is helpful to minimize food losses and waste. It reduces unwanted use of food and energy for cultivation and processing practice.
- Prevention of major insect pest disease can be helpful to improve production.

Role of livestock and fisheries in CSA

Livestock plays an important multifunctional role in many rural areas providing food, income, draught power for land preparation and transport by reducing energy consumption. It helps in agriculture by playing important role on soil nutrient cycle. Livestock is the main source of organic manure required for maintaining the soil fertility. It is also reported that it provides 9 million tons manure annually for the 3 million hectares of cultivated land through the use of grazing land 19%, crop by product (37%), forest biomass (35%) and secondary plant residues (9%) in Nepal (Sherchand, 2001). Livestock are the only ready source of cash to buy inputs for crop production like seeds, fertilizers and pesticides. A fishery also plays an important multifunctional role in many rural areas. It provides healthy meat, extra income and helps agriculture in many ways as livestock Thus, for rural areas, where agricultural practices are less possible for the livelihood the enhancement of livestock and fisheries practices are beneficial.

Furthermore, livestock saves energy by producing alternate energy like biogas, local transportation and in tillage operation where mechanization is impossible. It sequestrates carbon by enhancing agro forestry, pasture and rangeland management, reduces water demand by increasing water holding capacity in soil, increases soil fertility by the addition of organic source as FYM and recycles agricultural waste to soil nutrient. It is more resistant

to weather change than the crops because of its mobility and has negligible impact on livestock. Moreover itt is readily reachable, affordable, applicable and knowledgeable practice.

RECOMMENDATIONS

Climate Smart livestock and fisheries would be beneficial for mitigating climate change, improving environment and food security in the country. In order to address continued problems related to food security due to climate change. Following practices helps to improve food security in the country.

Livestock

- Agro-forestry: Systems are efficient safeguarding food security and the environment and much more resilient to climate change. Productivity is also higher in agro-forestry systems. Costs are reduced, especially for fertilizers. There would be more organic matter in the soil for better use of nutrients by the plants. Agro forestry and cover crops particularly in the Terai and hill region like: *Delbergia sissoo* and maize, *Eleusine coracana* and potato, double crop intercropping like sissoo, pigeon pea, and maize or *Eleusine coracana* and *Phasiolus vulgaris* would help poor farmers to improve livelihood in country.
- By reintroducing native plants and participatory rangeland management fodder requirements and ecosystems can be restored. Furthermore, conservation and introduction of local high nutritive fodder/pasture, elimination of poisonous weeds and improvement of range land would be helpful in livestock production. Alpine forage: Rye grass and Cocksfoot was found to be helpful for similar agro- ecological zone for sheep and goat production in Jumla.
- Monitoring the environmental performance of livestock supply chain would helpful to increase productivity of livestock.
- Multi nutrient blocks to improve digestibility of fibrous feeds will be beneficial to increase productivity of livestock with constant emission of GHGs. The technology should be distributed at farmer's level.
- Biological Nitrification Inhibition (BNI) by *Brachiaria humidicola* hybrids forage grass reduces N (nitrogen) losses; improve economic benefits and environmental sustainability from integrated crop-livestock production systems.
- Control of animal diseases related to climate changes should be done properly since disease and parasites are the foremost challenge in livestock production.

Fisheries

- Rice-Fish integrated system is an example of very productive systems that also provide more balanced diets and is resilient to climate change in low land.
- Energy efficient aquaculture: Farming of seaweeds requires minimal energy inputs, additionally; such systems can filter nutrients and provide a "cleaning service" to coastal marine environments.

- Low Energy Fuel Efficient Fishing system that uses gill nets, pots, hooks, lines and traps can reduce fossil fuel consumption by a 30-40 % over conventional active fishing gears. (December 29, 2010 FAO, climate smart agriculture)
- Aqua silviculture system commonly used in Indonesia, Vietnam, Hong Kong, Philippines, and Malaysia is more environments friendly.

CONCLUSION

The population is growing; it's time to move on climate smart agriculture (CSA) to ensure country's ability to feed everyone. Rapid increase in population and limited or no chance for expansion of agricultural land and natural resources is the major problem. It is difficult to feed the increasing population from the available resources. Therefore, above listed recommendations in this paper would be helpful in future for sustainability of agricultural development and for food and nutritional security of the country.

Improving agricultural productivity is vital to confront Nepalese challenges of reducing poverty, improving food security, and improving human nutrition and health. However, increased productivity must be achieved while reducing agriculture's environmental impact.

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ECONOMIC ASSESSMENT OF FEEDING PRACTICES AMONG RURAL PIG FARMING COMMUNITIES

Ram Deo Pandit[1], Ram Bali Sah[2], Bishnu Prasad Kushwaha[2], Rakesh Prasad Sah[2], Md. Shaha Navaz Ali[2] and Pawan Kumar Jha[1]

[1]Regional Agricultural Research Station, Tarahara, Sunsari

[2]National Buffalo Research Program, Tarahara, Sunsari

Email: ramdeopandit@yahoo.com

ABSTRACT

A trial was conducted at Banigama VDC of Morang District under Model Village of RARS, Tarahara to assess the increment of Pig carcass weight by using available farmer feeds. Altogether 12 farmers were randomly selected and 12 Piglets of two months of age were distributed. The experimental piglets were allocated into 4 treatments with 3 replications by using completely randomized design. The dietary treatment was D1 (scavenging+mash feed @300gm up to 1.5 kg/day/head; control), D2 (mash feed @300 gm up to 2.5 kg/day/head; dried), D3 (mash feed @300 gm up to 2.5 Kg/day/head; soaked) and D4 (mash feed @ 300 gm up to 1.5 Kg/day/head with chopped green leaves; cooked). The dietary mash concentrates included locally available rice polish, rice bran, rice chafer, wheat bran, maize bran, kitchen waste and green leaves (Latte leaves, Cauliflower leaves, Bethe shrubs, Jalkumbhi, Kachu shrubs, Kane shrubs, Mane shrubs, Rao leaves, Gagletto shrubs). Experiment revealed that the mean body weight gained at 12 months in D1, D2, D3 and D4 was found 74.56±3.64, 80.93±4.72, 97.63±5.67 and 112.14±7.35 Kg respectively that were statistically significant at 5 % level of significant. The feed conversion ratio (FCR) was found lowest (2.64:1 kg) in D4 as compared to D1, D2 and D3 (3.97:1, 4.73:1 and 3.92:1 Kg), respectively. However maximum profit NRs. 8519.00 was found in D4 up to age of 12 month.

Keywords: Model village, carcass weight, feed, FCR, profit

INTRODUCTION

Pig grows faster than any other farm animals. The total population of pig in the country has been estimated 1108465 producing about 17923 Mt. meats (MoAC, 2010/11). Pigs usually slaughtered while reach in active growth phase at about 90 kg body weight in most of the western countries in six months of the age. However, in Nepal such body weight has been achieved up to ten month due to poor quality rations. This means the nutritional needs of pigs for carbohydrates, proteins, fats, minerals and vitamins must be analyzed for profiTable - production.

Sah *et. al*. (1996) reported that pig can be fed 25 percent green grasses oat + berseem to reduced concentrate ration without any adverse effect of pig body. Similarly, Pandit *et al*. (2000) also reported that 35 percent farmers fed their pigs green grass, Rayo sag, Latte sag, Khubhindo, Sisno, Bethe, Banana leaves, sucker and kitchen waste. The good quality forage could be fed to pigs for increasing body weight and reduced the cost of concentrate. Possibility of feeding water hyacinth to pigs has also been shown (Ranjhan 1980). Friends *et al*. (1973) reported that

the full grown pig can conveniently supplied 3-5 kg of leafy succulent green feeds with 10-15 percent dry matter. Similarly, finisher pigs may be fed with succulent green feeds at the rate of 2.5 kg/day/head concentrate and the rest of the ration may be a green pasture as reported by Ranjhan *et al* 1971. Lush green pasture supply many vitamins, minerals, protein and unidentified factors (Banerjee, 1998).

MATERIAL AND METHODS

This study was conducted at Banigama VDC of Morang District under NARC Model Village of RARS, Tarahara to access the increment of pig carcass weight by using available farmers' feeds. Altogether 12 farmers were randomly selected and 12 male piglets of two months of age were distributed .The weight of piglets was between 8 to 9 kg. The trial was designed by using CRD and experimental animals were divided into 4 treatments with 3 replications. The dietary treatments were;

D1=scavenging+ mash feed @300gm up to 1.5 kg/day/head, Control
D2= Mash feed @300gm up to2.5 kg/day/head, dried
D3=Mash feed @300 gm up to 2.5 kg/day/head, soaked, and
D4=Mash feed@300gm up to 1.5 kg/day/head with chopped green leaves, cooked

The dietary feed was used home made concentrates(rice polish, rice bran, rice chapper, wheat bran, maize bran), green leaves(latte leaves, cauli leaves, bethe shrubs, jalkumbhi, kachu shrubs, kane shrubs, mane shrubs, rayo leaves, berseem grass, gagletto shrubs and kitchen waste. Piglets were vaccinated and drenched according to need. These were monitored time to time and data were monthly recorded. The analysis package were used MSTAT.

RESULTS AND DISCUSSION

Using available farmer feeds

The available farmers dietary feed was used home made concentrates(rice polish, rice bran, rice chapper, wheat bran, maize bran), green leaves(Latte leaves,Cauli leaves, bethe shrubs, jalkumbhi leaves, kachu shrubs, mane shrubs, Rayo leaves, Berseem grass, gagaletto shrubs and kitchen waste. It was made combination for used to feed pigs.

Monthly mean body weight gain (kg)

The two month age of piglets showed 8.40±0.36, 8.56±0.25, 8.53±0.35 and 8.23±0.15 kg compared to D1, D2, D3 and D4, respectively. Which was non significant at ($P<0.05$). The 4th month of age showed 18.03±0.55, 18.20±0.57, 20.73±0.67 and 20.67±0.47 kg compared to D1, D2, D3 and D4, respectively which were significantly differed at ($P<0.05$). The 8th month of weight gained 48.93±2.93, 57.26±3.59, 59.10±4.62and 63.96±5.49 kg as D1, D2, D3 and D4, respectively. However, the final mean body weight gained at 12 month in D1, D2, D3 and D4 was found 74.56±3.64, 80.93±4.72, 97.63±5.67 and 112.14±7.35 kg, respectively. Which were significant differed at ($P<0.05$). The monthly mean body weight gained up to 12 month showed Table - 1.

Table - 1: Monthly mean (± SD) body weight gain (Kg)

Month	D1	D2	D3	D4	CV%	F-test
2 month	8.40±0.36	8.56±0.25	8.53±0.35	8.23±0.15	3.46	NS
3 month	12.66±0.47	12.63±0.39	12.93±0.47	13.33±0.95	2.89	NS
4 month	18..03±0.55	18.20±0.57	20.73±0.67	20.67±0.47	2.91	*
5 month	24.80±1.05	22.66±1.16	28.06±1.07	30.40±1.95	4.01	***
6 month	30.83±1.45	35.73±1.80	39.96±1.59	41.20±2.57	2.10	***
7 month	39.50±2.01	49.66±2.30	48.33±2.95	52.40±2.95	2.26	***
8 month	48.93±2.93	57.26±3.59	59.10±4.62	63.96±5.49	1.89	***
9 month	59.00±2.55	63.50±3.75	66.80±4.00	78.16±5.61	2.03	***
10 month	65.46±2.80	68.70±3.61	77.66±4.50	87.40±5.95	1.96	***
11month	70.96±3.59	76.33±3.78	85.73±4.95	97.80±6.15	1.87	***
Final	74.56±3.64	80.93±4.72	97.63±5.67	112.14±7.35	1.44	***

NS= non significant *=significant ***=highly significant D=diet

Feed consumption up to age of 12 month (kg)

The total feed consumption 3 month up to 12 month was 296.5, 383.5, 383.5 and 296.5 kg in D1, D2, D3 and D4, respectively. The feed was provided according to dietary treatment. The feed was gradually increased 3 month up to 12 month of age. The feed consumption up to 12 month of age showed Table - 2.

Table - 2: Total feed consumption up to age of 12 month (kg)

Month	D1	D2	D3	D4
2month	0.0	0.0	0.0	0.0
3month	10.0	10.0	10.0	10.0
4month	12.0	15.0	15.0	12.0
5month	15.0	22.5	22.5	15.0
6month	22.5	30.0	30.0	22.5
7month	30.0	36.0	36.0	30.0
8month	36.0	39.0	39.0	36.0
9month	39.0	45.0	45.0	39.0
10month	42.0	51.0	51.0	42.0
11month	45.0	60.0	60.0	45.0
12month	45.0	75.0	75.0	45.0
Total	296.5	383.5	383.5	296.5

Total body weight gain and feed conversion ratio (FCR) Kg

According to feed consumption, the total body weight gained up to 12 month was found 74.56, 80.93, 97.63 and 112.13 kg in diet D1, D2, D3 and D4, respectively. Which were significantly differed at (P<0.0.05).However, feed conversion ratio(FCR) was found better 2.64 kg in D4 as compared to D1,D2 and D3 as 3.97,4.73 and 3.92 kg respectively. The total body weight gain and feed conversion ratio (FCR) showed Table - 3.

Table - 3: Total feed, body weight gain and FCR at the end of 12 month (kg)

Description	**D1**	**D2**	**D3**	**D4**
Total feed (kg)	296.5	383.5	383.5	296.5
Total live weight gain (kg)	74.56	80.93	97.63	112.13
Feed conversion ratio, FCR (kg)	3.97	4.73	3.92	2.64

Economic analysis

The maximum return showed NRs 8519.0 in D4 compared to NRs 3635.0, 3419.0 and 5590.0 as D1, D2 and D3, respectively. The cost was to be estimated on farmers selling prices. The farmers' sales their pigs on live weight basis to butchers through bargained. The cost benefit analysis showed Table - 4.

Table - 4: Economic analysis

S/N	**Ingredients**	**Price/kg**			
1	Rice polish	12.0			
2	Rice bran	14.0			
3	Rice chapper	10.0			
4	Wheat bran	12.0			
5	Maize bran	12.0			
6	Green grasses, shrubs& kitchen wast	0.0			
Average price NRs/kg		**12.0**			
Calculation		D1	D2	D3	D4
A. Total feed (kg)		296.5	383.5	383.5	296.5
B. Feed cost /kg		12.0	12.0	12.0	12.0
C. Total feed cost(Rs)		3558.0	4602.0	4602.0	3558.0
D. Total live weight gain(kg)		74.56	80.93	97.63	112.13
E. sales live weight/kg		130.0	130.0	130.0	130.0
F. Total live weight value (Rs)		9693.0	10521.0	12692.0	14577.0
G. piglets cost (Rs)		2500.0	2500.0	2500.0	2500.0
Return analysis					
Total live weight value (Rs)		9693.0	10521.0	12692.0	14577.0
Total Expenses C+G (Rs)		6058.0	7102.0	7102.0	6058.0
Net return (NRs)		**3635.0**	**3419.0**	**5590.0**	**8519.0**

CONCLUSION

This study showed that the combination of home made concentrate with chopped green leaves cooked together them fed to pigs give maximum return to rural farmers as small scale pig farming.

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EFFECT OF DIFFERENT COLOR ON WEIGHT GAIN AND REPRODUCTIVE PERFORMANCE OF KHARI GOAT IN THE EASTERN HILLS OF NEPAL

Ritesh Prasad Shah[1], Sanjay Kumar Jha[1], Upendra Yadav[1] and Nirajan Bhatrai[2]
[1]Agriculture Research Station Pakhribas, Dhankuta
[2]Institute of Agriculture and Animal Science, Rampur, Chitwan
Email: riteeshshah@gmail.com

ABSTRACT

This study was carried out to identify the effect of different color of Khari goats on growth and reproductive performance at ARS, Pakharibas, so that productive performance could be known. 72 goats, 24 female kid for reproductive performance, 24 male and 24 female kids for weight gain were distributed in to six group T1(Kali), T2 (Ghorali), T3, (Khairi), T4 (Singari), T5 (Dhobini) and T6 (Seti) with 4 replication in randomized complete block design. No significant effect was seen in reproductive performance, age and weight at first service, age and weight at first kidding, kidding interval, gestation period and kid born/doe/parity. Lowest mean days at first service (364.28±30.06 days) and mean age at first kidding (510.41±29.84) days was found in Singari. Mean highest body Weight at first service (16.63±1.01) kg and weight at first kidding (18.90±1.47 kg) were found in Khari. Lowest mean kidding interval (257.92±1.50) days and gestation period (145.91±0.37days) were found in Kali. Highest mean number of kid born /doe/parity was found in Ghorli (1.70±0.03) and lowest in Dhobini (1.35±0.12). No significant effect was seen in female birth and weans weight but at the six month weight significant effect was seen. The mean weight gain of six month of female khairi (11.80±0.49 kg) was significant over Seti (10.23±0.27 kg). Significant effect was seen in male kid in birth weight and 6 month weight where as non significant effect was seen in weans weight. Average birth weight of male kid Singari (2.07±0.15 kg) was found significant (P<0.05) over Seti (1.45±0.13 kg) and Khairi (1.55±0.17 kg). Mean weight gain of kali male kid was found (11.83±0.33 kg) significant (P<0.05) over Seti (10.38±0.189 kg). Thus, lowest mean number of kid born /doe/parity was found in Dhobini (1.35±0.1) and lowest mean weight gain was found in 6 month in female kid (10.23±0.27 kg) and male kid (10.38±0.189 kg) in Seti.

Keywords: Khari, colour, reproductive performance, weight gain

INTRODUCTION

Goat is one of the most important livestock commodities of Nepal. They offer s immense potential to generate employment opportunities and resources such as animal protein, manure, fur etc. Khari goats are most widespread and abundant (>50%), prolific than other breeds and can adopt different agro-climatic zones in mid hills of Nepal (Kharel and Neopane, 1998). In Khari breeds seven colors have been identified with dominance of black colour as first and brown as second (Kuwar, 2000). Neopane (1997) has identified six color type (Kali or black with no white marking; Seti or White; Khairi or Dark brown to red, some with white or black marking on face ears, spine, legs and underside of the body;, Ghorli or Light brown to tan colours, some with white marking as for Khari; Sigarior Black with white markings on face, ears, spine, belly, tail, and lower leg, Dhobini or White with

black markings on face, ears, spine, belly, tail and lower legs. Black goat possess a number of complex physiological adoption for dealing with a hot desert environment and heat gain was twice as greater in black goats as in white (Finch *et al.,* 1990). Among these colored lines, we examined interrelationship of such color pattern, body weight and reproduction performance.

MATERIALS AND METHODS

Experiments to examine the interrelationship among colour, reproductive performance and body weight in Khari was carried out in Agriculture Research Station, Pakharibas, and Dhankuta from 1999 to 2012. Altogether 72 goats were selected, out of which 24 female kids were taken for reproductive performance, 24 male and 24 female kids for weight gain experiments. The Khari goats were grouped into six groups by using CRD, T1 (Kali), T2 (Ghorali), T3 (Khairi), T4 (Singari), T5 (Dhobini) and T6 (Seti) with 6 goats per group and replicated four times. For weight gain experiment 4 male and 4 female of Kali, Ghorali, Khairi, Singari, Dhobini and Seti were selected, respectively from 492 Kali, 595 Ghorali, 267 Khairi, 63 Singari, 216 Dhobini and 160 Seti, herd on the basis of best birth weight, wean weight and 6 month weight. Similarly, for reproductive performance 6 colours of female goats Kali, Ghorali, Khairi, Singari, Dhobini and Seti were selected, respectively from 90 Kali, 118 Ghorali, 38 Khairi, 14 Singari, 38 Dhobini and 28 Seti. Female and male kids were given 100 gm of feed daily with adlib fodder where as does were given 200 gm of feed and allowed for grazing for 5 hour.

RESULTS AND DISCUSSION

The mean birth weight, wean weight and 6 months weight of female kid is presented in Table - 1. It is evident from the Table - there was no significant effect ($P>0.05$) female kid birth and weaning weight but at the six months weight significant effect ($P<0.05$) was seen. The mean weight gain of six month of female kid of Khairi was (11.80±0.49 kg), Kali (11.65±0.32 kg), Dhobini (11.58±0.40 kg) and Ghorli (11.43±0.35 kg) were significant over Seti (10.23±0.27 kg) but Singari (10.90±0.48 kg) was similar with Khairi (11.80±0.49 kg), Kali (11.65±0.32 kg), Dhobini (11.58±0.40 kg), Ghorli (11.43±0.35 kg) and Seti (10.23±0.27 kg).

Table - 1: Productive performance of goats, Kg

Treatment	Birth weight	Weaning weight	6 months weights
Kali	1.95±0.18a	9.18±0.27a	11.65±0.32ab
Ghorli	1.85±0.10a	9.35±0.35a	11.43±0.35ab
Khairi	1.53±0.21a	8.38±0.55a	11.80±0.49a
Sigari	1.83±0.23a	9.05±0.55a	10.90±0.48abc
Dhobini	1.68±0.12a	9.15±0.31a	11.58±0.40ab
Seti	1.93±0.19a	8.88±0.21a	10.23±0.27c
CV	9.8	4.6	1.1
LSD	0.51	1.12	1.25

Values are mean ± SE. Any two means having a common letter are not significantly different ($p>0.05$) at 5% level of significance.

The mean birth weight, wean weight and 6 months weight of male kid is presented in Table - 2. It is evident from the Table - 2 that significant effects were seen in buck birth weight and 6 months weight whereas no significant effect was seen in weaning weight. Mean birth weight of male kid Singari (2.07±0.15 kg) was found significant (P<0.05) over Seti (1.45±0.13 kg) and Khairi (1.55±0.17 kg) but at par with Dhobini (1.99±0.21 kg), Kali (1.83±0.12 kg) and Ghorli (1.75±0.24 kg). Mean 6 months weight gain of Kali male kid was found (11.83±0.33 kg) which was significant (P<0.05) over Seti (10.38±0.19 kg) and similar with Singari (11.58±0.32 kg), Dhobini (11.35±0.40 kg), Khairi (11.10±0.63 kg) and Ghorli (10.98±0.18 kg). Similar result of Seti was found by (Neopane, 1997). Growth performance of kids of different colored (black, white, speckled and grizzly) did not affect significantly by differences in hair color (Olfaz *et.al*, 2011)

Table - 2: Productive performance of goats, Kg

Treatment	Birth weight	Weaning weight	6 months weights
Kali	1.83±0.12abc	9.13±0.26b	11.83±0.33a
Ghorli	1.75±0.24abc	8.88±0.51b	10.98±0.18ab
Khairi	1.55±0.17bc	8.80±0.36b	11.10±0.63ab
Sigari	2.07±0.15a	9.03±0.28b	11.58±0.32ab
Dhobini	1.99±0.21ab	8.93±0.33b	11.35±0.40ab
Seti	1.45±0.132c	8.30±0.168b	10.38±0.189c
CV	10.3	1.07	3.6
LSD	0.49	1.6	1.03

Values are mean ± SE. Any two means having a common letter are not significantly different (p>0.05) at 5% level of significance**.**

The mean reproductive performance of Khari goat is presented in Table - 3. It is evident from the Table - 3 no significant effect were seen in reproductive performance, age and weight at first service, age and weight at first kidding, kidding interval, gestation period and kid born/doe/parity. Lowest mean days at first service (364.28±30.06 days) and mean age at first kidding (510.41±29.84 days) was found in Singari. Mean highest

Table - 3: Reproductive performance of Khari does

Treatment	Reproductive parameter						
	Age at first survive	Weight at first service	Age at first kidding	Weight at first kidding	Kidding interval	Gestation period	Kid born/doe /parity
Kali	383.63±21.94a	15.63±0.94b	29.53±22.1c	18.00±1.14d	257.92±1.5e	145.91±0.37f	1.66±0.03g
Ghorli	365.63±19.93a	14.10±1.28b	11.64±20.34c	17.50±1.53d	270.29±19.18e	146.01±0.84f	1.70±0.03g
Khairi	405.53±17.14a	16.63±1.01b	59.87±19.78c	18.90±1.47d	286.36±12.44e	154.35±6.51f	1.64±0.12g
Sigari	364.28±30.06a	15.38±0.31b	10.41±29.84c	17.40±0.84d	269.70±8.54e	146.14±0.24f	1.47±0.06g
Dhobini	373.35±38.50a	15.95±1.46b	525.06±43.09c	18.55±1.14d	263.99±14.07e	151.71±5.88f	1.35±0.12g
Seti	390.43±24.83a	14.63±0.94b	539.43±25.06c	17.05±1.30d	287.87±13.49e	149.01±4.36f	1.46±0.11g

Values are mean ± SE. Any two means having a common letter are not significantly different (P>0.05) at 5% level of significance**.**

Body weight at first service (16.63±1.01 kg) and weight at first kidding (18.90±1.47 kg) were found in Khari. Lowest kidding interval (257.92±1.50 days) and gestation period (145.91±0.37) days were found in Kali. Highest number of kid born /doe/parity was found in Ghorli (1.70±0.03) and lowest in Dhobini (1.35±0.12).

CONCLUSION

Lowest mean number of kid born /doe/parity was found in Dhobini (1.35±0.12) and lowest mean weight gain was found in 6 month in female kid (10.23±0.27) Kg and male kid (10.38±0.189) Kg in Seti .

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QUALITY ASSESSMENT OF DRIED MEATS OF DIFFERENT LINES OF *SAKINI* BREED OF DIFFERENT AGRO-ECOLOGICAL ZONES FROM CENTRAL DEVELOPMENT REGION

Neena Amatya Gorkhali[2], Achyut Mishra[1], Saroj Sapkota[2], Bishnu Bahadur KC[3] and Bhola Shankar Shrestha[2]

[1] Food Research Division, Khumaltar, Lalitpur

[2]Animal Breeding Division, Khumaltar, Lalitpur

[3]Department of Livestock Services, Harihar Bhawan, Lalitpur

E-mail: achyutmishra2000@gmail.com

ABSTRACT

The study was carried out to assess the quality of dried meats prepared from Sakini breeds (each of 22 weeks) collected from different agro-ecological zones such as Rasuwa, Kavre and Kathmandu and Rautahat, by physicochemical and sensorial analysis methods. Along with this, yield of different cut-up parts and byproducts and water holding capacity of flesh of these pars were studied. The yield of whole carcass on the basis of live weight and other cut up parts such as, trunk, wings and thigh on the basis of whole carcass were statistically significant ($p<0.05$) but drumstick, breast, and neck have no significant difference ($p>0.05$). Similarly, by products such as shank, blood, head and heart have no significant difference ($p>0.05$) but gizzard, viscera and liver have significant difference ($p<0.05$). The water holding capacity of fleshes of different lines have no significant difference ($p>0.05$) which is very much similar to Nigerian indigenous chicken (0.58). Moreover, the physicochemical parameters such as moisture, protein, fat and total minerals of dried meat prepared from fleshes of different lines have no significant difference ($p>0.05$). In addition to this, four experimentally prepared Sakini dried meats were studied by conducting sensory evaluation in terms of texture, taste and flavor by more than 10 panelists using 9-point hedonic rating method. The scores for texture, taste and flavor have no significant difference ($p>0.05$). The overall result showed that the Sakini lines from Kathmandu local market and Kavre were found best in terms of yield, nutrient content and sensory quality.

Keywords: Sakini, agro-ecological zones, physicochemical parameters, sensory evaluation

INTRODUCTION

Sakini chicken is the most common indigenous breed all over the country. Coverage of *Sakini* is around 50% of the total chicken population of the country (Anon, 2012). This breed is suiTable - for mixed farming system as it provides opportunity for additional income during dull season of crop cultivation. In addition, it also provides employment opportunity directly or indirectly and a good source of protein rich food at low cost to the resource poor farmers. Furthermore, there is no taboo to any communities and also called "universal meat". Moreover, it is popular for its taste and believed as more nutritive meat in comparison to commercial chicken, broiler (ICAR, 1989).

In developing countries including Nepal, meat production and consumption has been continuously increasing. The statistics shows the tremendous increment in the chicken meat

production in the country over the last one and a half decade (MoAD, 2012). The total meat production was about 25,000 Mt in year 2009/2010 and increased to 288,000 Mt up to 2011/12 (MoAD, 2012). Chicken meat (7.62%) ranks third in the total meat production of the country after buffalo (64.1%) and goat (19.45%),

Meat plays an important role in nutrition as a contributor of high quality protein. Meat protein also plays important physiological role as it promotes iron absorption and prevents calcium losses. The B-vitamins and mineral contents of meat are important nutritional factors. Meat quality depends on the same criteria against the same indicators in other food. The basic traits relate to nutritional content such as proteins, fat, fibers, vitamins and minerals, mainly iron. In muscle food, the pivotal qualitative characteristics that need to be determined are texture, nutritional value, and appearance.

There are economic, dietary and sensory aspects that make meat processing one of the most valuable modifications for adequately supplying animal protein to human populations (Heinz and Hautzinger, 2007). These circumstances coerce into the diversification of meat into variety of meat products such as dried meats, barbecue, sausages, meat loafs and cured meat products.

Raw meat protein started to degenerate at high ambient temperature within a few hours of exposure. But processed dried meat can be kept longer (Ramani, 2004). Traditionally dried meat is prepared in sun drying or drying over the wooden fire place in kitchen. Dried meat is a popular side dish in Nepal. Ethnic communities of high and mid hills such as Magar, Rai, Limbu, Newar, Sherpa and Gurung prepared dried meat by their traditional and indigenous knowledge. This product is consumed popularly in the hotels and restaurants as a delicacy. Dried meat production is an up-coming business in large volume of production which contributes to poverty reduction in the country.

On the basis of different agro-ecological zones (AEZ), there are variation in phenotypes and growth of Sakini (Anon, 2012). This study was conducted to assess the variation in the quality of dried meats from four different lines of *Sakini* breed of Central Development Region through physicochemical and sensorial analysis methods. Along with this, yield of different cut up parts and byproducts and water holding capacity of fleshes were also studied. This study will assist the challenge facing by the meat industry is to obtain reliable information on meat quality throughout the production process, which would ultimately provide a guaranteed quality of meat products for consumers.

The main objective of this study was to assess the quality of dried meats prepared from different *Sakini* breeds (each of 22 weeks) of different agro-ecological zones by physicochemical and sensorial analysis methods. Along with this, yield of different cut up parts and byproducts and water holding capacity of fleshes were studied.

MATERIALS AND METHODS

Sample collection

Three *Sakini* lines, one from each agro-ecological zone (AEZ) were raised on station in Swine and Avian Research Program, Khumaltar, Lalitpur, providing same environment (feed, vaccinations and others). These chicken were reared up to 22 weeks for the chicken to gains their market size. Three birds from the local markets were brought to keep as a control. *Sakini* breeds each of 22 weeks of different agro-ecological zones such as Rasuwa, Kavre and Kathmandu and Rautahat were collected 3 birds from each place. Collected birds were kept in starvation for 10 hours, but water was provided, prior to slaughtering. Ante mortem inspections were carried out for each bird prior to slaughtering and were found normal. Birds were hanged inside the bleeding cone and bled by slitting the vein beside ear-lobe with sharp knife. Bled poultry were scalded in hot water (60°C) for 3 minutes and Defeathered manually and finally washed with poTable - water.

Table - 1: Samples taken for the study

S/N	Agro Ecological Zone	Location	N. of birds	Live wt. (22 Wks)
1	High hill	Rasuwa	3	2.59
2	Mid hill	Kavre	3	0.93
3	Terai	Rautahat	3	1.45
4	Control (Local Market)	Kathmandu	3	1.47

Defeathered poultry were eviscerated and observation on cut up parts and by products was carried out with the help of sharp knife. Cut up parts such as neck, wings, drumstick, thigh, breast, trunk and by-products such as heart, gizzard, blood, head, shank, liver and viscera were weighed individually in digital balance and yields were calculated. The small amounts of fresh flesh were taken from thigh, breast and drumstick for the evaluation of average water holding capacity. Analysis was carried out within and between the lines.

Flesh were deboned and dried in solar drier (average drying temperature 48°C) for three days. Dried meats were individually packed normally in 25 micron polythene bags and stored in dry and cool place for until further analysis. Physicochemical analysis was carried out according to AOAC (2002). Sensory evaluation was carried out by 9 point hedonic rating method according to Ranganna (2005).

RESULTS AND DISCUSSIONS

Meat yield and water holding capacity (WHC)

The yield of whole carcass on the basis of live weight and other cut up parts such as, trunk, wings | and thigh on the basis of whole carcass were statistically different ($p<0.05$) but drumstick, breast, and neck were no difference ($p>0.05$).

Table - 2: Yield* and WHC* of *Sakini, %*

Lines Location	Carcass	Drumstick	Thigh	Wings	Breast	Trunk	Giblet	WHC
High hill	48.39	10.42	10.04	9.54	12.01	11.63	5.73	0.484
Mid hill (Control)	68.37	11.65	12.48	8.54	16.74	13.57	3.425	0.495
Hill	70.25	12.46	14.35	7.46	14.02	14.52	3.12	0.392
Terai	61.19	11.51	11.07	9.14	13.26	10.34	5.13	0.671
F. Pr.	<0.05	>0.05	<0.05	<0.05	>0.05	<0.05	<0.05	>0.05
SEM	1.162	0.654	0.557	0.286	0.486	0.463	0.151	0.098
LSD	4.222	2.377	2.025	1.040	4.895	1.684	0.535	0.355
CV%	11.54	8.2	6.7	4.6	13.5	5.2	15.3	24.4

* Values are the means of three replications

Similarly, by products such as shank, blood head (4-5%), heart (0.42-0.73%) were statistically no difference (P>0.05) but gizzard (viscera and liver were different (P<0.05). The water holding capacity of flesh of different lines (0.40-0.67) were statistically no difference (P>0.05) between lines which is very much similar to Nigerian indigenous chicken (0.58). Water holding capacity (WHC) resembles the quality of meat flesh which is very much essential for functional quality to prepare meat products. Terai lines have found the highest water holding capacity (0.671). However the WHC mainly depends on pre-slaughter handling of birds and excitation just prior to bleeding.

Physicochemical parameters of dried meat

The physicochemical parameters such as moisture, protein, fat (3.2-6.1%) and total minerals (4-4.4%) of dried meat prepared from fleshes of different lines were statistically no difference (P>0.05) (Table - 2). The permissible level for moisture of dried meat is below 10% for its longer preservation. The obtained values are almost within the range. The rest of the parameters highly depend on moisture content. Higher the moisture level, lower the solids and nutrients' density. The nutrients mainly protein and fat depends on plane of nutrition and thereby muscling. However in the study there is no nutrient different as all three lines were provided with same feed. The highest protein (82.6%) and fat (6.13%) were found in mid hill and high hill lines, respectively. Total mineral contents were varied in narrow range in all the groups.

Table - 3: Composition* of dried meats of *Sakini* breeds of different agro-ecological zones, %

Lines' Location	Moisture	Crude Protein	Fat	Total Ash
Rasuwa	9.75	79.8	3.06	4.38
Kathmandu	10.31	82.6	3.10	4.06
Kavre	9.38	78.0	6.13	4.01
Rautahat	9.73	77.2	5.3	4.27
F. Pr.	>0.05	>0.05	>0.05	>0.05
SEM	0.766	2.620	1.622	0.306
LSD	2.78	0.951	0.589	1.114
CV%	11.0	4.7	4.9	10.1

* Values are the means of three replications

Four experimentally prepared *Sakini* dried meats were studied by conducting sensory evaluation in terms of texture, taste and flavor by more than 10 panelists using 9-point hedonic rating method and dried meat of hill and terai lines stood in best position. However, scores for texture (6.45-6.75), taste (6.35-6.85) and flavor (6.45-6.75) were statistically no difference (P>0.05) to each other (Table - 3). The texture mainly depends on drying conditions and nature of muscle. Muscles of thigh and drumstick have tough texture compare to breast. Flavor and taste mainly guided by fat and mineral contents in meat. In overall, lines of hill and terai have been liked by majority of the panelists though the variation in score is very close.

Table - 4: Sensory scores*H of dried meats of *Sakini* lines of different agro-ecological zones

Breeds' Location	Score for Texture	Score for Flavor	Score for Taste
Rasuwa	6.70	6.55	6.45
Kathmandu	6.45	6.45	6.30
Kavre	6.85	6.65	6.55
Rautahat	6.55	6.75	6.75
F. Pr.	>0.05	>0.05	>0.05
SEM	0.273	0.239	0.253
LSD	0.543	0.476	0.503
CV%	12.9	11.4	12.2

H Values are the score out of nine (Hedonic Rating)

** Values are the mean score of ten replications

CONCLUSION

The study on quality assessment of dried meat of Sakini lines of different agro ecological zones from Central Development Region showed that Mid-hill and control lines were the best lines in terms yield, nutrients and sensory quality.

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Animal Health

IDENTIFICATION AND CONTROL OF CLINICAL AND SUB-CLINICAL MASTITIS OF DAIRY CATTLE IN EASTERN TERAI REGION

Bishnu Prasad Kushwaha, Rakesh Prasad Sah and Md. Shaha Navaz Ali
National Buffalo Research Program, Tarahara, Sunsari
Email.nbrp.tarahara69@gmail.com

ABSTRACT

Mastitis is regarded as an important problem of dairy animals causing great economic loss through decrease productivity of milk. During 2011 to 2012 A.D, a study was carried out to assess the status of mastitis in cattle and its efficient management in Sunsari and Morang districts of Nepal. Altogether 180 cattle were screened randomly. The milk samples were examined with California Mastitis Test (CMT) (Benjamin, 2010). Examination of milk samples showed 18% prevalence of mastitis in which 14.67% were found as sub-clinical mastitis and 3.33% as clinical mastitis. The positive samples were rendered for bacteriological culture and causative agents were identified. E. coli were isolated in sub-clinical mastitis cases where as staphylococcus and streptococcus was isolated in clinical mastitis cases. Drug sensitivity tests revealed Enrofloxacin (+++), Gentamicin (++) and Ciprofloxacin (++) as most effective in clinical mastitis. For the prevention and control measure, application of Povidine iodine solution (1:9) and Masticare ointment in sub-clinical cases had better result.

Keywords: Mastitis, dairy cattle, productivity, enrofloxacin, sensitivity

INTRODUCTION

Mastitis is one of the economically important diseases of dairy animals in Nepal which causes great economic loss of livestock farmers. It is an important disease from public health concern. The presence of different kind of bacteria, fungi in the milk may be unsuiTable - for human consumption and help in the spread of disease like Tuberculosis, Brucellosis, Staphylococcal toxemia, fever and gastro-enteritis. The presence of several bacteria may cause food poisoning that possibly occurs through milk of infected animals. Importantly, some countries have already banned the use of antibiotics in cattle production due to growing concern of antibiotic residues in milk and meat and on possibly increasing bacterial resistance and their potential transfer from animal to human via food chain. So, it is justifiable to develop effective preventive measures for the outbreak and spread of the disease in the farmer's field condition and contribute to poverty alleviation by solving the problems (Radostits *et al*., 2000 and Chakrabarti, 2003).

MATERIALS AND METHODS

Altogether 180 animals (One sample from each animal) were screened at farmer's field of Sunsari and Morang districts of Nepal. The milk samples from each animal were tested via California Mastitis Test (CMT). The CMT positive samples were investigated for microbiological involvement in laboratory via culture and further sensitivity test was carried out for the preferable antibiotic.

RESULTS AND DISCUSSION

In Morang district out of 90 milk samples, 18 (20%) were positive and among the positive, 4(4.44%) were found as clinical and 14 (15.55%) as sub-clinical form. Positive case was 4 (4.44%) in Murrah buffalo and 14 (15.55%) found in Jersey Local cattle and buffaloes milk samples were found negative (Table -1).

In Sunsari district out 90 collected milk samples 31(34.44%) were positive and among them 7(7.77%) were found as clinical and 24(26.66 %) as sub-clinical form. With respect to species 6.66% Murrah buffalo, 1.11% local buffalo and 26.66% Jersey and local cross cattle and buffalo milk samples were negative(Table -1).

Table - 1: Result of California Mastitis test

S/N	Inform action	Total sample	Positive	Negative	Clinical	Sub-clinical	Buffalo		Cow	
							Murrah	Local	Jersey	Local
1	Morang	90	18 (20%)	72 (80%)	4 (4.44%)	14 (15.55%)	25 (P-4, N-21)	2 (N)	57 (P-14, N-43)	6 (N)
2	Sunsari	90	31 (34.44)	59 (65.55)	7 (7.77 %)	24 (26.66%)	21 (P-6, N-15)	15 (P-1, N-14)	49 (P-24, N-25)	5 (N)

Table - 2: Result of treatment and control measures

S/N	Treatment/control measures	Sensitivity	Clinical mastitis	Subclinical mastitis
1	Genta + Enrofloxacilin with analgesic drug	-	effective (acute form	-
2	Povidine + Glycerin (9:1)	-	-	gradual recovery
3	Masticare ointment	-	-	gradual recovery
4	Drugs sensitive result	Enrofloxacin Gentamycin Ciprofloxacin	only 50 + 75% sensitive	-

Due to affection of one or more quarters of the udder, there may be reduction in milk quality. There was higher incidence of sub clinical mastitis in hindquarters in buffaloes than cross bred and local cows. There were high incidences of mastitis in forequarters of cross bred and local cows than in buffaloes. Among fore quarters, right forequarter were found to be more prone to infection in cross bred cows and left fore quarter in local cows. Teat dips (Povidine iodine+Glycerine-9:1) were effective against all mastitis organisms. They have been shown to effectively reduce mastitis caused by *S. aureus* and *S. agalactiae,* the most common types of mastitis. Enrofloxacin (+++) was found more sensitive than Ciprofloxacin and Gentamicin (Table --2).

CONCLUSION

Mastitis is the major problem of dairy cattle in Morang and Sunsari district. Comparative study of both districts showed that 34.44% positive case was found in Sunsari, whereas only 20% case was found in Morang district. Murrah and Jersey dairy animals were highly affected. Major cause of this result is due to poor sanitation with rough milking technique and incomplete milking. Drug therapy with early detection of disease gives good results both of clinical and sub-clinical form of disease. Especially poor sanitation may be the result of *E. coli* infection Regular test of milk sample can save the economic loss of dairy farmers.

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BIO-ANTHELMINTICS: IS THERE A POTENTIAL FOR THEIR USE UNDER NEPALESE FARMING CONDITIONS

Bhoj Raj Joshi[1], Ramesh Sah[2] and Shiva Hari Ghimire[3]
[1]National Animal Science Research Institute, Khumaltar, Lalitpur
[2]Agriculture Research Station, Pakhribas, Dhankuta
[3]Agriculture Research Station (Goat), Bandipur, Tanahun
Email: bhoj.joshi@yahoo.com

ABSTRACT

Since the emergence of anthelmintic resistance in the animal parasites against the commonly available anthelmintics in most of the world, study on use of bio-anthelmintics against the parasites has become an area of interest. Various plant species like Sericea lespedeza, Hedysarum coronarium L. (sulla), Onobrychis viciifolia Scop. (Sainfoin), Lotus pedunculatus Cav (big trefoil). Lotus corniculatus L (birdsfoot trefoil) have been identified as potential anthelmintics against Haemonchus contortus parasites in goats. The rich plant biodiversity, subsistence farming conditions and rich indigenous knowledge and practices of using various and plant products in human and animal diseases provide a unique opportunity for research and utilization of these resources against animal or human diseases and parasites in Nepal. Traditionally, various plant species have been used by farmers against Ascariasis in calves, however, none of these plants have been scientifically evaluated so far for their actual efficacy against other parasite species or in other animal species. In-vitro screening studies, have identified that plant species like Castanopsis indica (Dhalne Katus) and Acacia catachu, contain condensed tannin and these plants could possess anthelmintic activities against the parasites. In-vivo screening studies by feeding with Castanopsis indica, Artemisi indica (Titepati), Ficus semicordata (Rai Khanium) reduced the fecal egg counts in the naturally infected goats, but the decrease was no significant and transitory. Hence, more detailed experimental studies with artificial infection of the parasite larvae are needed to investigate and utilize these plant species against the parasites infecting the animals. The other plant species like Castanopsis tribuloides (Musure Katus), Melia azadarach (Bakaino) and Morus alba (Kimbu) did not show any anthelmintic properties against the parasites of goats. There is considerable potential for exploiting the available bio resources against animal parasites, however, it requires more detailed experimental studies, so that, this indigenous potential could be used against the diseases and parasites of human and farm animal species.

Keywords: Bio-anthelmintics, goats, nematode, parasites, Nepal

INTRODUCTION

Alternative approaches to chemical anthelmintics for control of gastrointestinal (GI) nematodes have been investigated around the world, among which, feeding condensed tannin (CT) rich plants have been researched as a promising method by many workers. Anti-parasitic effects have been reported for many CT- containing forages, including Sulla (*Hedysarum coronarium* L.; Niezen *et al.*,1995), Big trefoil (*Lotus pedunculatus* Cav; Molan *et al.*,2000), Sainfoin (*Onobrychis viciifolia* Scop; Paolini *et al.*,2003a), and Sericea lespedeza [SL: *Lespedeza cuneata* (Dum-Cours.) G.Don](Min *et al.,* 2004 and Shaik *et al.,* 2004). Inclusion of

CT rich forages equivalent to 5% of dietary dry matter as CT in goats significantly reduced fecal egg counts (FECs) but there was no effect on worm recovery (Paolini *et al.,*2003b). In another *in vitro* study, Sainfoin extract was found to inhibit larval migration of *Haemonchus contortus* L3 (Barrau *et al.,* 2005). A significant reduction in FEC and a noticeable decrease in worm burden were reported in goats fed on *Acacia karoo* dried leaves mixed in a basal diet compared to the control group given basal diet alone (Kahiya *et al.,* 2003). *Sericea lespedeza* hay fed to sheep and goats reduced FEC and worm burdens (Shaik *et al*., 2006 and Lange *et al.,* 2006). More recently, Joshi *et al*. (2011) reported lower establishment, lower fecal egg counts and worm burdens in experimental infection of *H.contortus* in goats fed on Sericea lespedeza leaf meal diet. These studies showed the potential of CT rich forages on reduction in fecal egg count (FEC), worm burden and egg hatching percentage of the parasites, which would be helpful to reduce the level of pasture contamination leading to reduced infection of animals and minimizing the economic losses due to parasites.

Nepal is rich in plant biodiversity and many plants and plant products have been used traditionally against the parasites of calves. However, none of the plant bio-resources have been used against the GI nematodes of goats. *In-vitro* studies, on the potential of Nepalese bio-resources showed that *Castanopsis indica* and *Acacia catechu* have high level of condensed tannin (CT) and have lethal effects on third stage larvae of *H.contortus*. Present studies were thus conducted to screen some plants for their efficacy against GI nematodes of goats infected naturally under the grazing management.

MATERIALS AND METHODS

Two studies were conducted to screen the plants for their bio-anthelmintic potentialities. The first study was conducted at Regional Agricultural Research Station, Lumle, during the post monsoon season of 2011 using the farm goats and the second study was conducted during the post monsoon months of 2012 at Agricultural Research Station (Goat), Bandipur, using the farm goats.

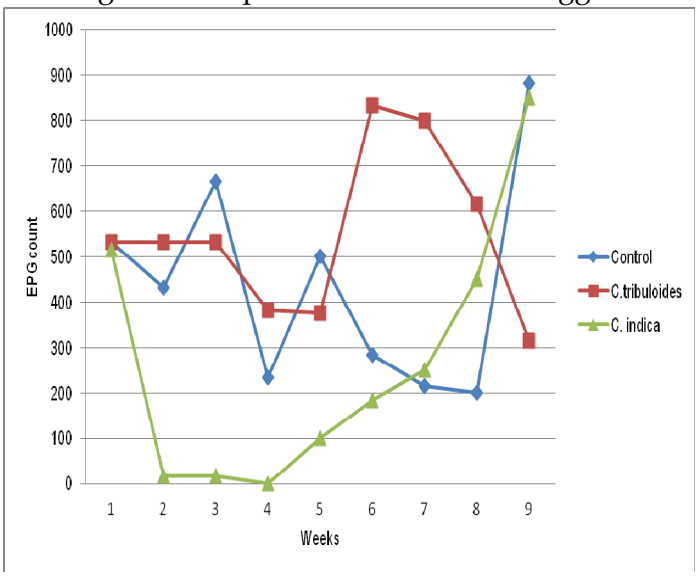
In the first study, eighteen female goats were allocated in to three groups pair matched on the faecal egg counts (EPG) and reared under stall fed management under conditions excluding parasite infection. Group one with six goats was reared as control group and fed on wheat/barley straw *ad-lib*, group two with six animals was fed on Musure Katus (*Castanopsis tribuloides*) and group three with six animals was fed on Dhalne Katus (*Castanopsis indica*) *ad libitum*. The animals were supplemented with concentrate feed @ 200 g/animal per day and were free access to drinking water.

In the second study, four plant species; Rai Khanayo (*Ficus semicordata*) Bakaino (*Melia azedarach*) Kimbu (*Morus alba*) and Titepati (*Artemesia vulgaris*) were screened for their potential activity against the GI nematode parasites of goats infected naturally under grazing. The goats were screened for the level of GI infection by fecal egg counts (Eggs per g of feces) and allocated to different groups' pair matching for their fecal egg counts and brought indoor under the stall fed management system on *ad-lib* feeding on the forage to be screened for a period of four weeks.

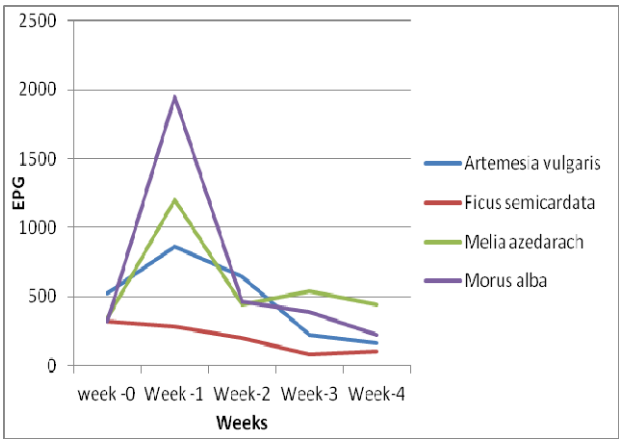
The initial parasite burdens and the changes on the parasite load were monitored by initial fecal egg counts and weekly changes in fecal egg counts. The first study was conducted for nine weeks feeding period and the second study was conducted for four week feeding period.

RESULTS AND DISCUSSIONS

The response to feeding in the naturally infected goats was variable with some plants showing better response in terms of fecal egg count reduction than the others, while some of the plants did not show any response at all. The most promising result was shown by Dhalne Katus (*Castanopsis indica*) with fecal egg count in the *Castanopsis indica* fed goats dropped to very low level and remained at this level for three weeks , however, from the fourth week onward, the fecal egg count in the *Castanopsis indica* group started to increase and become similar to the control group. The difference in fecal egg counts between *Castanopsis indica* fed goats and control goats was significant ($P<0.05$) for week two, three and four but non-significant for other periods. There was however, no difference between the *C.tribuloides* fed group and the control goats, indicating the lack of any bio-anthelmintic activities in this plant. Even in the *C. indica* fed goats, the fecal egg count started to increase after fifth week.



There was no change in the feeding and management of animals throughout the study period, and the reason for fecal egg count increase from fifth week is difficult to explain. One of the possible reasons might be the predominance of parasite species, which are not affected by the CT present in *C.indica*. This possibility, however, could not be verified in absence of the slaughter studies.



None of the four plant species screened for their bio-anthelmintic activity showed any definite trend on fecal egg counts of naturally infected goats. There was some reduction in fecal egg counts in goats fed on *Ficus semicordata* and Artemisia *vulgaris* but again the trend was inconsistent. During the first week after feeding there was some increase in fecal egg counts of goats except in *Ficus semicordata* fed group suggesting that there might be some

potential in this plant and further detailed analysis would be required to study this plant species. The other plant species *Artemisia vulgaris* showed the decline in fecal egg counts after week two of feeding, while in *Morus alba* and *Melia azedarach* fed groups, there was sharp increase in fecal egg counts on one week post feeding, which declined gradually in the succeeding weeks.

These studies indicated that the potential plants species identified in preliminary screening need to be evaluated further with artificial infection of specific parasite species under detailed experimental protocol to understand the bio-anthelmintic properties of these plant species selected in preliminary screening.

Nepal is rich in indigenous knowledge for using plant resources against the parasites. The diverse biodiversity potential of the nation should be evaluated to identify the potential plant species against the gastrointestinal parasites of goats as GI nematodes of goats have developed resistance to the commercial chemical anthelmintics in most of the countries. It is also important to promote the organic livestock production in view of the growing concern towards the chemical products used in the animals.

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CLINICAL EFFICACY OF PRAJANA ALONG WITH COFECU FOR THE INDUCTION OF ESTRUS IN CATTLE

Ramesh Prasad Sah[1], Bidur Gautam[2], Shankar Yadav[2] and Satya Jiwan Yadav[2]
[1]Agriculture Research Station, Pakhribas, Dhankuta
[2]District Livestock Service Office, Dhankuta
E-mail: rpsnarc@yahoo.com

ABSTRACT

Anoestrus is one of the causes for infertility in cattle. Non- hormonal herbal preparations Prajana and CoFeCu Table -t were tested for the induction of estrus at Sidhuwa village of Dhankuta District from 2010 to 2012. A total of 94 breedable cattle with varying age from 4 to 14 years exhibiting anoestrum for more than 4 months were taken in treatment group and 42 were kept in control group. All the cattle in average nutritional regime were kept under the same managemental conditions. Three Prajana capsules for two consecutive days and 1 Co, Fe, Cu Table -t daily for twenty days were administered orally. In the treatment group, 70 out of 76 cows (92.10%) evinced estrus and 43 out of 70 cows (61.43%) conceived as against 12 out of 33 cows (36. 36%) exhibited estrus and 8 out of 12 cows (66.67%) conceived in control group. In case of heifers, the incidence of estrus was 10 out of 18 heifers (55.55%) with conception in 7 out of 10 heifers (70%) in treatment group against any report of estrus in control group. These results indicated that Prajana and Co, Fe, Cu in recommended doses were significantly (P‹ 0.01) effective for induction estrus and conception. That is why they are recommended for treatment of true anoestrus cows and heifers.

Keywords: Estrus, conception rate, non hormonal herbal preparation–Prajana, cattle, Dhankuta

INTRODUCTION

In recent days, dairy farming is being considered as one of the most effective means for poverty alleviation. Due to ever increasing demand and hiking prices of fresh milk, it is becoming a profiTable - business among the resource poor farmers in the every region. However, dairy farmers have been facing many constraints; among them infertility is the important one in Nepal. Anoestrus is the most common single cause for infertility in cattle (Roberts, 1998). Anoestrus is a period of sexual quietness in which there is complete absence of sexual cycles without manifestation of clinical signs of heat. Anoestrus has been seen more or less in all regions of the country.

Physiologically, anoestrus may be a temporary phase in the reproductive life of the animals (before puberty, during pregnancy and for a short period after parturition). But at all other times, animals show recurrent cyclical activity and sexual receptivity at the time of estrus. When this does not occur, the condition is referred to as true anoestrus (Roberts, 1998).

Reproductive disorders resulting in delayed puberty or anoestrum are a serious drain on resources of farmers influencing adversely the economics of milk production (Zemjanis, 1961and Dowling, 1954).

Prajana, an herbal non-hormonal preparation, has been reported to be a product of choice for inducing ovulatory oestrus in bovines (Patil *et al*., 2004, Kodagali, 1984, Mohanty *et al*., 2007 and Sharma *et al*., 1995). Prajana HS is rich in special tri-enoic fatty acids which the body uses as precursors for prostaglandin biosynthesis. This helps to coordinate ovarian functions for release of hormones in a normal cyclic pattern, producing ovulatory oestrus leading to pregnancy. Tiwari *et al*., ((1993) found that Prajana has oestrogenic effect on the ovaries and uteri of mature rats. In the present study, an attempt has been made to further evaluate the efficacy of Prajana along with supplementation of mineral Table -t COFECU (containing copper, cobalt and iron) in feed in relation to induction of estrus and ovulation with fruitful results.

MATERIALS AND METHODS

A total of 136 cattle (109 cows and 27 heifers) with varying age of 4 to 14 years exhibiting anoestrus for more than 4 months at Sidhuwa village of Dhankuta District were selected for this study. The study was undertaken for 2 years from 2010 to 1012. The total animals in this study were taken in two groups - one is treatment and another is control. The treatment group comprised of 94 cattle (76 cows and 18 heifers) whereas control group comprised of 42 cattle (33 cows and 9 heifers). All the cows and heifers in average nutritional regime were kept under the similar managemental conditions. Prior to treatment, it was assured that the genital tract was free from all possible infections.

In case of treatment group, three Prajana capsules orally for two consecutive days and one COFECU Table -t daily for 20 days were administered orally. The COFECU Table -t started to administer five days prior to Prajana caps so that animal would get mineral supplement. Thereafter, the animals were followed regularly in the morning and evening for signs of estrus primary and then estrus was confirmed by rectal palpation of genital organs.

Pregnancy diagnosis was done two to three months post-insemination by rectal palpation of genitalia. If treated animals did not evince estrus within 10 days, a second course of Prajana capsules in the same doses was repeated. If the treated animals did not come in estrus within next 30 days, it was considered that the product did not respond. The data were analyzed by Chi square test.

Composition of used drugs

Prajana HS- 6 capsules pack, Oestrus inducer, Indian Herbs Research and Supply Co. Ltd. Dhara Shivpuri Sharanpur (U.P.), India. [Each capsule contains: Mrigakshi: 495 mg, Dharmpattan: 55 mg, Vadehi: 55 mg and Sringaver: 55 mg]COFECU Plus- 20 tabs pack, Mineral feed supplement- Indian Herbs Research and Supply Co. Ltd. Dhara Shivpuri Sharanpur (U.P.), India.

Each tab contains hydrated salts of: Copper sulphate: 200 mg, Cobalt sulphate: 40 mg, Ferrous sulphate: 100 mg and Maganese sulphate: 400 mg]

RESULTS AND DISCUSSION

The effect of Prajana and CoFeCu for induction of estrus in cattle is presented in Table - 1. Estrus appeared in 70 (92.10%) out of 76 cows of treatment group against 12 (36.36%) out of 33 cows of control group. Similarly, 10 heifers (55.55%) out of 18 heifers showed signs of visible estrus between 1 to 30 days of the treatment while none of the 9 heifers of control group showed estrus.

Table - 1: Effect of Prajana and COFECU for induction of estrus

Animal category	**Treatment group**			**Control group**			**X^2 values for treatment**
	N. of animals	**Animals evinced oestrus**		**No. of animals**	**Animals evinced oestrus**		
		No.	%		No.	%	
Cows	76	70	92.10	33	12	36.36	40.96**
Heifers	18	10	55.55	9	0	0	7.82**
Overall	94	80	85.11	42	12	28.57	
X values for animal category			26.85**			4.80	

*P<0.05, **P<0.01

The effect of Prajana and CoFeCu for inducing estrus in cows as well as in heifers was found to be highly significant (P<0.01). The efficacy of Prajana in inducing estrus in cows and heifers differed significantly (P<0.01). Similar finding was made by Sharma *et al*, (1995).In control group, the incidence of estrus in cows was 36.36% but no heifer exhibited estrus symptom.

The conception rate of cows of treatment group was found 61.43% and that of control group was 66.67% revealed a non-significant difference (Table - 2) indicating that the induction of estrus with the use of Prajana was ovulatory as in case of naturally evinced estrus.

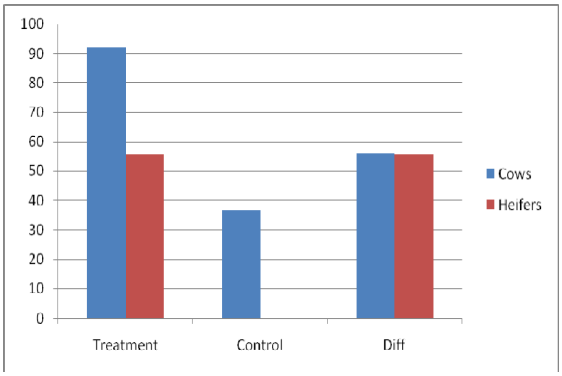
Table - 2: Comparative conception rate in treated v/s control group

Animal category	Treatment group			Control group			X^2 values
	No. of animals inseminated	No. of animals conceived	Conception rate	No. of animals inseminated	No. of animals conceived	Conception rate	
		No.	%		No.	%	
Cows	70	43	61.43	12	8	66.67	NS 0.10
Heifers	10	7	70.00	0	0		
Overall	80	50	62.50	12	8	66.67	
X values for animal category 0.24^{NS}							

NS: Non significant

To compare the efficacy of treatment in cows versus heifers, the relative increase in occurrence of estrus over that of control group, was worked out to be 55.74% in cows and 55.55% in heifers, indicating that the treatment was equally effective in both the categories.

In case of cows, the dose of 3 capsules of Prajana for two consecutive days and 1 Co,Fe,Cu Table -t daily for 20 days is recommended for inducing ovulatory estrus in true anoestrus (overdue) cows, which will reduce the inter-calving period, and in turn can provide higher returns to the farmer. In our conditions, co-administration of Co, Fe and Cu with Prajana is always desirable to take care of the deficiency of iron, copper and cobalt due to dietetic errors.



CONCLUSION

Prajana and Co, Fe, Cu in recommended doses were effective for induction estrus and conception. That is why they are recommended for treatment of true anoestrus cows and heifers. In our conditions, co-administration of Co, Fe and Cu with Prajana is always desirable to take care of the deficiency of iron, copper and cobalt due to dietetic errors.

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COMPARATIVE EFFICACY OF DOVENIX® AND OXYNIL® AGAINST FASCIOLIASIS AND GASTRO-INTESTINAL NEMATODIASIS IN CATTLE

Md. Shaha Navaz Ali[1], Mahabub Mostofa[2] and Kaji Rafaikul Islam[2]
National Buffalo Research Program, Tarahara, Sunsari
[2]Department of Pharmacology, Bangladesh Agricultural University, Mymensingh, Bangladesh
Email: nbrp.tarahara69@gmail.com

ABSTRACT

Parasitic disease has been regarded as an important problem of cattle and buffalo causing economic losses through morbidity, mortality and decreased productivity. A study was conducted to assess the efficacy of Dovenix® and Oxynil® against fascioliasis and gastro- intestinal nematodiasis in cattle at Bangladesh Agricultural University, Mymensingh farm during 2004. Altogether 50 cattle were randomly selected and examined for the prevalence of Fascioliasis and Gastro-intestinal nematodiasis (GIN). The prevalence rate of Liver fluke (Fasciola sp.) , Strongylids (Haemonchus sp. Trichostrongylus sp and Mecistocirrus sp.), Strongyloides sp., Bunostomum sp., Trichuris sp., and Oesophagostomum sp. were found as 70%, 62%, 4%, 46%, 8% and 26% respectively via Modified Stoll's egg counting method and McMaster method. 18 severely infected animals were selected and categorized in three groups A, B and C containing 6 animals in each group. The first group A were treated with Dovenix® @ 1ml/25 kg B.wt., group B were with Oxynil® @ 1 ml/25 kg B.wt subcutaneously and group C kept as control. Reduction of mean EPG (P<0.01) on 3rd, 7th , 14th and 28th day against fascioliasis after treatment with Dovenix® was found as 83.91%, 81.67%, 78.12% and 73.70%, respectively where as reduction of mean EPG after treatment with Oxynil® on same days were found as 80.78%, 80.74%, 77.03% and 61.18%, respectively. Reduction of mean EPG (P<0.01) on 3rd, 7th , 14th and 28th day against GIN after treatment with Dovenix® was found as 91.63%, 90.41%, 88.93% and 86.25%, respectively where as reduction of mean EPG after treatment with Oxynil® on same days were found as 88.23%, 87.60%, 85.43% and 82.68%, respectively. Hematological parameters (TEC, Hb & PCV) and body weight found significant increased in animals treated with Dovenix® than in treated with Oxynil® on 3rd, 7th, 14th and 28th day. Considering all the results of the study, Dovenix® was found more effective against fascioliasis and Gastro-intestinal nematodiasis than Oxynil® in cattle.

Keywords: Parasites, efficacy, Dovenix®, Oxynil®, EPG, productivity

INTRODUCTION

The agro-ecological and geo-climatic condition of Bangladesh is highly favorable for the growth and multiplication of parasites. As a result about 50% apparently healthy cattle population has been recognized to be affected with two more different species of parasites (Garrels, 1975). Parasitism is one of the main constraints in cattle rearing in Bangladesh. The hot and humid climate in Bangladesh is ideally suited for the survival and reproduction of parasites. Among parasitic infections, fascioliasis is considered to be a major disease of ruminants in this country. Afazuddin (1985) observed 3.39% ascariasis, 7.11% fascioliasis

and 19.22% nematodiasis in cattle at military farm, Savar, Dhaka. Rahman and Razzak (1973) reported that 37% cattle infected with various helminthes a major portion (16.3%) were infected with *F. gigantica* as detected by faceal sample examination of 838 cattle in Comilla. Kendall (1954) reported 60% prevalence of fascioliasis in slaughtered cattle in Dhaka. Bhuyan (1970) reported that fascioliasis occurred in 60% cattle, 90.9% buffaloes, 12.92% goats and 8.34% sheep. Rahman *et al.* (1972) reported 8.35% clinical incidence of bovine fascioliasis in Mymensingh district.

In developed countries the principle of controlling parasitic diseases are based on pasture and barn management (Radostits *et al.*, 2000) and protective treatment but in Bangladesh where animals are mainly maintained in mixed farming system with virtually no pasture land for grazing, these methods have limitation to control parasites. Furthermore, indiscriminate use of these anthelmintics by the field veterinarians and the quacks increases the resistant population of liver fluke (*Fasciola* sp.) and gastro-intestinal nematodes.

To minimize the effects of parasites on animal, different types of anthelmintics are being used all over the world. Nitroxynil is one of the latest broad spectrum anthelmintics. Therefore, Nitroxynil (Dovenix®, Merial, France and Oxynil®, Techno Drugs Limited, Bangladesh) were selected for the research.

MATERIALS AND METHODS

The experiment was conducted in the Department of Pharmacology and Department of Parasitology, Bangladesh Agricultural University, Mymensingh, for a period of 28 days to study the effects of Dovenix® and Oxynil® against liver fluke and gastro-intestinal nematodiasis in cattle. The effects of Dovenix® and Oxynil® on some haematological parameters and body weight were also determined in this study. The experiment was performed at the animal house of the Dairy farm of University. The research work was carried out during the period of 1st July, 2004 to 28th July, 2004.

Two injecTable - Nitroxynil preparations Dovenix® (Merial, France) and Oxynil® (Techno Drugs Limited, Bangladesh) were selected for the experiment. Fecal samples were collected from 50 cattle and were examined by Modified Stoll's egg counting method and McMaster method. A total 18 positive cases were selected and were divided into 3 groups (A, B and C), each group consisting of 6 cattle. Dovenix® (@1ml/25kg b. wt. S/C) was injected to the cattle of group A. Cattle of group B were treated with Oxynil® @ 1ml/25kg body weight subcutaneously. Cattle of group C was kept as infected control group without giving any treatment. The animals were maintained in intensive husbandry condition and supplied with food and water *ad libitum*.

During the experimental period the faecal samples, body weight and some haematological parameters (TEC, Hb and PCV) were examined on 0 day, 3rd, 7th, 14th and 28th day for the determination of effects of Dovenix® and Oxynil®. Analysis of blood was carried out by the standard method as described by Coffin (1955) and Schalm (1965). Collected data were

statistically analyzed by the computer using statistical package programme MSTAT-C developed by Russel (1996). A one way ANOVA was made by F variance test.

RESULTS AND DISCUSSION

Prevalence of fascioliasis and gastro-intestinal nematodiasis in cattle

The prevalence rate of liver fluke (*Fasciola* sp.), Strongylids (*Haemonchus* sp. *Trichostrongylus* sp. and *Mecistocirrus* sp.), *Strongyloides* sp., *Bunostomum* sp., *Trichuris* sp. and *Oesophagostomum* sp. were 70%, 62%, 04%, 46%, 08% and 26%, respectively. Prevalence of fascioliasis and gastro-intestinal nematodiasis in cattle were shown in the Table --1.

Table - 1: Prevalence of fascioliasis and gastro-intestinal nematodiasis in 50 cattle

S/N	Name of Parasites	Number of cattle affected	Prevalence, (%)
1	*Fasciola* sp.	35	70
2	Strongylids (*Haemonchus* sp. *Trichostrongylus* sp. and *Mecistocirrus* sp.)	31	62
3	*Bunostomum* sp.	23	46
4	*Strongyloides* sp.	02	04
5	*Trichuris* sp.	04	08
6	*Oesophagostomum* sp.	13	26

The prevalence rate of liver fluke (*Fasciola* sp.) was 70% in cattle. Similar findings also observed by Ahmed *et al*. (1994), Fromunda *et al.* (1995) and Alam (1997) in cattle. Among gastro-intestinal nematodes, the prevalence rate of liver fluke (*Fasciola* sp.), Strongylids (*Haemonchus* sp. *Trichostrongylus* sp. and *Mecistocirrus* sp.), *Strongyloides* sp., *Bunostomum* sp., *Trichuris* sp. and *Oesophagostomum* sp. were 70%, 62%, 04%, 46%, 08% and 26%, respectively. This result is in conformity with earlier reports made by Rahman and Ahmed (1991) in cattle.

Comparative efficacy of Dovenix® and Oxynil® against fascioliasis in cattle

The results of the comparative efficacy of Dovenix® and Oxynil® against fascioliasis in cattle were shown in Table - 2. A significant ($p<0.01$) reduction of EPG count were found on 3rd, 7th, 14th and 28th day of Dovenix® and Oxynil® treated cattle of group A and B respectively. The EPG count of untreated control group (group C) were significantly ($p<0.01$) increased 7 day onwards up to experimental period. Similar findings also observed by Richards *et al*., (1990), Fromunda *et al.* (1995) and Alam (1997) in cattle.

Comparative efficacy of Dovenix® and Oxynil® against gastro-intestinal nematodiasis in cattle

The results of the comparative efficacy of Dovenix® and Oxynil® against gastro-intestinal nematodiasis in cattle were shown in Table - 3 and Fig. 3. A significant ($p<0.01$) reduction of EPG count was found on 3rd, 7th, 14th and 28th day of Dovenix® and Oxynil® treated cattle of group A and B respectively. The EPG count of untreated control group (group C) were significantly ($P<0.01$) increased 7 day onwards up to experimental period.

Effects of Dovenix® and Oxynil® on haematological parameters in cattle

Dovenix® and Oxynil® caused significant changes on total erythrocyte count (TEC). The TEC was increased significantly ($p<0.01$) after Dovenix® and Oxynil® treatment in group A and B respectively in Table -- 2.

Table - 2: Effects of Dovenix® and Oxynil® on TEC (million/cu.mm.) in cattle

Group	Treatment	Pre-treatment	Post-treatment			
		0 day	3rd day	7th day	14th day	28th day
A	Dovenix®	7.652±1.07	8.282±0.19**	8.345±0.15**	8.495±0.11**	8.503±0.1**
B	Oxynil®	7.683±0.44	8.107±0.19**	8.230±0.20**	8.367±0.15**	8.403±0.23**
C	Untreated infected control	7.583±0.48	7.555±0.35**	7.358±0.33**	6.960±0.23**	6.777±0.44**

The above values represent the mean ± standard deviation (SD) of 6 cattle
** = Significant at 1 per cent level ($p<0.01$)
* = Significant at 5 per cent level ($p<0.05$)

The hemoglobin content was also increased significantly ($p<0.01$) after Dovenix® and Oxynil® treatment in group A and B respectively, were shown in the Table --3.

Table - 3: Effects of Dovenix® and Oxynil® on Hb content (gm %) in cattle

Group	Treatment	Pre-treatment	Post-treatment			
		0 day	3rd day	7th day	14th day	28th day
A	Dovenix®	9.08±0.49	9.62±0.45**	9.77±0.26**	10.02±0.29**	10.37±0.42**
B	Oxynil®	8.5±0.63	9.18±0.49**	9.42±0.38**	9.67±0.41**	9.86±0.45**
C	Untreated infected control	8.6±0.55	8.48±0.45**	8.25±0.42**	7.83±0.26**	7.56±0.63**

The above values represent the mean ± standard deviation (SD) of 6 cattle
** = Significant at 1 per cent level ($p<0.01$)
* = Significant at 5 per cent level ($p<0.05$)

The PCV was increased significantly ($P<0.01$) after Dovenix® and Oxynil® treatment in group A and B, respectively, shown in the Table -- 4.

Table - 4: Effects of Dovenix® and Oxynil® on PCV (%) in cattle

Group	Treatment	Pre-treatment	Post-treatment			
		0 day	3rd day	7th day	14th day	28th day
A	Dovenix®	27.83±0.75	30.33±1.63**	30.33±1.51**	31.33±1.51**	31.67±1.75**
B	Oxynil®	26.83±0.98	28.83±0.75**	29.5±0.55**	30.17±0.75**	30.67±1.51**
C	Untreated infected control	26.67±0.82	26.33±1.03**	25.67±0.52**	25.0±0.89**	24.5±1.38**

The above values represent the mean ± standard deviation (SD) of 6 cattle
** = Significant at 1 per cent level ($p<0.01$)
* = Significant at 5 per cent level ($p<0.05$)

The TEC was increased significantly ($p<0.01$) after Dovenix® and Oxynil® treatment in group A and B respectively. Mean TEC before treatment was 7.652±1.07 and after treatment with Dovenix® mean TEC on 3rd, 7th, 14th and 28th day were 8.282±0.19, 8.345±0.15, 8.495±0.11 and 8.503±0.10 in group A, receptively. The improved level of TEC content of blood in treated cattle might be due to elimination of blood sucking gastro-intestinal nematodes. The hemoglobin content was also increased significantly ($p<0.01$) after Dovenix® and Oxynil® treatment in group A and B, respectively. The increase in hemoglobin content may be due to the increase of total erythrocyte count (TEC).

Effects of Dovenix® and Oxynil® on body weight (kg) in cattle

The body weight was increased significantly ($p<0.01$) after Dovenix® and Oxynil® treatment in group A and B respectively in the Table -- 5.

Table --5: Effects of Dovenix® and Oxynil® on body weight (kg) in cattle

Group	Treatment	Pre-treatment	Post-treatment			
		0 day	3rd day	7th day	14th day	28th day
A	Dovenix®	195.7±0.79	196.37±0.85**	201.5±1.52**	203.83±1.94**	220.17±1.33**
B	Oxynil®	190.83±0.98	192.83±1.17**	196.5±1.64**	201.67±1.63**	206.0±1.26**
C	Untreated infected control	210.17±1.33	207.67±1.03**	204.17±0.41**	197.17±2.64**	196.83±1.72**

The above values represent the mean ± standard deviation (SD) of 6 cattle
** = Significant at 1 per cent level ($p<0.01$)
* = Significant at 5 per cent level ($p<0.05$)

The body weight gains in the nitroxynil treated are supported by the findings of Isles *et al.* (1985) in heifers. The parasitic infection might be responsible for the stunted growth. The body weight was increased may be due to removal of parasitic load might have had

facilitate the weight regain through proper digestion, absorption and metabolism of feed nutrient in the parasite free gastro-intestinal tract**.**

CONCLUSION

The findings of the present study reveals that both Dovenix® and Oxynil® are highly effective for reduction of EPG of liver fluke and gastro-intestinal nematodes. These two drugs have wide therapeutic index and they may kill or inhibit egg production of liver fluke and gastro-intestinal nematodes.

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PREVALENCE AND ANTIBIOTIC SENSITIVITY OF SALMONELLA ISOLATES IN CHICKEN MEAT OF CHITWAN

Prazila Shrestha[1], Mira Prajapati[1], Narayan Poudel[2] and Nirajan Bhattarai[3]
[1]Animal Health Research Division, Khumaltar, Lalitpur
[2] Regional Agriculture Research Station, Khajura, Banke
[3]Institute of Agriculture and Animal Science, Rampur, Chitwan
Email: prazila@yahoo.com

ABSTRACT

A study was carried out on raw poultry meat samples from the local meat market of Chitwan during March 2008 to July2008 for isolation of Salmonella bacteria and their drug resistant pattern. A total of 90 raw meat samples were collected and analyzed. Isolation of Salmonella was performed using BGA and SS agar respectively. Samples with bacterial growth within 24 hours incubation were subjected to Grams stain. Salmonella were identified by Gm–ve samples and by other biochemical test. Salmonella spp were found in 17 samples out of 90 (18.88%) meat samples. By drug sensitivity test Gentamycin and Chloramphenicol were found to be highly sensitive (87.5%) followed by Erythromycin (75%), Streptomycin (62.5%), and Ciprofloxacin and Doxycycline 4 (50%). On the other hand highest resistance was observed against Penicillin, Ampicillin, Cloxacillin and Trimethoprim (100%) followed by Cephalexin 75% and Nitrofurantoin (55%).

Keywords: Salmonella, chicken meat, Nepal

INTRODUCTION

Meat is a good source of protein, vitamins, minerals especially iron. Poultry meat is a leading source of animal protein for human consumption in many countries. The local poultry industry provides more than 80% of the total poultry used by consumers. Along with this growth, poultry meat has been increasingly implicated in food-borne illness. Meat is also a good media for the growth of microorganisms. Owing to the implementation of greater numbers of monitoring and testing programmes in the poultry industry, isolation of *Salmonella* is reported more often in poultry and poultry products than any other animal source. Estimates of the incidence of *Salmonella* in poultry meat and poultry products vary considerably.

In Nepal almost 50% of 23.02 million poultry are found in the Central region and are predominantly commercial. The annual growth in commercial chicken eggs and meat production were estimated as 10.6% and 18.3% respectively up to year 2001(Shrestha, 2005). In Nepal, commercial poultry contributes 8% of AGDP and 4% of national GDP (Karki, 2005). Emergence of high yielding breeds' gradual development in management and disease control measures has all made poultry a large segment of agribusiness in Nepal. Major broiler breeds in Chitwan were Vencobb, Arboracre, Hubchix, Avian34, Marshal etc. Similarly the layer breeds in Chitwan were Hyaline Brown, Lohman Brown, Babcock, Isa Brown, Keystone Brown etc (Thapa, 2005).

Salmonellosis has caused a burning problem for poultry raiser as well as consumers. Since it is a zoonotic and egg borne disease and has a great importance in transmission of disease in the country. Poultry are a common source and, in recent years, much attention has been focused in determining the prevalence of Salmonella during the different stages in the poultry production chain. Poultry are commonly infected with *S. pullorum* and *S. gallinarum* which are host-specific.

The incidence of S*almonella* associated with food poisoning in human has been well documented. The direct link between *S. enteritidis* and infected poultry flock and outbreaks of human illness in different countries has been reported. In most industrialized countries, *S. enteritidis* is considered the predominant serovar, followed by *S. typhimurium*. Thus those persons who are engaged in the field like farmers, slaughterhouse worker, veterinarians etc. all constitute high risk group for certain zoonosis.

Salmonellosis includes various disease caused by different salmonella species and is one of the deadly maladies of poultry with public health importance. *Salmonella* spp. is among the most common causes of human bacterial gastroenteritis worldwide, and food animals are important reservoirs of the bacteria. In recent years, an increase in the occurrence of antimicrobial drug–resistant *Salmonella* spp. has been observed in several countries. Fatality rates are higher for patients with infections caused by drug-resistant *Salmonella* Resistance increased to a number of commonly used antibiotics, possibly related to overuse of antibiotic.

The extensive use of antimicrobials in human and animals has led to an increase in bacterial multidrug resistant among several bacterial strains. This phenomenon of multiple resistances represents a worldwide problem both for veterinary and public health sectors. Bacterial resistance is observed especially when the antibiotics are abundantly used and that the bacteria can be transmitted easily between the individuals. Various antimicrobials in intensively managed food animals including chickens are often administered through feed or drinking water either for therapy, prophylaxis or growth promotion. Salmonella spp is one of the most frequently isolated bacteria in avian production units. The increasing single and multiple antimicrobial-resistant *Salmonella* strains isolated from human cases of salmonellosis have been associated with widespread use of antimicrobial agents in food animal production. This may represent a public health risk by transfer of resistant *Salmonella* strains to humans through the consumption of contaminated food and food products. Upadhyay and Mishra (1978) reported that all the strains isolated from different animals were sensitive to Ampicillin, Tetracycline, Streptomycin, and chloramphenicol and resistant to Erythromycin. Hoszowaski *et al*. (1999) found commonest resistant to tetracycline and streptomycin and 88% of the *Salmonella* isolates showed multi resistant. Regular monitoring of sensitivity patterns of antibiotics is essential for the effective treatment and control of the diseases, and to minimize the improper use of antibiotics. Therefore the objectives of present study were to investigate the prevalence of Salmonella in chicken meat and their sensitivity patterns to different commonly used antibiotics.

MATERIALS AND METHODS

Sample collection and preparation

Meat samples were collected in a sterile polybags from different shops and transported to the Bacteriology laboratory within 2 hours, stored in refrigerator at 4^0C and examined within two hours. Each sample was aseptically removed from plastic bag, 1 g of each sample was weighted and inoculated in the tube containing double concentrated lactose broth and the tubes were incubated at 37^0C for 24 hrs.

Isolation and identification of organism

One ml of pre-enriched culture was transferred to the 9 ml of Selenite F broth and reincubated for 24 hrs at 37^0C. From Selenite broth, a loopful of enriched inoculate was streaked in Brilliant Green Agar (BGA) and SS Agar. The culture plates were then incubated for 24 hrs at 37^0C. *Salmonella* suspected colonies in BGA and SS agar were picked up with sterile loop and inoculated in nutrient agar to obtain pure culture. These culture plates were then incubated for 24 hrs at 37^0C. The different biochemical tests were done.

Assessment of antibiotic resistant

Salmonella isolates obtained from chicken meat were further tested to evaluate their antibiotic sensitivity patterns to different commonly used antibiotics manufactured by Hi-Media, India. *Salmonella* isolates were inoculated onto nutrient broth separately and incubated at 37^oC for 24 hrs. Inoculum of each isolate was transferred with sterile cotton swab onto corresponding petridishes uniformly containing Muller–Hinton Agar. The surface of each plate was allowed to dry. Then the antibiotic discs were gently pressed down on each agar plate using sterilized forceps to ensure complete contact with the agar surface. Plates were then incubated at 37^oC for 24 hrs in an inverted position and the plates were examined. The sensitivity patterns were determined by the disk diffusion method as described by Bauer *et al*. (1966). The results were recorded as sensitive, moderate sensitive and resistance on the basis of zone of inhibition.

RESULTS AND DISCUSSION

Out of total 90 samples, 17(18.88%) samples were found positive for salmonella Spp. This result was almost similar with the study reported by Anon (2000) and Shrestha (2005) however Acharya (2007) and Boonmar *et al.,* (1998) reported higher positive percentage of Salmonella than in the present study. The differences with the previously reported results may be due to differences in origin of sample, detection methods, sampling procedures and sanitation during processing. This study shows the lower prevalence (18.88%) of salmonella than the finding (26.09%) of Acharya (2007) in the poultry meat in Chitwan Valley. Manandhar (2006) reported 11.4% (14/123) meat samples positive for Salmonella which is lower than the present study.

Among those isolated salmonella, Gentamycin and Chloramphenicol was highly sensitive drugs (87.5%) followed by Erythromycin (75%), Streptomycin (62.5%), and Ciprofloxacin

and Doxycycline (50%). On the other hand highest resistance was observed with Penicillin, Ampicillin, Cloxacillin and Trimethoprim (100%) followed by Cephalexin 75% and Nitrofurantoin (55%). Pradhan and Aryal (1999/2000) found that Nitrofurantion and Doxycycline were most sensitive drugs for isolates salmonella from poultry, whereas this study shows Choramphenicol and Gentamycin to be the most sensitive drug against Salmonella. Studies done by Moharana *et al.*, (1993) revealed that the Salmonella strains tested were 100% sensitive to Gentamycin and are similar to the present findings. Upadhyay and Mishra (1978) reported that all the strains isolated from different animals were sensitive to Ampicillin, Tetracycline, Streptomycin, Chloramphenicol and resistant to Erythromycin. Hoszowaski *et al*. (1999) found commonest resistant to Tetracycline and Streptomycin and 88% of them showed multi resistant.

CONCLUSION

From this study, it was found that prevalence of *Salmonella* in poultry meat of Chitwan was 18.88%. The isolates of salmonella were resistant to different drugs like Nitrofurantoin Tetracycline and Cephalexin and more sensitive to Gentamycin. This study also suggests that chicken meat were contaminated with salmonella. Members of the genus *Salmonella* still occupy first place as causative agents of food-borne diseases. Consumption of contaminated poultry meat has frequently been implicated in outbreaks of human salmonellosis. For these reasons the presence of *Salmonella* strains in poultry meat is of great concern to the poultry industry, as well as to institutions involved in food hygiene and health protection of consumers, in order to prevent possible food-borne outbreaks among the population. The results of the present study indicate single or multiple resistances of *Salmonella* strains isolated from poultry, that constitutes a potential source of transmission of these resistant strains to man and poses a problem in public health. More detail studies on food borne salmonella eg *Salmonella enteritidis, Salmonella typhimurium* have to be studied

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IDENTIFICATION OF POISONOUS PLANTS IN MUSTANG DISTRICT

Ramesh Prasad Sah[1] and Guru Prasad Khakural[2]
[1]Agriculture Research Station, Pakhribas, Dhankuta
[2]District Livestock Service Office, Jomsom, Mustang
Email: bidya_2064@hotmail.com

ABSTRACT

Poisoning of animals occurs frequently in rural areas of Nepal when animals are mainly fed with forest forages/fodders which may accidently consist of poisonous plants resulting in economic loss. An attempt was made during 2011 to identify poisonous plants with their toxic effects in goats and sheep of Mustang District. A semi-structured questionnaire survey format was developed, distributed to a total of 192 goat and sheep raising farmers in Jharkot, Jomsom, Marpha and Lete of Mustang. Farmers were asked to provide information regarding poisonous plants found in their locality, toxic effects of poisonous plants, duration of death after ingestion and indigenous antedotes used. Suspected poisonous plant samples were collected from the above sites with their local names and were brought to National Herbarium and Plant Laboratory, Godawari, Lalitpur for identification. Animals younger than six months of age were reported to be the most susceptible for deleterious effect of poisonous plants followed by two years or older. Several plants reported to be poisonous to sheep and goats were Angeri (Lyonia ovalifolia), Bikh (Aconitum spicatum), Aanke (Calotropis gigantea), Hanuman jhar (Ageratum conyzoides), Ghurilo (Cynanchum spp.), Banko (Arisaema flavum) and Pauli (Reinwardtia indica) in Mustang. Amilo, Chuk, Pakhanbed (Bergenia ciliata), Panchaule (Dactylorhiza hatagirea), Timur (Zanthoxylem armatum), Nirmasi (Acotinum gammiei) and khoto were frequently used as antidotes for poisoning cases in sheep and goats.

Keywords: Poisonous plants, goat and sheep, Mustang, toxic effects and antedotes.

INTRODUCTION

Nepal has diversified physiographic zones with different types of vegetation. Some of the plants may contain biologically active chemicals. Some of these have been found to be extremely useful for treating various human and animal diseases (e.g. digitoxin, colchicines and atropine). However, some plant constituents produce adverse health effects following exposure. The onset of these adverse effects can be quite sudden or take some time to develop. The severity of poisoning is related to the quantity of material consumed, the species of the animal, portion of the plant and condition of the plant eaten, level of ground moisture, general health of the animal prior to ingesting the substance and the age and size of the animal. Most of the time animals do not show symptoms of injury or poisoning where as death is the only sign. Fortunately, among the thousands of plants in the environment of animals, relatively few toxic plants cause acute, life-threatening illnesses when ingested.

The magnitude of animal losses to ingestion of poisonous plants varies considerably between geographic regions. Losses include not only those due to mortality but also those

due to poor productivity such as decreased weight gain or decreased milk production. In addition, the economic cost of controlling poisonous plants needs to be considered. Economic loss in Pennsylvania, U.S.A. due to poisonous plant ingestion by livestock is relatively small compared to that in other States, particularly those in the Western U.S. In 17 Western states, it has been estimated that yearly cattle and sheep death losses to poisonous plants are 1% and 3.5%, respectively (Nielsen *et al.*, 1988). Although the value of livestock varies from year to year, the total annual economic loss in these states is estimated to be nearly a quarter billion dollars. Ingestion of a potentially toxic plant is the number one route of poisoning in animals. Factors contributing to plant poisoning are starvation, accidental eating and browsing habits of animals. Starvation is the most common reason.

It is important to emphasize that many, but certainly not all, toxic plants are not very palaTable -. Therefore, if given the choice, animals will avoid ingesting them even though they may be prevalent in the environment of the animal. In these situations, animals will often eat such plants only when other suiTable - feedstuffs are unavailable or when the animal is not able to selectively avoid the plants.

In Nepal, limited studies have been carried out regarding the poisonous plants along with its toxic effect. Therefore this study aims to explore and identify the poisonous plants in Mustang of the western region.

MATERIALS AND METHODS

In order to obtain information on toxicity of poisonous plants, a semi structural questionnaire format was developed and distributed to goat and sheep raising farmers in four sites viz. Jharkot, Jomsom, Marpha and Lete of Mustang District as per suggestion made by DLSO, Mustang in 2011. Altogether 192 farmers were asked verbally to get information on available poisonous plants found in their location, toxic effects of poisonous plants after ingestion, duration of death after ingestion, toxic parts of the plants, effective age of animal, their indigenous practice reducing the toxicity of plants as well. Required plants sample were collected from the above sites with their local name they called and were subjected to National Herbarium and Plant Laboratories (NHPL), Godawari, Lalitpur for complete identification. Furthermore, some plants were identified with their botanical names. Collected information was analyzed through SPSS statistical package.

RESULT AND DISCUSSION

Farmers were questioned to provide information of available poisonous plants along with toxicity of these plants in their sheep and goat. All of respondents reported prevalence of toxic effect in their animals due to ingestion of poisonous plants sporadically.

Duration of death after ingestion

Majority of farmers (54.2%) reported death of animals within 12 hours of ingestion of poisonous plants followed by death within 2 hours and 24 hours after ingestion (Table -1). This finding is in accordance with the finding made by Aryal and Singh (1999).

Table - 1: Duration of death after ingestion

Duration of death	Frequency	Percent
2 hours	48	25
12 hours	104	**54.2**
24 hours	40	20.8
72 hours	0	0
Total	192	100

Toxic parts of the plants

Shoot was found to be the most toxic part of plants (87.5%) followed by leaf (12.5%), while stem had no toxic effect according to the farmers. The young leaves of Laligurans and young leaves and buds of Angeri were found poisonous in goats (Table - 2). This finding is similar to the findings made by Aryal and Singh (1999), Anon (1970) and Joshi (1991).

Table - 2: Toxic parts of the plants

Toxic parts	Frequency	Percent
Shoot	168	87.5
Stem	0	0
Leaf	24	12.5
Total	192	100

Age of animal

Six months of age was reported to be the most susceptible age for deleterious effect of poisonous plants followed by two years and more than two years (Table - 3).

Table - 3: Age of animal

Age	Frequency	Percent
6 months	104	54.2
2 years	80	41.7
> 2 years	8	4.1
Total	192	100

It may be due to low immunity power against poisoning. The older animals might tolerate the toxicity level to some extent. Similar finding was also reported by Sah *et al.*, (2012).

List of poisonous plants

Table - shows the toxicity in their animals from these plants. Several plants had found poisonous for sheep and goats. Among these Angeri, Bikh, Anke, Pauli, Hanuman jhar, Ghurilo, Banko etc. were the most commonly found poisonous plants available in sampled sites (Table - 4). Toxicity of these plants was also reported by Aryal and Singh (1999) in mid western region and Sah *et.al*. (2012).

Table - 4: List of poisonous plants (%)

Poisonous plants	Botanical name	Yes	No	Total
Angeri	*Lyonia ovalifolia*	70.8	29.2	100
Bikh	*Aconitum spicatum.*	66.7	33.3	100
Aanke	*Calotropis gigantean*	54.2	45.8	100
Hanuman jhar	*Ageratum conyzoides*	50.0	50.0	100
Ghurilo	*Cynanchum sp.*	43.8	56.3	100
Banko	*Arisaema flavum*	35.4	64.6	100
Pauli	*Reinwardtia indica*	31.3	68.8	100
Laligurans	*Rhododendron arboretum*	26.0	74.0	100
Khirro	*Sapium insigne*	22.9	77.1	100
Tunnee	*Cedrella toona*	21.9	78.1	100
Pore	NA	11.5	88.5	100
Aijaeru	*Scurrula parasitica*	11.5	88.5	100
Cardomum	*Amomum subulatum*	8.3	91.7	100
Tatasiri	NA	8.3	91.7	100
Ikro	NA	4.2	95.8	100

Farmer's indigenous antidote measures

Farmers were using common things against poisoning due to ingestion of poisonous plants in their animals given in Table - 5.

Table - 5: Farmer's indigenous antidote measures (%)

Common name	Botanical name	Yes	No	Total
Amilo	-	70.8	29.2	100
Chuk	-	65.6	34.4	100
Pakhanbed	*Bergenia ciliate*	50.0	50.0	100
Panchaule	*Dactylorhiza hatagirea*	46.9	53.1	100
Timur	*Zanthoxylum armatum*	40.6	59.4	100
Nirmasi	*Acotinum gammiei*	33.3	66.7	100
Khoto	-	22.9	77.1	100

Farmers have developed their indigenous control measures against animal diseases since many years. Likewise, they have used Amilo, Chuk, Pakhanbed, Nirmasi, Panchaule, Timur and khoto for the treatment of poisoning case in their sheep and goats. Majority of respondents reported effectiveness of these antidote measures.

CONCLUSION

The following conclusions were made after study:

- Majority of farmers (54.2%) reported the duration of death of animals within 12 hours of ingestion of poisonous plants.
- Shoot was the most toxic parts of plants (87.5%).

- Six months of age was reported the most susceptible age for deleterious effect of poisonous plants.
- Angeri, Bikh, Anke, Pauli, Hanuman jhar, Ghurilo, Banko etc. were the most commonly found poisonous plants.
- Amilo, Chuk, Pakhanbed, Nirmasi, Panchaule, Timur and khoto for the treatment of poisoning case.

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PREVALENCE OF INFECTIOUS BURSAL DISEASE AND NEW CASTLE DISEASE IN BACKYARD POULTRY IN KAVRE

Upendra Man Singh[1], Madhav Prasad Acharya[2] and Bhoj Raj Joshi[1]
[1]National Animal Science Research Institute, Khumaltar, Lalitpur
[2]Animal Health Research Division, Khumaltar, Lalitpur
Email: vet.ums@gmail.com

ABSTRACT

A total of 55 households (36 of Pipaltar and 19 Ryale) of Panchkhal Kavre were visited and information's regarding overall management, marketing and health care were collected by interviewing farmers. Backyard poultry farmers of Kavre district were selected for testing of birds for Infectious bursal disease and New Castle disease virus. Household survey revealed backyard poultry are raised in free ranging during day time and were housed inside in bamboo doko for chicks and local shed for adult birds. These birds did not have any waterer or feeders as birds have access for stagnating water in the backyard. Feeds consisted of maize, wheat or Rice bran was given. Major diseases reported by the farmers were white/ green diarrhea, fowl pox diarrhea and chick mortality. The marketing age of birds were 6 months to 1 year with body weight 1.5- 3 kg(male 3 kgs and female 2 kgs) and marketing price 80- 100 Rs/ 200 g. The backyard poultry usually layed 12- 25 eggs/ bird/lay with 3-4 times lay/ year. Almost all farmers did not give any health services (deworming, vaccinations and antibiotic and feed supplements). A total of 100 backyard poultry(< 16 weeks of age) from Pipaltar(59) and Ryale(41) of Kavre district were tested for prevalence of New Castle disease virus by using Antigen rapid IBDV test kit(Bionote Inc. Korea) and were found negative. Similarly a total of 100 backyard poultry from Pipaltar(44) and ryale(56) of Kavre district were tested for prevalence of New Castle disease virus by using Antigen rapid NDV test kit(Bionote Inc. Korea) and were found negative. This study shows that backyard poultry of Pipaltar and Ryale of Kavre are free of Infectious Bursal disease and New Castle disease virus.

Keywords: Backyard poultry, New castle disease, infectious bursal disease

INTRODUCTION

Infectious Bursal disease affects chicks and growers below 10 weeks of age. It is a highly infectious and contagious disease of poultry causing serious economic loss for subsidized farmers. The status of occurrence and prevalence in backyard poultry is not known. Similarly New Castle Disease is also a highly contagious and economic disease of poultry. It can affect any age of poultry Prevalence of this disease in backyard poultry also not known.

Infectious bursal disease (IBD) was identified by Agar gel precipitation test (AGPT) in small scale broiler farm at Parbat district (Joshi *et al*., 1996). Infectious Bursal disease caused highest mortality in 1162 chickens necropsied during 1987-1995 (Johan *et al*., 1996) A total of 1170 samples were collected from commercial layers and 45 from backyard birds. Out of these samples 1041 were found positive for sera prevalence and 1153 for specific immunity to NDV with over all percentage of 88.97 and 98.54 in commercial layers in backyard poultry. 15 were

positive for seroprevalence and 22 for specific immunity to NDV with over all percentage of 33.33 and 48.88, respectively (Shrestha and Basnet, 2010).

Backyard poultry is mostly maintained by subsidized farmers and it is very common in rural areas. Considerable loss of poultry can occur due to highly contagious and infectious diseases like Infectious Bursal Disease and New Castle Disease. The status of these diseases in back yard poultry should be identified which will help in developing control measures against these diseases.

The ultimate beneficiaries envisaged by this study are the small scale backyard poultry farmers. The outcome of the project will help in the livelihood upliftment of the Dalit, marginal, Janjati and the socially excluded groups of the society. The researchers, extension agents, this will help in controlling Infectious Bursal Disease and New Castle Disease in poultry

The major objective this project was to find the seroprevalence status of New Castle disease and Gambaro disease (IBD) in rural backyard poultry population of the country.

MATERIALS AND METHODS

A total of 45 households (36 of Pipaltar and 19 Ryale) of Panchkhal Kavre were visited and information's regarding overall management, marketing and health care were collected by interviewing farmers. Backyard poultry farmers of Kavre district were selected for testing of birds and Identification of farmers were carried out. As Gambaro disease (IBD) is a problem of growing chicken of below 1 weeks of age. So a total of 100 birds comprising two groups of chicken <16 weeks and > 16 weeks birds were tested. Similarly for New Castle Disease a total of 100 birds comprising two groups of chicken <16 weeks and > 16 weeks birds were tested. Rapid diagnostic test kit of IBD and ND from Antigen Korea were procured. Conduction of screening tests was the major activities.

RESULTS AND DISCUSSION

Household survey

A total of 45 households (36 of Pipaltar and 19 Ryale) of Panchkhal Kavre were visited). Backyard poultry are raised in free ranging during day time and were housed inside in bamboo doko for chicks and local shed for adult birds. These birds did not have any waterer or feeders as birds had access for stagnating water in the backyard. Feeds consisted of maize, wheat or Rice bran was given. Major diseases reported by the farmers were white/ green diarrhea, fowl pox diarrhea and chick mortality. The marketing age of birds were 6 months to 1 year with weight 1.5- 3 kg (male 3 kgs and female 2 kgs) and marketing price 80- 100 NRs/ 200 g. The backyard poultry usually layed 12- 25 eggs/ bird/lay with 3-4 times lay/ year. Almost all farmers did not give any health services (deworming, vaccinations and antibiotic and feed supplements).

Table - 1: Result of rapid IBDV and NDV Ag test in backyard poultry of Kavre

Place	Total no. of household	Total no. of birds in farms	No. of birds tested with Ag test kit			
			IBDV		NDV	
Pipaltar	36	292	59	-ve	44	-ve
Ryale	19	76	41	-ve	56	-ve
Total	55	368	100		100	

A total of 100 backyard poultry (< 16 weeks of age) from Pipaltar (59) and Ryale (41) of Kavre district were tested for prevalence of infectious Bursal disease virus by using Antigen rapid IBDV test kit (Bionote Inc. Korea) and were found negative. Similarly a total of 100 backyard poultry from Pipaltar(44) and ryale(56) of Kavre district were tested for prevalence of New Castle disease virus by using Antigen rapid NDV test kit (Bionote Inc. Korea) and were found negative (Table -1).

CONCLUSION

This study shows that backyard poultry of Pipaltar and Ryale of Kavre are free of Infectious Bursal disease and New Castle disease virus. White diarrhea could be due to salmonellosis and vaccination against fowl pox should be mandatory for the backyard poultry. There is necessity for regular deworming against round worms and vaccinations against New Castle disease.

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PATHOLOGICAL FINDINGS IN LOCAL CHICKENS CHALLENGED WITH FIELD ISOLATE OF NEWCASTLE DISEASE (ND) VIRUS

Mira Prajapati, Madhav Prasad Acharya, Swoyam Prakash Shrestha and PrazilaShrestha
Animal Health Research Division, Khumaltar, Lalitpur
Email: prajapati_m@hotmail.com

ABSTRACT

This study was aimed to identify the clinical signs, gross and histopathological findings of the local chickens experimentally challenged with field isolate of ND virus at Animal Health Research Division (AHRD), Khumaltar from June to August 2012. A total of Local chickens of day old were bought and reared in a brooding house up to 4 weeks and given only IBD vaccine. Birds were then divided into 2 groups: A (treatment group) and C (the control group) ; each group containing 30 birds. Field isolate of ND virus was injected on day 56. Clinically, decrease in feed and water consumption, dullness and depression was seen after 5 days of inoculation. From fifth days onward, 2-4 birds/day were found dead. Birds showed signs of wing paralysis, torticollis, head shaking and greenish diarrhea. Pathological lesions were haemorrhages in the mucosa of anterior proventriculus and in gizzard were observed. Histopathological study of trachea showed mucosal disruption and tracheitis. In proventriculus, disruption of proventricular epithelium and engorged blood vessels were seen.

Keywords: Newcastle disease, virus, pathology,

INTRODUCTION

Newcastle disease (ND), also known as Ranikhet is an acute viral disease of poultry and other bird species caused by Newcastle disease virus (NDV) which are classified in the serotype group avian paramyxovirus type 1 (APMV-1) in the genus Avulavirus and family Paramyxoviridae. ND is an OIE list a disease; it spreads rapidly, extends beyond national border, and has serious socio economic importance and major trade implications.

Isolates of Newcastle disease virus are grouped as virulent (velogenic), moderately virulent (mesogenic), and low virulence (lentogenic) by chicken embryo and chicken inoculation (Aiello and Mays, 2000). Velogenic isolates are further divided into a velogenic viscerotropic pathotype, which those strains are causing predominantly diarrhea and visceral haemorrhage, and a velogenic neurotropic pathotype which are those strains causing predominantly neurological signs (Alexander, 1997; Hanson *et al*., 1973 and Alexander, 2007). The disease can be transmitted directly through faeces and respiratory discharges or by contamination of the environment including food, water, equipment, and human clothing. Birds can be prevented from Newcastle disease by vaccination and not exposing to infected birds. Clinically, the disease is manifested by gastrointestinal, respiratory and nervous signs depending upon the virus virulence and the age, immune status and susceptibility of the host species (Alexander, 2003). Histopathology of NDV varies and can be affected by strain of the virus and host species, the method of infection, host immune

status and virus dose. The main objective of this study is to identify the clinical signs and histopathological lesions of Nepalese field isolate of ND virus.

MATERIALS AND METHODS

Chickens

A total of 30 day old local chickens were bought from Suwal hatchery, Bhaktapur and reared in a brooding house of Animal Health Research Division (AHRD), Khumaltar for up to 4 weeks. They were fed Poshak feed 3 times a day and IBD vaccine was given on day 28.

Virus

Newcastle disease virus was isolated at Animal Health Research Division (AHRD) from field sample.

Experimentation

A total of 30 birds that were brought into AHRD lab were challenged with local isolate of ND virus at the dose rate of 10^6 EID50/0.1ml/bird/intra ocular/intranasal which was isolated from field samples at AHRD and virus was titrated. Birds were monitored for the symptoms shown and mortality was recorded. Postmortem examination were conducted for all dead birds and tissue samples eg proventriculus, trachea were taken and fixed in 10% buffered formalin solution. Tissue samples were processed and embedded in paraffin wax, sectioned were made and stained with Haemotoxyllin and Eosin (H and E) for Histopathological examination.

RESULTS AND DISCUSSIONS

Birds started showing clinical signs of Newcastle disease in treatment group after 3 days of inoculation. Firstly, there was decrease in feed and water consumption. Infected birds were dull and depressed and huddled together. Birds were found more severely affected later and were found in isolation and showed the neurological signs like head shaking, difficulty in breathing, paralysis, torticollis and finally death. However, neurological signs were not found in the study conducted by Galindo-Muniz and colleagues. This could be due to the difference in the pathogenicity of the virus used.

Postmortem conducted on the affected birds showed congestion of trachea and had accumulation of mucus or exudates. There was consolidation in lungs and congestion in liver, intestine inflammation and haemmorrhages on tip of proventricular glands, and severe haemorrhages on horny layer of gizzard was seen.

Microscopically, the tracheal mucosa was inflamed as characterized by congestion and mucosal damage in proventriculus. There was disruption of proventricular epithelium, lymphocytic infiltrations in lymphoid follicles and engorged blood vessels were seen which were similar to the findings of Mohammadamin and Qubih (Mohammadamin, 2011). In a study conducted by Galindo-Muñiz and colleagues, lymphocytic inflammations were seen in the proventriculus of the infected bird.

In the present study, the symptoms of the Newcastle disease appeared only after 3 days whereas the symptoms appeared earlier in a study conducted by Galindo-Muñiz and colleagues. This may be due to the difference in the pathogenecity of the field isolate virus introduced to the bird. Moreover, the histopathology of the organs following NDV infection varies with the clinical signs and gross lesions and was greatly affected by the strain of the virus and host immunity (Alexander, 2003). The study conducted by reported distinctly different disease syndromes as a result of the viscerotropic and neurotropic strains of the virus (Brown, *et al*., 1999).

Hence, the field isolate of ND virus used in the present study is velogenic in nature. However, besides trachea and proventriculus, other organs like brain, thymus and bursa should also be studied histologically.

CONCLUSION

Hence, the field isolate of ND virus used in the present study is velogenic in nature. However, besides trachea and proventriculus, other organs like brain, thymus, bursa should also be studied histologically.

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STUDY ON ETHNO VETERINARY PRACTICES IN JUMLA

Niraj Baskota[1] and Doj Raj Khanal[2]
[1]Regional Agricultural Research Station, Lumle, Kaski
[2]Animal Health Research Station, Khumaltar, Lalitpur
E-mail: nirajbaskota@hotmail.com

ABSTRACT

Ethno-veterinary is an indigenous knowledge, abilities and methods for caring, healing and managing livestock's. A study was conducted in three different sites namely Rini, Patmara VDC-4, 5 and 6 and Gutichaur VDC-6, 7 and 8 during 2010/11(206768) to explore the ethno -veterinary practices. A total of 15 different species of plants were known to be used in ethno-veterinary practices for different cases of external parasitic infestations, internal parasites and retention of placenta etc. Commonly used - practices included Acorus calamus (Bojho) against skin infection, Epehedra-gerardiana (Somlata) emetic agent in poisoning cases, Drepanostachymum falcatum (Nigalo) against liver flukes, Sanemone obtusiloba (Maurimuo) against intestinal worms, Girardiania diversifolia (Allo) in retention of placenta etc. The local amchis had the wider and sound knowledge on the use of different Medicinal and Aromatic plants. Winter feed scarcity, Shepherding problem, Livestock's Diseases, Lack of marketing and linkages, Poisonous plants etc.were identified as major constraints of livestock farming. Ethno-veterinary *knowledge has been transmitted from eneration* to ge*neration traditionally.*

Keywords: Livestock, ethnoveterinary practice, Nepal

INTRODUCTION

Ethno-veterinary medicine or ethno-veterinary research is the holistic, interdisciplinary study of local knowledge and its associated skills, practices, beliefs, practitioners, and social structures pertaining to the healthcare and healthful husbandry of food producing animals with applications within livestock production systems. They can generate useful information needed to develop livestock healing practices and methods that are suited to the local environment, (McCorkle and Martin, 1995). Ethno-veterinary medicine covers people's knowledge, skills, methods, practices and beliefs about the care of their animals. Ethno-veterinary in simple terms, is supposed to be a sub-discipline of ethno-ecology that simply means the ecological wisdom of local people regarding animals healthcare **(**Köhler and Bräunig, 1998**)** .Ethno-veterinary can also be defined as an indigenous knowledge, abilities and methods for caring, healing and managing livestock. Un- like scientific veterinary medicine, ethno-veterinary practices have been developed through trial-and-error and deliberate experimentation. But ethno-veterinary medicine is developed by farmers in fields and barns, rather than by scientists in laboratories and clinics. It is less systematic and less formalized, and is usually transferred verbally without written documents. More than 100 different plants species are known to be herbal and medicinal plants in Jumla. Among them, 15 different species of plants are known to be used in ethno-veterinary practices. Different species of plants are used for different cases eg external and internal parasitic infection and

retention of placenta. Some commonly used - practices include *Acorus calamus* (Bojho) against skin infection, Epehedra-gerardiana (Somlata) emetic agent in poisoning cases, Drepanostachymum falcatum (Nigalo) against liver flukes, Sanemone obtusiloba (Maurimuo) against intestinal worms, Girardiania diversifolia (Allo) in retention of placenta etc. The local amchis had had the wider and sound knowledge on the use of different Medicinal and Aromatic plants.

MATERIALS AND METHODS

The study was conducted during 2010/11(206768) in three different sites viz. Rini, Patmara VDC 4,5 and 6 and Gutichaur VDC 6, 7 and 8. A survey was conducted to identify general livestock production system. The data was collected with a questionnaire format, personal interviews with local amchis, elderly knowledgeable and experienced persons, who had traditional knowledge on the ethno-veterinary practices. The data was updated by qualitative information gained through informal discussions with the farmers during field work. Information regarding observation and experiences of local people were collected. The biological materials were identified by consulting subject matter specialists.

RESULTS AND DISCUSSION

General farming system and potentiality of livestock production

Altitude of Jumla ranges from 639 masl to 2102 masl. The temperature varies from -10^0 c to 29^0 c. Three types of geographical texture are present in the district

- Himalaya range: The entire range gets covered through snow from 6 months to 12 months.
- High hills: Moderate density of population lives here and upper part gets covered with snow for 3 months.
- River basins: Land suiTable - for agronomical activities like oat, rice, barley etc.

The inputs and outputs from agronomy and horticultural practices have been very limited in the district. The fragmented land holdings, poor soil fertility and long cropping interval have been unable to support the population. Despite many constraints, different livestock's species are reared in the district eg. Cattle, buffalo, sheep, goat, swine, horse, donkey, rabbit, yak/nak/Chauries, and poultry are the chief livestock's of Jumla. Livestock's hold important contribution to small and marginal farmer compared to field cropping for economic subsistence in Jumla.

Constraints of livestock farming related ethno veterinary practices
Livestock's diseases

External and internal parasitic infection, pneumonia, foot rot, poisoning, abscess and external injury, lameness, colic in horses, white bacillary diarrhea in poultry, was the diseases reported from the record of SGRP. Similarly, 44,802 cases of different diseases like parasitic gastroenteritis, external parasitic infection, metabolic disorder, gynecological disorder, respiratory diseases, H.S., B.Q., Coccidiosis, Ranikhet and poisoning have been reported in the annual report of DLSO, Jumla,065/066.

Poisonous plants

Bish (*Aconitum spicatum*), Pore, Tinno, Ayar, Chimalo (*Rhododendron barbatum*), Neuro etc. were the poisonous plants found in the surroundings of Patan where livestock's grazed. Thus, poisoning of livestock's has been occurred frequently while grazing in the Patan. Tiwari (2002) has reported poisoning (10.6%) cases due to poisonous plant.

Inadequate veterinary and extension services

DLSO situated at the headquarter of the district and three veterinary service centers, nine veterinary sub service centers provide Veterinary and extension service which had extension services down to village level. SGRP, Jumla has been working in the field of research and providing the OPD services as well. An adequate veterinary and extension service is needed.

Transfer indigenous knowledge on medicinal and aromatic plants

The old men have the knowledge about locally available medicinal and aromatic plants. The old man prefers to use locally available medicinal and aromatic plants instead of the modern drugs. Transfer indigenous knowledge on medicinal and aromatic plants to the new generation is essential

Jumla is rich in medicinal plant i.e. around hundred medicinal plant have been reported as native of Jumla (Booklet of District Banaspati/Vegetation Office, 2012). The natural forests have long been a large repository of medicinal of medicinal and aromatic plants supporting rural people for the livelihoods. These plants (Jadibuti**)** are being exported every year, worth more than NRs 20 millions. There is no scientific means for the collection. Approximately 20 thousands ton of medicinal and aromatic plants are exported from Nepal per annum and more than in 90% of them in crude form.

General veterinary practices

Commercial veterinary drugs are not available easily and are expensive. Healthcare providers may practice with mixed efficacy. Ethno-medicine is known to be safe and widely used in human. Plant species that are known for ethno-veterinary practices in Jumla are enumerated with botanical name, vernacular name in Nepali, family name and parts used for the treatment of various ailments. The data obtained during the field surveys is summarized in Table -. Fifteen/sixteen different species were found to be used for ethno-veterinary practices.

Table - 1: Description of herbal plants used in ethno veterinary practices

S.n.	Parameters	Description
1	Scientific Name	*Stellariachamejasme*
	Local name	**Jogiful / Deuraliful**
	Family	Caryophyllaceae
	Location	Found in Himalayan region of Nepal at 2700-4300 masl
	Medicinal uses	Used against dysentery of livestock's
	Mode of application	Rhizome is minced with the usage of mortar and pestle. The syrup extracted is given to livestock's
2	Scientific name	*Epehedra gerardiana*
	Local name	**Ephedraceae**
	Family	Somlata
	Location	Found in Himalayan region of Nepal at 2300-5200 m asl
	Medicinal uses	Fruits used as emetic agent in poisoning cases
	Mode of application	Fruit is minced with the usage of mortar and pestle. The syrup extracted is given to livestock's
	Principal content	Plants contains epehedrine, pseudoephedrine, tannins, catechins, saponins and essential oil
	Harvesting time	Plant parts are harvested during sep-october.
3	Scientific name	*Lyonia ovalifolia*
	Local name	**Angeri**
	Family	Ericaceae
	Location	Found in different eco-zones of Nepal at 1300-3300 m asl
	Medicinal uses	Used as external parasites such as ticks, lice , mites etc.
	Mode of application	Bark is minced with the usage of mortar and pestle. The syrup extracted is applied topically.
4	Scientific name	*Acoruscalamus*
	Local name	**Bojho**
	Family	Araceae
	Location	found in Himalayan region of Nepal at 1700-2300 m asl
	Medicinal uses	Rhizome is emetic, stomachicand nerve tonic It is used for bronchitis and dysentery of children Used against external parasites
	Mode of application	Rhizome is minced with the usage of mortar and pestle, mixed with boiled water and applied externally
5	Scientific name	*Rhododendron campanulatum*
	Local name	Chimalo
	Family	Ericaceae
	Location	Found in Himalaya region of Nepal at 2800- 4400 m asl
	Medicinal uses	Used as external parasites such as ticks, lice , mites etc
	Mode of application	Flowers and leaves minced with the usage of mortar and pestle. The syrup extracted is applied topically
6	Scientific name	*Drepanostachy mumfalcatum*
	Local name	**Nigalo**
	Family	Graminae
	Location	Found in different eco-zones of Nepal at 1500-3000 m asl
	Medicinal uses	Used against liver flukes
	Mode of application	Leaves minced with the usage of mortar and pestle. The syrup extracted is given to livestock's
7	Scientific name	*Cedrus deodar*
	Local name	**Deodar**
	Family	Pinaceae
	Location	Found in Himalaya region of Nepal at 2000-2500 m asl
	Medicinal uses	Used as external parasites such as ticks, lice, mites etc. Anti fungal and insect repellent properties
	Principal Toxin	The bark of *Cedrusdeodara* contains large amounts oftaxifolin. The wood contains cedeodarin (6-methyltaxifolin), dihydromyricetin (ampelopsin), cedrin (6-methyldihydromyricetin), cedrinoside and deodarin(3',4',5,6-

		tetrahydroxy-8-methyl dihydroflavonol). The main components of the needle essential oil include α-terpineol (30.2%), linalool (24.47%), limonene (17.01%), anethole(14.57%), caryophyllene (3.14%) and eugenol (2.14%). The deodar cedar also contains lignans and the phenolic sesquiterpene himasecolone together with isopimaricacid. Other compounds have been identified as (-)-matairesinol, (-)-nortrachelogenin and a dibenzylbutyrolactollignan (4,4',9-trihydroxy-3,3'-dimethoxy-9,9'-epoxylignan
	Mode of application	Oil extracted from the timber is used against fleas, ticks, mites. The oil extracted is applied topically.
8	Scientific name	*Stephaniagracilenta mires*
	Local name	
	Family	Menispermaceae
	Location	Found in Himalaya regions of Nepal at 2100-2400 m asl
	Medicinal uses	Used as anti diarrheal agent
	Flowering	June-August
	Mode of application	Rhizome is minced with the usage of mortar and pestle. The syrup is fed orally
9	Scientific name	*Sanemone obtusiloba*
	Local name	**Maurimuo**
	Family	Ranunculaceae
	Location	Found in Himalaya regions of Nepal at 2300-4200 m asl
	Medicinal uses	Used against intestinal worms
	Mode of application	Rhizome is minced with the usage of mortar and pestle. The syrup is fed orally
	Active principal	Plant contains betulinic acid and saponins
10	Scientific name	*Berginiaciliata*
	Local name	**Simpadi pat**
	Family	Saxipragaceae
	Location	Found in Himalaya regions of Nepal at 1600-3200 m asl
	Medicinal uses	Used as anti diarrheal agent
	Mode of application	Rhizome is minced with the usage of mortar and pestle. The syrup is fed orally
	Active principal	Plant contains wax, galic acid, tannin, berganin and mucilage
11	Scientific name	*Girardiania diversifolia*
	Local name	**Allo**
	Family	Urticaceae
	Location	Found in Himalaya regions of Nepal at 1700-3000 m asl
	Medicinal uses	Used in retention of placenta
	Mode of application	Rhizome and roots is minced with the usage of mortar and pestle, boiled and mixed with flour. The syrup is fed orally
	Active principal	Plant contains betulinic acid and saponins
12	Scientific name	*Neopicorrziascrophularii folia*
	Local name	**Katuko**
	Family	scrophulariaceae
	Location	Found in Himalaya regions of Nepal at 3500-4800 m asl
	Medicinal uses	Used as anti diarrheal agent
	Mode of application	Rhizome is minced with the usage of mortar and pestle, boiled and mixed. The syrup is fed orally
	Active principal	Rhizomes contains katukin, kutikol, kutkisterol, picrorhizin, picroside, picroliv
	Harvesting time	Rhizome are harvested during october-November
13	Scientific name	*Rosa brunonilindley*
	Local name	**Airi**
	Family	Rosaceae
	Location	Found in Himalaya regions of Nepal at 2000-2400 m asl
	Medicinal uses	Used as anti diarrheal agent
	Mode of application	Vinegar extracted from the fruits acts against intestinal worms
	Active principal	The covering of fruit is rich in vitamin C
	Harvesting time	Fruits harvested during July to September.

CONCLUSION

Ethno veterinary medicines are often not as fast-working and potent as allopathic medicines. They may therefore be less suiTable - to control and treat epidemic and endemic infectious diseases (e.g., haemorrhagic septicaemia, anthrax, black quarters), and acute life-threatening bacterial infections (e.g., E. coli or mastitis). For these problems, allopathy drugs might be the best choice. But for common diseases and more common conditions such as colds, skin diseases, worms, wounds, reproductive disorders, nutritional deficiencies, and mild diarrhea, ethno-veterinary medicine has much to offer and can be a cheap and readily available alternative to costly imported drugs. For some diseases, a combination of modern and local remedies and management practices might be preferable. Ethno-veterinary technologies can be the starting point for drug and technology development. Ideally, information obtained from local people should be used within the communities of its origin to ensure that they benefit from their own knowledge. Or a selected remedy can be improved outside of the community through pharmacological and clinical research and then be returned, 'value-added', to its place of origin. Promoting the conservation and use of ethno-veterinary medicine does not mean down grading or ignoring the value of modern medicine and attempting to replace one with the other. However, it does mean recognizing that both types have their strengths and limitations. In some instances, they complement each other, in others, local practices will be the better choice, and again in others modern practices should be recommended.

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TRICHINELLOSIS: PREVALENCE STUDY BY PEPSIN DIGESTION AND I-ELISA

Swoyam Prakash Shrestha[1], Ganndhi Raj Upadhyay[2] and Mira Prajapati[1]
[1]Animal Health Research Division, Khumaltar, Lalitpur
[2]District Quarantine Check Post, Rupandehi
Email: swoyamsps@yahoo.com

ABSTRACT

Trichinellosis is a re- emerging worldwide parasitic zoonotic disease caused by Trichinella spp. For the prevalence survey of Trichinella, 375 meat samples (tongue and diaphragm) from 8 districts of western and central region of the country were tested by Pepsin Digestion Technique and 260 sera samples from the same district were subjected for I- ELISA test. All the pork samples tested by PDT were found to be negative while 9 (3.46%) sera samples were found to be positive by I-ELISA test. A total of 14(5.38%) sera were termed as doubtful as it did not posses sufficient antibody level. The possible maximum prevalence by PDT would be 0.79% at 95%confidence interval. The details of serological test and its results have been discussed according to districts, sex and breed. The doubtful cases are tabulated and discussed accordingly as per the antibodies possessed in the sera. From this study, it can be concluded that Nepal is not free from Trichinella spp in the swine population as 3.46% of the sera possessed detecTable - circulating antibodies. More pork samples need to be tested by PDT which is a gold standard technique.

Keywords: Gold standard, pepsin digestion, ELISA, sera

INTRODUCTION

Nepal is an agrarian country where 65.6% of the people depend on agricultural activities. About 53% of total pig population is concentrated in the eastern region of Nepal (CBS, 2010). Pork contributes about 7% of the total country's meat production. There was 52% annual growth rate in the pig production, which was the highest among the South Asian countries, in between 1992-2002 (FAO, 2003).

Trichinellosis is a re-emerging worldwide parasitic zoonosis caused by intracellular nematode *Trichinella* spp which are intracellular parasites of vertebrates with an entire life cycle confined to the host. It remains a serious public threat in both developed and developing countries (Murrel and Pozio, 2000 and Liu and Boireau, 2002) including many countries of North, Central and South America, Europe and Asia, Egypt (Africa), and in New Zealand (Australian region) (Pozio, 2001).

Trichinella spiralis can infect humans and more than 150 species of mammals all over the world. Sylvatic (wild type) isolates of the genus *Trichinella* are widespread in the environment due to an expansive host range and worldwide geographic distribution. There are eight species and three morphologically indistinguishable additional genotypes in the genus (Murrell and Pozio, 2000). *Trichinella spiralis* (genotype- T1) is the best known species, with high infectivity to swine and rats, with cosmopolitan distribution because of passive introduction with domestic pigs and synanthropic rats. Most infections in humans, domestic

pigs, and synanthropic rats are related to this pathogen. In Thailand, *T. spiralis* infection occurs frequently in domestic animals (pigs and dogs) and humans (more than 6,000) infections since 1962, with 1.6% mortality.

These are intracellular parasites specific for mammalian skeletal muscle. The infection occurs through the consumption of raw or undercooked meat from a wide variety of wild and domestic pigs (Dupouy- Camet *et al*., 2002). The symptoms are characterized by uncomplicated febrile course; cardiac involvement and acute abdominal pain. The clinical signs include fever (100%), myalgia (100%), periorbital oedema and conjunctivitis (85%), nausea, vomiting and diarrhea (65%) and maculo-paular rash (20%) (Piergili-Fioretti *et al*., 2005)

MATERIALS AND METHODS

Study Period was from June, 2010 to May, 2012

Meat samples

Diaphragmatic pillar, base of tongue (muscle sample) of pigs were collected from slaughter slabs irrespective of age, sex and breed from Kathmandu valley, Rupandehi, Chitwan, Kaski, Baglung and Syangja. A total of 375 meat samples were collected and stored in Deep Freezer at -20^{0}C. From each pig, at least 50 grams of meat sample was taken. Magnetic stirrer method with sedimentation (protocol for **Pepsin Digestion Technique (PDT)** according to the EU-regulation (EG) number 2075/2005) is the most common method world-wide which was used in our context.

Sera sample

A total of 260 sera of pigs were collected from the above mentioned 8 districts from ear vein and slaughtered pigs for indirect ELISA test (ID Vet, France).

Fig 1: Plate layout for I-ELISA test

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
A	Nc1	FS5	FS13	FS21	FS29	FS37	FS45	FS53	FS61	FS69	FS77	FS85
B	Nc1	FS6	FS14	FS22	FS30	FS38	FS46	FS54	FS62	FS70	FS78	FS86
C	Pc1	FS7	FS15	FS23	FS31	FS39	FS47	FS55	FS63	FS71	FS79	FS87
D	Pc1	FS8	FS16	FS24	FS32	FS40	FS48	FS56	FS64	FS72	FS80	FS88
E	FS1	FS9	FS17	FS25	FS33	FS41	FS49	FS57	FS65	FS73	FS81	FS89
F	FS2	FS10	FS18	FS26	FS34	FS42	FS50	FS58	FS66	FS74	FS82	FS90
G	FS3	FS11	FS19	FS27	FS35	FS43	FS51	FS59	FS67	FS75	FS83	FS91
H	FS4	FS12	FS20	FS28	FS36	FS44	FS52	FS60	FS68	FS76	FS84	FS92

Nc1 = negative control serum
Pc1 = positive control serum
FS = Field sample

RESULTS AND DISCUSSION

There are numerous serological tests for Trichinellosis. However, in this study only I-ELISA (ID Vet, France) was used to detect circulating antibodies and the gold standard test namely Pepsin Digestion Technique was considered.

Pepsin digestion technique

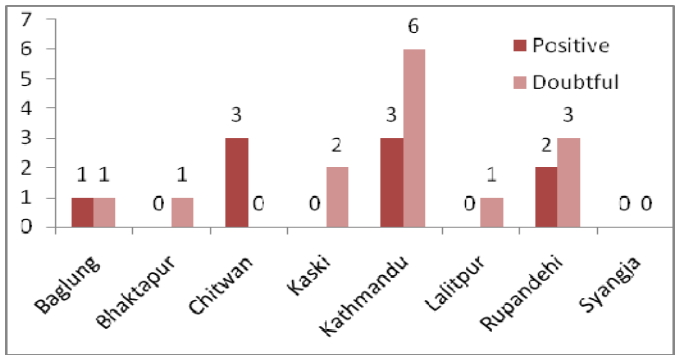
Out of 375 meat samples (Diaphragm, tongue and massetor muscle parts) from 8 districts of central and western region, *Trichinella* larvae could not be detected by the Pepsin Digestion Technique. As for the digestion results, all samples were negative. Hence, possible maximum prevalence of *Trichinella* was calculated by
Win Episcope formula for Pepsin Digestion: D=[1-(1-CL)^1/n] x [N-(n-1)/2]
Where,

- D=the maximum number of Trichinella positive animals.
- CL=confidence limit as a fraction
- n=samples size that showed negative
- N=Total number of pigs in Central and Western Development Region(8 district) of Nepal.
- D = [1-(1-0.95)^1/375] x [51000-(375-1)/2]
- = 405 Pigs (Prediction)

The Pepsin Digestion Test has a detection limit of 1 to 3 larvae/gm according to the EEC directive. A minimum of 1 g of muscle tissue is sufficient to detect *Trichinella* where the aim is to prevent clinical Trichinellosis (Gamble *et al.*, 2000). In practice, this is true for high larval densities but in case of low infection rates the larvae are not distributed homogenously.

Indirect- Enzyme Linked Immuno Sorbent Assay (I-ELISA)

1. District wise seroprevalence

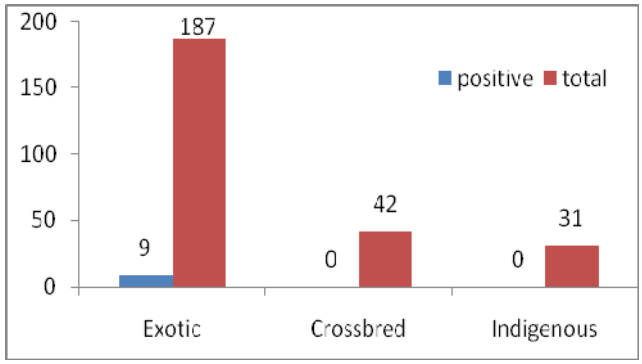


Out of total 260 sera included in the study, 9 (3.46%) were found having *Trichinella* anti-bodies and 14(5.38%) sera sample were doubtful by Indirect ELISA (Table -1). Sero-prevalence in eight districts varied between 0 to 9.37%. Chitwan district had the highest seroprevalence (9.37%) followed by Kathmandu (5.3%), Rupandehi (4.32%), Baglung (2.86%) and rest 4 districts did not show any positivity for I-ELISA test. Similarly in doubtful cases of seroprevalence, it was Kathmandu district topping with 10.7% followed by Rupandehi (6.52%), Bhaktapur (6.25%), Lalitpur (5.88%), Kaski (5.5%). Baglung (2.80%) and the remaining two districts had zero doubtful sera samples. Syangja was the only district in the study which was completely negative for circulating *Trichinella antibodies*.

Table - 1: District wise total antibody positive and doubtful sera cases as well as meat sample

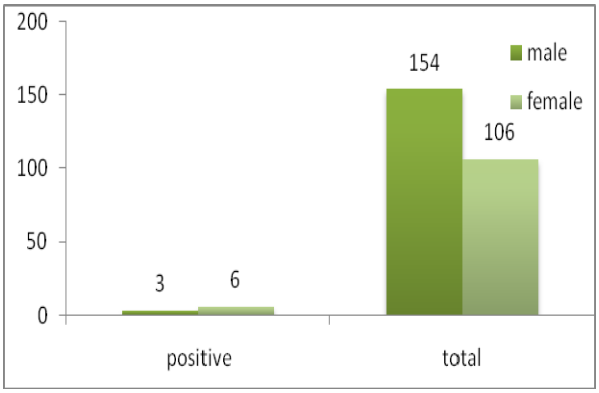
S/n	Districts	Serum collected	I-ELISA		Collected meat Sample
			Positive	Doubtful	
1	Baglung	35	1	1	42
2	Bhaktapur	16	0	1	18
3	Chitwan	32	3	0	67
4	Kaski	36	0	2	47
5	Kathmandu	56	3	6	75
6	Lalitpur	17	0	1	23
7	Rupandehi	46	2	3	72
8	Syangja	22	0	0	31
Total		260	9	14	375

2. Breed wise prevalence



The overall breed wise seroprevalence of *Trichinella* infection in exotic, crossbred and indigenous pigs were recorded as 4.81% (9/187) and nil in both cross breed and indigenous, respectively. Among the positive percentage Chitwan district 11.53% topped the list while Kathmandu district seconded the rate with 8.80% four districts viz Kaski, Syangja, Lalitpur and Bhaktapur were negative for any antibodies presence in the sera by I-ELISA test. All the crossbred (42 samples) and Indigenous (31 samples) did not show any positive reaction to I-ELISA.

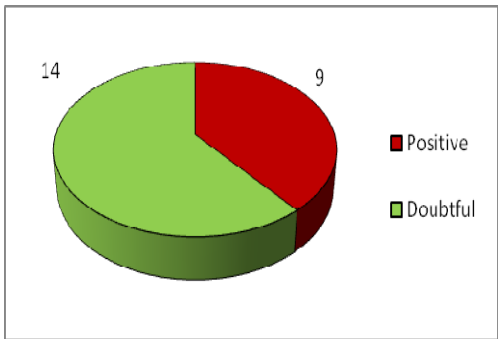
3. Sex wise prevalence



Sex of the animals did not appear to have any direct bearing on their susceptibility or resistance to *Trichinella* infection since there was no significant difference in the number of male and female animals having antibodies against the disease.

However anti-*Trichinella* antibodies were detected in higher proportion of sow's population. This might be due to the breakdown of pre-immune status following stress of pregnancy, parturition and lactation.

4. Doubtful sera by I-ELISA



There were 14/260 sera samples doubtful to place them either to positive or to negative side. For, the safety of the human health, if we place them in the positive category, then the total positive sample would be 8.84% (23/260).

DISCUSSION

Over all seroprevalence of our study was 3.46 % (9/260) which is less than the findings of Karna (2007) in which he had shown 12.18% positive. Joshi *et al*., (2005) had shown 0.47% positive (2/425), Sapkota *et al*., (2006) had shown 1% positive. The ELISA kit used was developed by ID vet, France which had more than 95% of sensitivity, specificity and repeatability. However, using synthetic beta-tyelose antigen in ELISA Gamble *et al*., (1983) unexpectedly obtained high positive cases. According to Gamble *et al*., (1983), the use of E/S antigens increases the sensitivity and specificity of the diagnosis of *T. spiralis* in pigs, thus increasing the detection of natural infections, even those with very low parasitic densities.

Though all the meat samples were negative by Pepsin digestion technique, it may be due to the less number of samples collected for testing. It may be also that the infectivity in the pig population is very low. Calculation of positive probable cases by Win Episcope formula in our study area with the swine population being 51000; it was 405 pigs which are likely to get infected by *Trichinella*. At least a minimum of 3000 samples must be taken for PDT to ascertain the prevalence of the diseases in the area. Our samples size and those of other researchers in Nepal have not conducted tests in required number. In future, samples representing from all the geographical regions of the country must be taken and subjected for PDT tests. As I-ELISA is highly sensitive and specific, there are chances for false positive and cross reaction with other migratory larvae (Toxocara); taking into consideration of the entire test conducted in our context by all the researchers, Trichinellosis is not alarming in our context. However, routine PDT should be conducted to find the larvae, which is a gold standard to safeguard the interest of public health.

It has been reported that the time of seroconversion is correlated to infection dose and there are no known cross-reactions using E/S antigens in ELISA (Nöckler *et al*., 2000). Therefore, it can be assumed that doubtful result obtained in this study could be due to old age infection or low infection dose of *Trichinella* in the pig. However, Sapkota (2006) showed all the positive samples were from pigs under the age of nine month, which highly contradict with our findings. According to our findings seroprevalence was higher in older animals (>3 years of age), eight pigs out of twenty five (32%) were ELISA test positive which is also validated as of Joshi *et al.* (2004). He had shown 25.58% seropositive.

It is worth noting that ELISA fails to detect infected pigs during both early and very late stages of infection (OIE, 2004). Epidemiological calculation was done to estimate the maximum probable prevalence of *Trichinella* in Central and Western Development Region of which was 0.79%. The similar prevalence rates of 0.47 % and 1 % were estimated, by Joshi *et al*., (2005) and Sapkota *et al*., (2006), respectively. The prevalence of Trichinellosis is recorded in Nepal on the basis of Serological tests like ELISA and Western Blot method. However, no Larvae are found till date by PDT.

CONCLUSION

A total of 260 serum samples collected from swine were subjected for I-ELISA (ID vet) test. The prevalence of trichinellosis infested pig in Central and Western development regions (8 districts) was 3.46% (9/260) and 5.38 % (14/260). However, 375 meat samples, tested by Pepsin digestion technique were found to be all negative.

The serological evidence of Trichinellosis in pigs suggested that *Trichinella* exist in Nepal. The negative result in pepsin digestion concludes that pigs tested were not infected or had a very low infection with *Trichinella* at the slaughter level.

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STUDY ON INFESTATION AND CONTROL MEASURE OF CATTLE TICKS IN WESTERN HILLS OF NEPAL

Keshab Prasad Dhungana[1], Swoyam Prakash Shreshtaha[2], Purna Bhadra Chapagain[1], Niraj Baskota[1] Manoj Kumar Sah[1], Budhi Ram Acarya[1], Keshab Prasad Shreshtha[1] Ramesh Prasad Sah[1] and Yamuna Kumar Shreshtha[1]

[1]Regional Agricultural Research Station, Lumle, Kaski

[2]Animal Health Research Division, Khumaltar, Lalitpur

Email: dhunganakeshab1@gmail.com

ABSTRACT

An attempt was made to study the tick's infestation and efficacy of commercial ingredients and herbal extracts to control ticks in cattle. A semi-structural questionnaire was prepared and household survey conducted to 95 cattle raising farmers of Dhamilikuwa and Village Development Committee of Lamjung, Bandipur VDC of Tanahun, Walling Municipality of Syangja and Ghana of Myagdi districts. Moreover, efficacy of Cypermethrin, Ivermectin, solution of Sisno (Urtica dioica) and Titepaty (Artemisia vulgaris) was evaluated through in-vivo as well as in-vitro test to control cattle ticks on station and on-farm. Majority of cattle raising farmers (87.4%) reported the infestation of cattle ticks. They reported that exotic breeds were highly infested by ticks(65.3%). 41.1% cattle of three years and above were found more infested where as only 34.7% and 20% cattle of six month to three year and age below six month were found infested respectively. The peak time of tick's infestation was found between July to September followed by April to July and October to January. Spraying of 0.1% Cipermethrin (Tick out) was found to be more effective followed by Ivermectin injection, rubbing of 20% solution of Titepaty, and rubbing of 20% solution of Sisno in both in-vivo and in-vitro test for the quick down effect.

Keywords: Cattle ticks, epidemiology, efficacy, in- vitro, in-vivo, Nepal

INTRODUCTION

Among the various constraints of livestock production parasitic disease is a global problem and considered as a major obstacle in the health and productive performance of cattle .These may be caused due to endo-parasites that the live inside the body or ecto-parasites such as ticks, mites, fleas, flies etc. which attack the body surface. Among the ecto-parasites, ticks are arthropods belonging to class Arachnida, very harmful blood sucking parasites of mammals, birds and reptiles (Rajput *et.al*., 2006).There are more than 850 species of ticks existing in the world(Fantahun and Mohamad, 2012). These are considered to be responsible for major economic loss due to their ability to transmit disease to humans and animals. Loss due to ticks adversely affect on loss of blood, reduction in milk yield, live weight and anemia, while their bites also reduce the quality of hides. In Nepal, a large proportion of livestock species have been infested with ticks and causing tick borne diseases since time immoral.

The medicinal and economic importance of ticks had been recognized due to their ability to transmit disease to human beings and animals. Tick surpasses all arthropods in number and

variety of pathogen that they transmit to disease to animals and rank second only to mosquito. Economic loss due to ticks is not transmitting disease only, which associated with nagging irritation and depreciation of value of skins, adverse effect on milk and beef production, anemia and loss in live weight with failure to replace lost protein. Besides, it tick bite paralysis by an acute ascending flaccid motor paralysis caused by the injection of a toxin by certain ticks while feeding..A recent estimate indicates that globally livestock ticks alone are responsible for 14-17 billion decrease economic loss annually. Information relating to the east African region indicates that cost of acaricide application can account between USD6-36 per adult animal in Kenya, Tanzania and Uganda (http//www.ilri.org).Early studies on production loss caused by cattle ticks seemed to be indicate that an average of one mature tick per day caused a growth rate depression equivalent to at least 450 grams per year (Turner and Short, 1972).In Australia alone in 1974, loss due to cattle ticks (*B.Microplus*) were estimated to be USD 62 million (Rajput *et.al.*,2006,Springell,1983).In Brazil, economic loss due to ticks was reported as USD 2 billion per year (Grisi.*et.al.*,2002).

In Nepal, economic loss due to ticks and ticks borne disease in cattle was reported by 18.71% of total of cost (Shrestha and Acharya, 2002). So, the authors wish to study on infestation and control strategy against tick to minimize the economic loss due to ticks and tick-borne disease then by increase in productivity of animals.

MATERIAL AND METHODS

Tick and sample collection

Ticks from infested animals were collected from different areas of cattle. Ticks were picked from ears, neck, shoulders, dewlap, forelegs, ventral abdomen, inguinal region, perennial region, hind legs and tail. Ticks sample were also collected from Syangja and Arghakhanchi. Collected ticks were preserved in 70% alcohol with 5% glycerine. About two ml of blood was collected from each animal in vacutainer tubes with EDTA and thin and thick blood smears were made.

Information collection on ticks infestation and tick borne disease

Lamjung at least one site in Myagdi and two sites in Lamjung and Tanahun were selected for study with collaboration with DLSO's. A questionnaire format was developed with information on extent of infestation by ticks; any other diseases caused by tick, economic losses and decrease in milk production. Collected information was analyzed through SPSS statistical package.

Farmers and site selection

A total of 12 cattle raising farmers comprising of 6 in Dhamilikuwa and 6 in Chandreswar along with a total of 24 tick infested cattle were selected for experimentation. Among these cattle were divided into four group comprising of 3cattle in each group in each site. Another site was kept in the station at RARS, Lumle.

Farmers training on research methodologies

One and half day training was organized for the selected cattle raising farmers (no.15) in Dhamilikuwa, Lamjung. This training was focused research methodologies and ticks control measures.

Experimentation on tick control measure

A total of three sites were chosen purposively for *In –Vivo* experimentation of different Acaricide and herbal medicine. At Lumle altogether 4 treatments was set. All the experimental animals were marked by colour label in one square feet at the neck prior to starting the efficacy trial then by ticks inside marked areas were counted as well.

Treatment1 -S/C injection with Ivermectin injection (Kepromec, KEPRO, B.V. Maagdenburgstraat, Deventer, Holland) @ dose rate of 50mg/body weight

Treatment 2- Strategic spraying with 0.1% cypermetrin solution

Treatment 3- Brushing whole body with 20% Sisno (*Urtica dioica*) solution.

Treatment 4- Brushing the whole body with 20% Titepaty *(Artemisia vulgaris*) solution

Data was gathered in Microsoft Excel and analyzed in Zen stat statistical package

Preparation of solution of herbal plants and In-vitro experimentation

Fresh shoot of Titepaty and Sisno was picked from the station and air dried in room till 3-4 days whenever the shoot was dried. The shoot was grinded then by powder was prepared. Water was mixed in the powder at the ratio of 4:1 water and powder of Titepaty and Sisno. The solution was kept in lab at room temperature at 24 hour and filtered at muslin cloth and alkaloid solution was prepared so far. After preparation of water soluble, Petridis were covered with filter paper and desired solution of Ivermectin injection, tick out, Sisno and Titepaty was kept in the respective Petridis till the paper was not completely wet. Cattle ticks were picked from cattle and subjected to lab then by a total of 10 adult ticks were kept in respective Petridis. Again, filter paper was wet with wear and required hole was made and covered in the respective petridish. The solution was added whenever necessary for wetness in the paper. After one hour onwards, motility of ticks was observed and died ticks were discarded by using Simple microscope. The observation was taken at one hour interval until 8 hours then by data was recorded so far.

RESULTS AND DISCUSSION

Identification of ticks and causal organism

Collected ticks from the aforementioned sites were identified with their morphological characteristics under stereomicroscope as per guideline described by Shrestha and Acharya (2004/05), Acarology Division, IMR (1995), Morel (1989). Accordingly all the ticks species were belong to *Boophilus microplus.* No others ticks species were found in the collected samples. Furthermore, no any blood protozoan disease was found in sampled population.

Epidemiological information

Table -1: Number animals in households

	N	No of animals	Mean
Cattle	89	1- 22	2.62±2.53
Buffaloes	44	1- 5	1.95±1.18
Goat	53	1- 40	5.90±5.60
Other	4	1- 4	2.00±1.41
Valid N (list wise)	2	-	-

Table - 2: Major reported diseases in farmer's field

S/n	Ticks	Liver fluke	Lice	Mange	Pneumonia	Roundworm	Mastitis	Diarrhea
Yes	87.4	68.4	11.6	2.1	4.2	7.4	21.1	8.4
No	12.6	31.6	5.3	2.1	2.1	2.1	-	-
Missing	0	0	83.2	95.8	93.7	90.5	78.9	91.6
Total	100	100	100	100	100	100	100	100

Majority of respondents (87%) reported the infestation of ticks in their cattle, while only 12.6% of them reported no infestation. Similarly infestation of ticks was found highest proportion followed by Liver fluke (68.4%), mastitis (21.1%) in the sampled population.

Season wise occurrence of ticks

Srawan to Ashoj months are found to be peak season for tick infestation (47.4%) followed by Baisakh Asad and Kartik Poush The reason behind it is due to wet season. The start and end of rainy season influence the different phases of life cycle of ticks. It is agreed with the finding made by Norval (1981), Rechav (1981) and Floyd *et.al*. (1987), Radunz (2008) and Ficher and Ralphsay (1989).

Ecozones wise occurrence of tick infestation

To view over the infestation of ticks in different agro ecological zone, majority of respondents (51.6%) reported highest infestation of ticks in mid hill followed by plain and while only few of them reported in high hill. The findings suggest that high hill is less susceptible rather than low hill and mid hill.

Clinical symptoms of ticks' infestation as reported by farmer

Decrease in milk yield is the main clinical sign reported by the farmers, followed by fever, and blood in urine. It is in agreement with .

Age wise infestation of ticks

The effect of age is related to burden of ticks infestations. Infestation of ticks has been found in all age group of cattle. Among these, three years and above are the most susceptible (41.1) than age group between six month to three years and six month below. Lower infestation of tick in young cattle may be due to exposed to lower parasite burdens on the pasture. It is

agreed with the statement made by Faseha (1983), Morel (1989) and Fantahun and Mohamed (2012) that adult cattle presented the higher burdens of ticks rather than young calves and disagree with Tamru (2008) that there is no significance difference within any age group

Breed wise infestation of ticks

Resistance to ticks infestation varies among individuals and breed of cattle. Indigenous cattle breed are found most resistant rather than crossbred and exotic breed. Majority of respondents (75%) replied that exotic breed is highly susceptible for the infestation of cattle ticks followed by crossbred and indigenous. It is in accordance with finding made by Muhhamad *et.al,* (2008), Wharton, (1983), Rajput *et.al*. (2006) and Norval *et.al,* 1991). Furthermore, Norval.*et.al,* (1991) reported that, in many sub-tropical and semi-arid environment in Africa, indigenous breeds were found highly resistance to ticks resulting low infestation rates. Similarly, Rajput *et al*., (2006) cited the high level of ticks' resistance in Zebu cattle and low level of resistance in European cattle. This statement is agreed with Springell (1983), Juvenal and Edward (2010) and Tittapalapong, *et.al*. (2004), Rajput *et.al*. (2006) and Peter *et.al.*(2005) that ticks cause significant economic loss in cows through reduction in milk yield.

Experimentation of different chemical and biological control measure

Cypermethrin (tick out)was found more effective followed by Ivermectin, Titepaty and Sisno interrms of quick down control of ticks, however not significance difference was observed among the treatments .Efficacy of these acaricide and herbal plants were found 100% effective against ticks however dropping of ticks varies from 4-7 days onwards of topical application. It is consistent with the finding made by Petro *et.al. (*2012)

Result of invitro test

To view over the efficacy of above acaricide and herbal plants, Cipermethrin was found most effective among the treatment groups followed by Ivermectin, Titepaty and Sisno. Among the treatments there was no significant difference. To view over the efficacy of acaricides and herbal plants, Cipermethrin and ivermectin were found, 100%effective while Titepaty and Sisno were found 90% and 85% effective against ticks in invitro test.. It was in accordance with the finding made by Shrestha (2053/054) .To sum of the following evaluation, strategic spraying of tick out at fortnightly interval will control the infestation of cattle ticks where as topical application of Sisno and Titepaty at alternate days till thrice at fortnightly interval is safety measure to control the cattle ticks, no any hazard in human health then by contribute to environment protection.

CONCLUSION

The result revealed that ticks infestation in cattle was found to be the major problems among the reported disease. *Boophilus microplus* was the most commonly found tick species abundantly in the western hills. Indigenous cattle breed were found most resistant rather than crossbred and exotic breed. Srawan to Aswin months were found to be peak season

for tick infestation followed by Baisakh Asad and Kartik and Pouch. The effect of age is related to burden of ticks infestations. Infestation of ticks has been found in all age group of cattle. More than three years age groups were the most susceptible than six month to three years and less than six month age group.

Efficacy of Cipermethrin (tick out) was found more effective followed by Ivermectin, Titepaty and Sisno. Efficacy of these were found 100% in topical application in the body while Cipermethrin and Ivermectin were found , 100%effective and Titepaty and Sisno were found 90% and 85% effective against ticks in invitro test.

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ABSTRACT

ANALYZING GAPS OF LIVESTOCK AND FISHERIES RESEARCH INSTITUTIONAL STRUCTURE FOR IMPROVING SERVICE DELIVERY TO TARGETED STAKEHOLDERS

Tek Bahadur Gurung[1], Doj Raj Khanal[2], Chet Raj Upreti[3], Suresh Kumar Wagle[4], Damodar Neopane[5], Agni Prasad Nepal[1]

[1]Nepal Agricultural Research Council, Singha Durbar, Plaza, Kathmandu

[2]Animal Health Research Division, Khumaltar, Lalitpur

[3]National Cattle Research Program, Khumaltar, Lalitpur

[4]Fisheries Research Division, Godawari, Lalitpur

[5]Swine and Avian Research Program, Khumaltar, Lalitpur

E-mail: tek_fisheries@hotmail.com

Gap analysis is known to identify gaps between the optimized allocation and integration of the inputs (resources), and the current allocation level. Thus, with objective to analyze the existing gaps for improvement, we performed a simple gap analysis to foster the research outputs of livestock and fisheries research efficiently to targeted stakeholders. The analysis revealed that there exist several gaps to transfer livestock and fisheries technological information to stakeholders as institutional arrangement of representative from livestock and fisheries in several cross cutting research areas. The livestock and fisheries research sector under the Nepal Agricultural Research Council needs several improvement for delivering quality outputs to stakeholders such as farmers, concern agencies, technicians, scientists, agricultural journalists, entrepreneurs, dairy and meat industry, fish traders and merchants, students etc. Some of the common gaps were the absence of explicit breed and line development, certification and recognition mechanisms in livestock and fisheries research. To improve the current situation and provide the quality outputs more robust linkages among institutions under NARS needs to develop to avoid duplication of studies, efficient use of resources, saving quality time of researchers and streamline the outputs in livestock and fisheries research.

Keywords: Livestock, fisheries, gap analysis, institutions, Nepal Agricultural Research Council

OBSERVATION ON THE SHIPPING METHOD OF EYED EGG OF RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) ON HATCHABILITY AND SURVIVAL OF FRY

Gopal Prasad Lamsal, Prem Timilsina, Kamala Gharti, Hari Ram Devkota, Murali Prasad Thapaliya and Mahesh Kumar Karn
Agriculture Research Station (Fishery), Trishuli, Nuwakot
E-mail: lamsal_gopal@yahoo.com

Scaling up and commercialization of trout farming has been constrained by the availability of fish seeds in mountainous remote areas, despite of huge potential exist for its development in the country. In particular fry transportation from hatchery to far distant grow out areas has been a crucial effort for years to many farmers. Therefore, shipping method of eyed egg of trout was practiced in an experimental basis and its outcome in terms of hatchability, fry survival and feeding efficiency was monitored. Eyed egg was loaded in Styrofoam box in 4 layers separated by Styrofoam plates and each layer was covered by ice in order to maintain 4-5^{o}C temperature inside the box. Eyed eggs shipped in Styrofoam was observed for 48 hours for their viability and found that the eggs are in good condition. After delivery the eggs were incubated further until hatch. The hatching rate of shipped eyed egg was between 90-95% and the fry survival rate was approximately 50%. Statistically no significant difference ($P<0.05$) was observed in hatchability and survival rates in between eyed eggs shipped in Styrofoam box for 48 h and the fresh eggs incubated in hatchery. These results suggest that the shipping of the eyed egg could be considered as alternative methods of seed supply, particularly in far remote trout grow out areas.

Keywords: Rainbow trout, shipping, eyed egg, hatchability, survival

PERFORMANCE OF PARTICIPATORY TILAPIA (*OREOCHROMIS NILOTICUS*) FISH FARMING AT OUTREACH SITE OF RARS, TARAHARA

Arjun Bahadur Thapa[1], Umita Sah[1], Shiva Narayan Mehta[1] and Suresh Kumar Wagle[2]
[1]Regional Agriculture Research Station, Tarahara, Sunsari
[2]Fisheries Research Division, Khumaltar, Lalitpur
E-mail: rarst@sailung.com.np

Tilapia (*Oreochromis niloticus*) is often promoted as alternative to carps aquaculture due to its wide range of aquatic environment, biological characteristics to adopt climate change and high productivity relative to carps. Aquaculture technologies for harvesting seasonal waters are essential to increase livelihood resilience in flood prone areas. Therefore, participatory trial was conducted on productivity of tilapia in seasonal ponds in Sunsari district. Eight small ponds (83-167 m^2) owned by small farmers in Aurabeni and Simariya VDC were stocked with mixed sex tilapia at a density of 15000 fish/ha. Experimental fish were fed with locally prepared ration comprised of rice bran, wheat flour and mustard oil cake. Fish were grown for a period of nine month starting from Srawan when fish rearing facilities are filled with rain water to harvesting on Falgun when water level in ponds became critically low for the survival of fish. Fish yield from seasonal ponds was 3.5±0.7 t/ha. Newly recruited fish contributed to the total yield by 27% in pond. Despite of small size of recruited fish (70-90 g), most of the small fish were consumed by the participating family. Although not significant, large variation in survival of fish at harvest was estimated among ponds.

Keywords: Tilapia, seasonal water, participatory, climate change

PRESENT STATUS OF THE FISH FARMING DEVELOPMENT PROJECT IN NEPAL

Agni Prasad Nepal[1], Tek Bahadur Gurung[1], Doj Raj Khanal[2] and Suresh Kumar Wagle[3]
[1]Nepal Agricultural Research Council, Sinha Durbar Plaza, Kathmandu
[2]Animal Health Research Division, Khumaltar, Lalitpur
[3]Fisheries Research Division, Godawari, Lalitpur
Email: agninepal@gmail.com

The project on Fish Farming Development in Nepal (FFDN) is a Norwegian supported project to improve food security and livelihoods. One of the main objectives of the project is to establish a nexus of "*river-energy-fish-food*" in Nepal. The project has started from 2012 and focusing on promotion of pond aquaculture in 10 districts namely Ilam, Sunsari, Ramechhap, Nuwakot, Bara, Gorkha, Tanahun, Kaski, Baglung and Syangja. Before starting the project as it is common, a baseline study was carried out from October to December 2012 in above 10 districts to collect the present status of aquaculture and related information. This study provides general information on existing fish farmers, farming activities, production level and some other socio-economic parameters of the project area. The survey revealed that Bara, a terai district has the highest 480.0 ha of pond area and 1940.0 ton of fish production in 2012 (2068/69). Similarly, from mid-hill districts Kaski is the highest with 50.6 ton fish production per year from 23.5 ha. Ramechhap is the district having least number of ponds (11), water surface area (0.35 ha) and the production (1.0 ton) with 2.9 ton/ha/year of productivity. The average pond productivity in project area calculated is 3.6 ton/ha/yr for terai and 2.1 ton/ha for mid-hill districts. It is expected that the project would initiate a linkage of "river-energy-fish-food" nexus successfully in its 4-year project period.

Keywords: Fish farming, food security, pond productivity, "river-energy-fish-food" nexus

EVALUATION OF THERMO STABILITY OF ND I – 2 VACCINE FOR NEW CASTLE DISEASE PREVENTION IN VILLAGE CHICKEN

Madhav Prasad Acharya[1], Upendra Man Singh[2], Sushil Kumar Adhikari[3], Mira Prajapati[1], Sudarshan Prasad Gautam[4] and Sulochana Shrestha[4]

[1]Animal Health Research Division, Khumaltar, Lalitpur

[2]National Animal Science Research Institute, Khumaltar, Lalitpur

[3]Institute of Agriculture and Animal Science, Rampur, Chitwan

[4]Biological Products Division, Tripureswor, Kathmandu

E-mail: mpacharya555@yahoo.com

A study was conducted from June to August 2012 at Animal Health Research Division, Khumaltar, to evaluate thermo stability of ND I-2 vaccine for New Castle Disease prevention in village chicken. The vaccine was prepared at Biological Production Division, Tripureswor. Titration of vaccine was done in 10 days embryonated eggs, HA test was done as per OIE guidelines and EID_{50} was calculated. ($10^{6.64}$ /0.1 ml) Three treatments of Vaccine were made and kept in different temperature. Treatment A: at 4°c in Refrigeration for 15 days, Treatment B: at Room temperature for 15 days and Treatment C: at 37°c temperature in an incubator for 7 days. 120 local chicks of day old age were reared and randomly divided into 4 groups (30 birds in each) named as Treatment Group A, B, C and Control. After 4 weeks birds were given ND I-2 vaccine by intra ocular route @ 0.1ml/bird except control group. Before vaccination blood were collected for base line antibody monitoring against ND.14 days and 28 days post vaccination again blood were collected for antibody analysis. All chickens of 4 treatment groups were challenged by field virus of ND @ 0.1ml ($EID_{50}10^6$ /0.1 ml) by intraocular route and birds were observed daily and PM was performed. Death records of Treatments A, B, C and control group were found 3.34%, 13.33%, 23.34% and 90%, respectively. Average antibody titre against Newcastle disease in pre-vaccinated blood were 2^0 $2^{2,}$ $2^{0,}$ 2^2, in 14 days post vaccinated blood were $2^{6,}$ $2^{6,}$, $2^{3.4}$, $2^{1.5,}$ and in 28 days post vaccinated blood were $2^{6.2,}$ $2^{5.2,}$, 2^4 , $2^{2.4}$ in treatment A, B,C and control group, respectively. Antibody titre and Mortality % show that ND I-2 vaccine used for treatment A and B were found effective in prevention of New Castle Disease in village chicken. Field trials are needed for verification and field application.

Key words*:* ND I-2 vaccine, Thermostability, Antibody titre, EID_{50}

ENHANCEMENT OF HEALTH AND PRODUCTIVE PERFORMANCE IN LAYERS SUPPLEMENTED WITH STINGING NETTLE

Doj Raj Khanal[1], Madhab Prasad Acharya[1], Meera Prajapati[1] and Subarna Man Pradhan[2]
[1]Animal Health Research Division, Khumaltar
[2]Swine and Avian Research Program, Khumaltar
E-mail: drkhanal7@gmail.com

In continuation with previous studies of feeding stinging nettle formulation in animals, a response trial was conducted at Swine and Avian Research Programme, Khumaltar for deciphering more evidences on its health benefits and enhancement of productive performance in layers. A total of 100 layers and 12 cocks, aged 45 weeks, divided equally into four groups, each comprising 25 females and three cocks were daily supplemented with four levels of stinging nettle powder: 0.5%, 1.0%, 1.5% and 0%, respectively for Groups I, II, III and IV for a period of one month (June 2012). Each bird was allocated 120 gm of commercial ration daily and provided with *ad lib* water. Total egg production in each group was enumerated until one week post nettle supplementation. To assess the yolk appearance and shell thickness, 10 eggs from each group that were laid at the first week of the trial were stored at room temperature and broken at the end of the trial to compare with that of freshly laid eggs. Furthermore, sera were collected from each group (n=5) and tested for the levels of antibody against Newcastle disease vaccine. Laying performances were 5.20%, 12.2% and 11.00% in Groups I, II and III receiving daily 0.5%, 1.0% and 1.5% nettle powder, respectively compared to control. Nettle supplemented groups exhibited more appealing yolk color and egg shell thickness compared to that of non-supplemented group. Sera from all nettle supplemented groups demonstrated higher levels of antibody titre against Newcastle disease when compared to control group. This response trial has provided further evidence for the potential exploitation of stinging nettle in poultry enterprises.

Keywords: Nettle powder, yolk color, supplementary, Newcastle disease

PRESENT STATUS, CONSTRAINTS AND POTENTIALITY OF WOOL AND PASHMINA SECTOR IN NEPAL

Krishna Prasad Rijal
Central Sheep and Goat Promotion Office, Hariharbhawan, Lalitpur
E-mail: kprijal2003@yahoo.com

Sheep and goats are important small ruminants that have significant contribution in the livelihood of smallholder farmers particularly in the hills and mountains of Nepal. Besides, providing meat and serving as a handy source of cash, these animals are equally important as they provide wool and valuable Pashmina. Among four native sheep breeds, Bhyanglung sheep found in trans-Himalayan region produce wool suiTable - to produce hand knotted carpet for export, while wool produced from Baruwal is coarse and is being used for producing local *Radi/ Pakhi* only. Wool from Kage and Lampuchhre sheep is of only little uses. The population of sheep and annual wool production are both declining over the years and only producing 500 thousand kg of raw wool annually from about 0.8 million sheep. All wool required for carpet industries at present is being imported from New Zealand and Tibet. Merino, Ramboullet, Polwarth, Romney Marsh and Boarder Leicester are the introduced fine and carpet wool breeds, but at present, their population is nominal. The crossbred did not adopt well in the migratory system. Recently, frozen semen of carpet wool breed has been imported and an attempt has been made for AI through laparoscopic method. The population of Chyangra goats found in the trans- Himalayan region from which fine Pashmina is produced is also nominal, quantity of Pashmina produced, and utilization in national Pashmina industries is insignificant. Like wool, all Pashmina thread required for the industries are also being imported and only value addition is taking place in the country. The export of carpet and Pashmina garments significantly contributes in the foreign currency earnings of the country, but the sector is facing many inherent and external constraints. This paper analyzes the constraints and potentialities of wool and Pashmina sector in the country.

Keywords: Pashmina, Chyangra, Carpet, Bhyanglung

SOME ETHICAL ISSUES IN LIVESTOCK RESEARCH

Bhola Shankar Shrestha and Saroj Sapkota
Animal Breeding Division, Khumaltar, Lalitpur
E-mail: bsshrestha@yahoo.com

Livestock research in Nepal started lately and adoption of research outputs at farmers' level has not been adequate. This might have been cumulative effects of many reasons in addition to some critical ethical issues from the researchers' side. Recently animal welfare issues have been raised worldwide and authorities have been established to look after these issues before conducting any animal experimentation. So far, no such body exists in Nepal and the issues have been the sole mercy of individual researchers. Besides, knowingly or unknowingly, sometimes researchers are not found to be abided by the critical research ethics. In this paper, some ethical issues, an individual researcher or organization has to consider in any research and do's and do not with animal experimentation have been discussed.

Keywords: Experimentation, livestock, ethics

FEEDING VALUE OF BHIMAL (*GREWINA OPTIVA*) ON GROWTH PERFORMANCE OF CASTRATED MALE GOATS IN MID-WESTERN DEVELOPMENT REGION OF NEPAL

Luma Nidhi Pandey[1], Megh Raj Tiwari[2] and Jagan Nath Banjade[3]
[1]Sheep and Goat Research Program, Guthichaur, Jumla
[2]National Animal Science Research Institute, Khumaltar, Lalitpur
[3]Regional Agricultural Research Station, Khajura, Banke
E-mail: pandey_luma@yahoo.com

Goat is important component of Nepalese farming system. Bhimal has been considered as multipurpose tree and proteins fodder for livestock found in mid western part of Nepal. Its feeding value has not been evaluated so far on growth performance of goats. Therefore, an experiment was carried out at Dhanabang VDC of Salyan district. Sixteen castrated male goats of five months age were allocated into four treatments in completely Randomized Design (CRD). Dry matter (DM) requirement of experimental animals was calculated at the rate of 4 kg DM/100 kg live weight. Experimental animals of T1 received seasonal fodder adlib and 100g concentrate mixture, animals of T2 received Bhimal fodder adlib and 100 g concentrate mixture, T3 was provided 75% Bhimal + 25% seasonal fodder 100 g concentrate mixture and T4 was provided 50% Bhimal and 50% seasonal fodder and 100 g concentrate mixture. Both concentrate mixture and fodder was provided individually in plastic vassal. Concentrate mixture was provided to the experimental animals once a day in the morning whereas adlib amount of fodder were provided twice a day in-group (morning and evening). All experimental animals were drenched against internal parasites with Fenbendazole @ 5mg/kg body weight before assigning the experiment. Experimental animals' were kept in wooden cage individually. Quantity of concentrate mixture, fodder given daily to the animals was weighed daily, and refusal was weighed in next morning. Experimental animal had free access to drinking water. The body weight gain of animals was measured fortnightly in the morning before feeding. Experiment revealed that total weight gain was highest in T2 (9.21 kg) followed by T4 and T3 (8.08 and 8 kg, respectively). The lowest weigh gain was recorded for T1 (7.19 kg) which was significant different among diet groups ($P<0.05$). Highest dry matter intake was noted for T2 (52.75 kg) followed by T4 and T3 (51.7 and 48.56 kg, respectively). The lowest dry matter intake was observed for T1 (32.69 kg). Feed conversion ratio was highest in T4 (6.39:1 kg) followed by T3 and T2 (6.07:1 and 5.72:1 kg, respectively). Concentrate mixture intake was no significant differences among diet groups, whereas intake of Bhimal and seasonal fodder was observed highly significant ($P<0.001$) among diet groups. Average daily gain was found to be highest in T2 (66.6 g) followed by T3 and T4 (31.66 and 30.88 g, respectively) and the lowest in T1 (25.25).

Keywords: Goat, bhimal feeding, growth performance

QUALITY ASSESMENT OF FRESH FISH IN TERAI USING SENSORY AND MICROBIAL ANALYSIS

Nita Pradhan[1] and Achyut Mishra[2]
[1]Fisheries Research Division, Godawari, Lalitpur
[2]Food Research Division, Khumaltar, Lalitpur
E-mail: pradhanita@yahoo.com

Fish is a perishable product, especially in hot tropical areas. Fish handling prior to processing was studied in Sunsari, Bara, Parsa and Dhanusha districts of Nepal. Sensory (Quality Index Method, QIM) and microbial analyses (*Salmonella* spp. and total plate count) were applied to assess the quality of fresh fish from capture to marketing. Samples were collected from net, landing sites, markets near by the capture area and commercial fish markets. The QIM showed poor quality of fish marketed in the commercial fish markets of Terai region. *Salmonella* was not detected in most of the samples collected from net immediately after catch. Total plate count was also below the recommended permissible level. Microbial loads exceeded the recommended permissible level in most of the samples collected from the landing sites and markets.

Keywords: Perishable, quality, Salmonella, fresh fish, microbial analyses

SILENT HEAT IN BUFFALOES

Husnet D. Azad and Netra Prasad Osti
Animal Nutrition Division, Khumaltar, Lalitpur
Email:azardhusneid@yahoo.com

In silent heat animals will not show behavioral signs of estrus although the physiological symptoms of heat will be present. Although the general pattern of sexual behavior is almost similar in cattle and buffaloes but the intensity of expression of behavioral signs of estrus in buffaloes is markedly less pronounced especially during summer months as the buffaloes are relatively inefficient to maintain their thermoregulation under increased environmental temperature and at high relative humidity. Incidence of sub-estrus in buffaloes has a wide variation in the frequency (15 - 73%). In this review paper, the cause of silent heat and way to overcome is discussed.

Keywords: oestrus, silent heat and thermoregulation

RICE AND FISH PRODUCTIVITY FROM RICE-FISH FARMING USING TRENCH AND POND AS REFUSE SYSTEM TO FISH IN MAKWANPUR DISTRICT

Kamlesh Kumar Srivastav
Regional Agricultural Research Station, Parwanipur, Bara
E-mail: ksrivastav58@yahoo.com

The study was conducted at Hatia-6, Makwanpur outreach research site of Regional Agricultural Research Station, Parwanipur, Bara with an objective to increase the productivity of rice and fish from integrated rice-fish farming during 2012. Four treatments were established viz. trench refuse across rice field (60 cm wide and 30 cm deep), pond refuse (4 m long, 3 m wide, and 1 m deep), sequential two rice crop with fish, and two sequential rice-fish crop integrated with pig. Common carp and tilapia fish having 5-10 g size at 1:1 ratio was stocked at density 5000 fish/ha in duly prepared rice field 15 to 20 days after rice transplantation. Stocked fish received a ration comprised of rice bran and mustard oil cake at 5:1 ratio. Farmers practiced single rice-fish farming with trench refuse harvested 256 kg fish/ha in response to 1500 kg feed/ha and growing period of 68 days.

Fish grown longer period (151 day) with 2500 kg/ha fish feed application in trench based rice fish field yielded 623.9 kg fish/ha. Fish yield obtained from pond refuse based rice-fish integration for the two sequential rice crops was 1946 kg/ha while the former practice supplemented with pig manure yielded 2403 kg fish/ha in response of 6000 kg feed/ha for the fish growing period of 210 days. The results indicated that productivity of fish in rice fields depends on duration of fish culture, quantity of feed supplied to the fish. The productivity of fish under pond refuses system increased by the addition of pig manures. Rice production ranged from 3800 to 4189 kg/ha depending on the rice cultivar planted at different rice seasons.

Kewwords: Refuse pond, trench, Rice-fish farming, productivity

RECOMMENDATION OF THE WORKSHOP

Animal Health

Research challenges and issues

Cattle/Buffaloes

- HS vaccine (Pasteurella serotyping)
- Calf scores
- Brucellosis
- Tuberculosis
- Leptospirosis
- Cysticercosis
- Ticks, lice and mites
- Degnella diseases in buffaloes
- Blood protozoan diseases
- Khari diseases (Technology generated and handed over)
- Gastrointestinal nematodes
- Fasioliasis (Drug problem)

Sheep and Goat

- PPR (not covered through vaccination)
- GI nematodes
- Plant toxicity
- Blue tongue
- Kid mortality
- Brucellosis

Pig

- Cysticercosis
- Piglet mortality
- Mycotoxicosis
- Swine fever
- TGE

Poultry

- Avian Influenza (HPAI, LPAI)
- Vaccination efficacy and schedule
- Mycotoxicosis (Aflatoxin and Ochratoxin)
- Mycoplasmosis

Research Need

Technology

- Control of contagious and infectious diseases
- Control of managemental diseases and problems

Natural Resource Management

- Development of herbal drugs/Ethno veterinary field
- Identification of toxic plants of animals
- Mapping of all macro elements in soil and fodder/biological samples
- Molecular characterization of all pathogens
- Mapping of tick fauna

Commercialization

- Development of diagnostic reagent and kits
- Development of herbal drugs
- Development of vaccines

Gender

- Equal Inclusion of gender in all activities (Participation, decision making, Lab, field, organizational institution)

Organizational/institution Reform

- One division (AHRD) includes all field of veterinary science
    - Clinical-medicines, surgery and gynecology
    - Para clinical- Parasitology, Pathology, Microbiology and Public health
    - Basic Vet Science- Biochemistry including molecular biochemistry, Physiology and pharmacology
- Experimental Animal Sheds
- Development BSL-2/3 Lab

Policy Change and Reform

- According to present day need
  Policy of 20 years back to be modified
  For examples
    - Recruitment of veterinarian according to subject matter discipline/lab/units i.e. Pathology, Microbiology, Medicines, Gynecology, Parasitology

Human Resource Development

- In-service training for all scientists/technical officers/technicians
- Livestock and Vet JTAs, Lab technician to be recruited in livestock sector

Infrastructure for Research

- Molecular lab development DNA and gene mapping
- Experimental animal sheds for various commodities
- Up grading of lab and physical facilities
- Facilities for advanced lab equipment eg. HPLC, Atomic absorption spectrophotometers

Animal Breeding, Livestock Products Production and Management

Research Challenge and Issues

- Biometric backup to project design, execution and reporting
- The geographic coverage of NARC stations and the need for collaboration for research with DLS
- Carpet wool/ fine wool sheep breed development
- Development of black colored pig
- Friendliness of approaches to changing climate
- Food Safety in terms of microbiology of meat is a challenge

Research Need

Technology

- Appropriate meat drying technology for buffalo, chicken and rabbit
- Development of Dual purpose poultry breed in Nepalese rural conditions
- Reproductive management to address silent heat in buffaloes
- Meat Safety
- Fast track breeding in sheep through ET
- Enhancement of Chyangra for supporting Pashmina industries

Natural Resource Management

- Indigenous knowledge that makes best use of the available natural resources eg. Feeding, treatment
- Feeding practice to be followed using locally available resources
- Integrated farming (climate smart) to be adopted for mutual benefit for individual commodities
- Promotion of local genetic resources to promote local level production from livestock commodities

Commercialization

- Meat drying package and marketing
- Commercialization of dual purpose poultry breeds

Gender

- Potential of reducing drudgery of women in livestock raising
- Explore income generating activity for women empowerment
- Institutional study on repayment of microfinance in livestock raising
- Institutional study on management of community insurance for livestock based agro enterprises.

Policy Change and Reform

- Change in priority for Commercial chicken; shift from rural poultry
- Re-orientation (structure) in cooperatives for livestock production
- Premium and reward for conserving indigenous resources (in-situ)
- Support to commercial livestock breeding centres (resource centres)

Human Resource Development

- Orientation/Refresher training
- Management Training
- Biometric unit to support project planning and execution

- Higher studies for scientists and technical officers on national needs

Infrastructure for Research

- Central laboratory
- Research farms (different commodities – shed and animals)

<u>Fodder, Pasture and Animal Nutrition</u>

Research Challenges and Issues

- Breeder Forage Seed/Nucleus Seed
- Lab strengthening
- Lack of forage breeders
- Biotech facilities
- Biochemist in nutrition lab
- Lack of updated data/Baseline information

Research Need

Technology

- Forage-based livestock farming
- Seed Production technology
- Seed certification
- Development of Fast-growing, frost-tolerant, disease resistant, shade-tolerant, multicut, drought-tolerant varieties
- Total mix ration/Complete Feed Block
- Conservation of forages (Hay, Silage, Pellet, Block)
- Conservation of native forage species
- Nonconventional feedstuff and agro-industrial byproducts utilization as animal feed
- Indigenous Technical Knowledge (ITK) exploration
- Verification of proven technology

Natural Resource Management

- Rangeland management
- Agro forestry and Silvipasture
- Forage production in community forestry and Buffer zone area
- Waste marginal land management
- Reservoir pond for irrigation

Commercialization

- Public-private partnership for seed production
- Contract farming for seed production
- Green Forage marketing
- Resource center for fodder nursery/fodder bank
- Total mix ration/compressed feed block production
- Hay bailing,
- Bypass protein for commercial dairy
- Farm Machinery (forage harvester, chaff cutter, Grass mower, Tractor, Deep boring, Accessories)

Gender

- Increase women involvement in research and implementation of activities

Organizational Reform

- Activate existing disciplines (LPM Division)
- Biotech lab establishment
- Addition of Outreach research station (Hill and Terai)
- Linkage (Academic-Research-Extension)
- Information distribution center

Policy Change and Reform

- Policy for forage/fodder integration in agro forestry, community forestry, leasehold forestry, buffer zone and protected areas
- Policy for grass production in waste, marginal, barren land, terrace and bund

Human Resource Development

- Capacity development for technical manpower (Biotech, Forage Breeding, Biochemistry, Ruminant nutrition, forage/straw block preparation (TMR), Variety release etc)
- Fulfillment of lacking experts/Creation of additional vacancies
- Exposure visits for knowing/observing the proven technologies
- Exchange Visits of experts

Infrastructure for Research

- Building for Animal Nutrition Division (Laboratories, Office, Residence)
- Building for National Buffalo Research Programme Tarahara (Laboratories, Office, Residence, Gobargas plant)
- Building for Glass house
- Shed renovation, Deep Boring with reserve tank, Irrigation Canal, fencing for farms
- Vehicles
- Equipments for threshing, processing, grading, packaging, forage harvester

Fisheries

Major Challenges and Constraints

- Water resources underutilized/unutilized
- Inadequate fish farming technologies suited to different ecological/climatic region
- Limited fish species diversity in aquaculture
- Intensification (competition for resources)
- Degradation of genetic potential of aquaculture fish species
- Poor supply of quality fish seed
- Variable pond bottom soil and water quality
- Feed and nutrition management (replacement for fish meal in fish feed)
- Fish health management (unavailability of drugs)
- Poor preservation (post harvest technology)
- Aquaculture practices in natural waters
- Harvest technology in open water
- Hydropower impact on aquatic biodiversity
- Limited knowledge on aquatic resources and biodiversity (database)
- Coping with climate change

Research Needs

Technology:

- Broodstock improvement (crossing+selection) of carps, trout and tilapia
- Application of molecular marker in selection program
- Seed production technology and aquaculture practices of cold water native species
- Cryopreservation in fish
- Development of breeding technology for native and ornamental fish
- Extrusion feed technology for high value fish species (eg. trout)
- Feed formulation based on local resources for different development stages of fish
- Substitution of animal protein source in feed
- Pond productivity assessment
- Identification of factors affecting susceptibility to disease on fish
- Parasite control (Trichodina, argulus, dactylogyrus, emeria, etc)
- Development of disease resistant strains through genetic selection/hybridization
- Best management practices (BMP)
- Investigation on non-infectious disease
- Development of small-scale aquaculture model in hill and mountain areas
- Development/standardization of aquaculture technology in ghols and shallow wetlands
- Improvement of nursing and rearing of all aquaculture fish species
- Development of appropriate technology on culture practices of economically important indigenous fish species
- Nutrient analysis and value addition of small indigenous species
- Processing and packaging of high value commercial species
- Socio-economics, marketing and policy research
- Aquaculture engineering and mechanization (aeration, feeding device, pond & raceway design)
- Technology generation/Improvement in cage fish culture, rice-fish farming
- Cost effective energy recycling system for integrated fish farming
- Technology development for hydropower friendly fisheries/aquaculture
- Participatory technology development in irrigation infrastructure and community operative wetlands

Natural Resource Management

- Resource inventory of rivers, lakes and reservoirs including fishes therein
- Risk factor analysis of introduction of exotic species
- Threat categorization (vulnerability) of indigenous fish species
- Development of fish stock enhancement model in lakes and rivers
- Mitigation measures on threat imposed by development scheme in aquatic biodiversity
- Impact assessment and management of effluents from intensive aquaculture system
- Climate change impact assessment and development of adaptation and mitigation measures in aquaculture and fisheries

Commercialization

- Technology for round year quality seed supply
- Mechanization and intensification
- Fish species diversification
- Fish preservation and processing
- Market study

Gender

- Post harvest technology
- Small-scale integrated aquaculture
- Seed production technology
- Natural resource management

Organization/Institutional Reform

- Fisheries Research Institute for disciplinary research
- Warm water aquaculture research program to address the warm water areas in Terai region
- Cold water aquaculture research program to address cold water aquaculture in mid and high hill region
- Research Stations in mid and far western region to address location specific need/problem based research

Policy Change and Improvement

- Access to water control structure for research & development of fisheries
- Status of institution
- Scaling up of technology & system
- Training

Human Resource Development

- New recruitments (scientists, support staff, lab technicians)
- Long-term training
- Short term specific training on advance technology
- Knowledge/technology sharing visit program
- Motivation to research workers

Infrastructure/facility for Research

- Researchable ponds and raceways, indoor tanks
- Laboratories, store house
- Access roads, water supply, quarters, guest house
- Vehicle
- Equipment & machinery

Name of participants

S/n	Name	Designation	Office
1	Dr. D.B. Gurung	Executive Director	NARC
2	Mr. V. K. Mallick	Joint Secretary	MoAD
3	Ms. J. P. Lama	Director General	D0FTQC
4	Dr. R. K. Khatiwada	Deputy Director General	DLS
5	Mr. D. Pariyar	Ex. ED	NARC
6	Dr. N.P. Shrestha	Ex. ED	NARC
7	Mr. H.R. Shrestha	Ex. Director	NARC
8	Mr. H.R. Shrestha	Former Director	NARC
9	Dr. M.N. Paudel	Director	NARC
10	Mr. N.K. Yadhav	Director	NARC
11	Dr. B.R. Joshi	Director	NASRI, Khumaltar
12	Dr. N.P. Adhikari	Director	NARI, Khumaltar
13	Mr. R. N. Mishra	Program Director	
14	Mr. S. Paudel	Director	DLS
15	Dr. D. P. Parajuli	Program Director	DoCP, Hariharbhawan
16	Dr. K.P. Premi	ED	DoPMP Centre, Hariharbhawan
17	Dr. L.N. Paudel	Senior Livestock Development Officer	DoAP, Hariharbhawan
18	Dr. C.R. Upreti	Coordinator	NCRP, Khumaltar
19	Dr. B.N. Mahato	Chief	PPD, Khumaltar
20	Dr. B.P. Sah	Chief	BTD, Khumaltar
21	Dr. J. Bajracharya	Chief	SSTD, Khumaltar
22	Dr. Y.N. Ghimire	Chief	Planning Division, NARC
23	Mr. K.P. Rijal	Chief	CSGP Office, Hariharbhawan
24	Mr. P. Mandal	Chief	AND, Khumaltar
25	Dr. R.P. Thakur	Chief	AHRD, Khumaltar
26	Mr. S.K. Wagle	Chief	FRD, Godawari
27	Dr. A.K. Gautam	Chief	AERD, Khumaltar
28	Mr. K.K. Shrestha	Chief	PFRD, Khumaltar
29	Mr. B.S. Shrestha	Chief	AND, Khumaltar
30	Dr. D. Gauchan	Chief	SAPROD, Khumaltar
31	Mr. B.H. Adhikari	Chief	CPDD, Khumaltar
32	Dr. T.P. Barakoti	Chief	ORD, Khumaltar
33	Mr. S.M. Shrestha	Chief	AED, Khumaltar
34	Mr. R. Paudel	PD	CLDP, Hariharbhawan
35	Dr. G.R. Panta	Senior Veteterinary. Officer	RVPL, Tripureswor
36	Dr. K. Karki	Senior Veteterinary. Officer	VPH, Tripureswor
37	Dr. K. Shrama	Senior Veteterinary. Officer	CVL, Tripureswor
38	Dr. B.B. Chand	Senior Livestock Development Officer	DoAH, Tripureswor
39	Dr. S. Manandhar	Senior Livestock Development Officer	VQ and DMO, Tripureswor
40	Mr. R.B. Sah	Coordinator	NBRP, Tarahara, Sunsari
41	Mr. D. Neopane	Coordinator	SARP, Khumaltar
42	Mr. L.N. Panday	Coordinator	SGRP, Guthichaur, Jumla
43	Dr. U.M. Singh	Senior Scientist	NASRI, Khumaltar

44	Mr. S.P. Shrivastav	Senior Scientist	SSD, Khumaltar
45	Dr. R. Shrestha	Senior Scientist	CSD, Khumaltar
46	Mr. N.P. Osti	Senior Scientist	AND, Khumaltar
47	Dr. S.P. Shrestha	Senior Scientist	AHRD, Khumaltar
48	Dr. D.R. Khanal	Senior Scientist	AHRD, Khumaltar
49	Dr. M.R. Tiwari	Senior Scientist	NASRI, Khumaltar
50	Mr. R.P. Ghimire	Chief	ARS (Goat), Bandipur, Tanahun
51	Me. S. Ahamad	Senior Scientist	RARS, Khajura, Banke
52	Ms. N. Pradhan	Senior Scientist	FRD, Godawari
53	Mr. S. Prasad	Senior Scientist	ARS (Fishery), Begnas, Pokhara
54	Mr. M.K. Thakur	Senior Scientist	CPDD, Khumaltar
55	Mr. G. Malla	Senior Scientist	AERD, Khumaltar
56	Mr. N.P. Paudel	Senior Admin Officer	NARI, Khumaltar
57	Mr. G. Lamsal	Chief	ARS (Fishery), Trisuli, Nuwakot
58	Mr. P. K. Yadav	Chief	CCRD, Khumaltar
59	Dr. M.P. Aryal	Senior Livestock Development Officer	DoLMP, Hariharbhawan
60	Mr. B. Khanal	Chief	ARS (Pasture), Dhunche, Rasuwa
61	Ms. S. Sapkota, Nepal	Scientist	SAPROD, Khumaltar
62	Mr. A.B. Thapa	Scientist	RARS, Tarahara, Sunsari
63	Ms. S Sanjyal	Scientist	PFRD, Khumaltar
64	Mr. M.K. Shah	Scientist	RARS, Lumle, Kaski
65	Dr. R.P. Sah	Scientist	ARS, Pakhribas, Dhankuta
67	Mr. R.P. Sah	Scientist	ARS, Pakhribas, Dhankuta
68	Mr. D.P. Adhikari	Scientist	ARS (Goat), Bandipur, Tanahun
69	Mr. J.N. Banjade	Scientist	RARS, Khajura, Banke
70	Dr. D.K. Yadav	Scientist	SGRP, Guthichaur, Jumla
71	Mr. B. B. KC	Scientist	SGRP, Guthichaur, Jumla
72	Dr. A.K. Jha	Scientist	RARS, Parwanipur, Bara
73	Mr. D. Adhikari	Scientist	ARS (Goat), Bandipur, Tanahun
74	Dr. B.R. Baral	Scientist	ARS (Pasture), Dhunche, Rasuwa
75	Mr. B.B. Bhandari	Scientist	ARS, Pakhribas, Dhankuta
76	Dr. P. Shrestha	Scientist	AHRD, Khumaltar
77	Mr. S. Sapkota	Scientist	ABD, Khumaltar
78	Ms. B. Sah	Scientist	AND, Khumaltar
79	Dr. S.N. Ali	Scientist	RARS, Tarahara, Sunsari
80	Mr. A. Mishra	Scientist	FRD, Khumaltar
81	Mr. B. Kafle	Scientist	ORD, Khumaltar
82	Mr. A.P. Nepal	Senior Technical Officer	NARC
83	Mr. N.K. Roy	Senior Technical Officer	FRD, Godawari
84	Mr. R.D. Pandit	Senior Technical Officer	RARS, Tarahara, Sunsari
85	Mr. S.B. Shrestha	Senior. Technical Officer	SARP, Khumaltar
86	Mr. K.K. Shrivastav	Senior Technical Officer	RARS, Parwanipur, Bara
87	Mr. A.K. Rajbhandari	Senior Technical Officer	PFRD, Khumaltar
88	Mr. D.R. Dhakal	Senior Account Officer	NARI, Khumaltar
89	Mr. D.N. Tiwari	Senior Technical Officer	RARS, Khajura, Banke
90	Dr. B.P. Kushwaha	Senior Technical Officer	RARS, Tarahara, Sunsari

91	Ms. S.M. Amatya, Shrestha	Senior Technical Officer	SAPROD, Khumaltar
92	Dr. S. Panday	Livestock Development Officer	PF&AN Office, Hariharbhawan
93	Ms. D. Karki	Senior Technical Officer	AHRD, Khumaltar
94	Mr. S.K. Shrestha	Senior Technical Officer	FRD, Godawari
95	Mr. S.K. Kafle	Senior Admin Officer	NARC
96	Mr. B. Khadka	Senior Admin Officer	NARC
97	Mr. B.K. Shrestha	Technical Officer	AND, Khumaltar
98	Mr. T.P. Paudel	Technical Officer	SARP, Khumaltar
99	Mr. R. Karki	Technical Officer	FRD, Khumaltar
100	Mr. K.P. Dhungana	Technical Officer	RARS, Lumle, Kaski
101	Mr. A. Sharma	Technical Officer	AERD, Khumaltar
102	Mr. P.K. Jha	Technical Officer	RARS, Tarahara, Sunsari
103	Mr. B. R. Acharya	Technical Officer	RARS, Lumle, Kaski
104	Dr. S.H. Ghimire	Technical Officer	ARS (Goat), Bandipur, Tanahun
105	Dr. R. Bastola	Technical Officer	NCRP, Khumaltar
106	Dr. Md. H. Azad	Technical Officer	AND, Khumaltar
107	Mr. P. Timilsina	Technical Officer	ARS (Fishery), Trishuli, Nuwakot
108	Ms. A. Jha	Technical Officer	FRD, Godawari
109	Mr. B. Paudel	Technical Officer	SARP, Khumaltar
110	Mr. K.R. Acharya	Technical Officer	ABD, Khumaltar
111	Mr. N. Hamal	Technical Officer	NCRP, Khumaltar
112	Dr. B. Shrestha	Technical Officer	NCRP, Khumaltar
113	Mr. B.R. Pokharel	Technical Officer	ABD, Khumaltar
114	Mr. R.U. Mahato	Technical Officer	SARP, Khumaltar
115	Mr. R.R. Adhikari	Computer Officer	CPDD, Khumaltar
116	Mr. N. Lakhe	Admin Officer	NASRI, Khumaltar
117	Mr. B.D. Neopane	Admin Officer	NARC
118	Ms. S. Basnet	Admin Officer	AERD, Khumaltar
119	Mr. R.N. Sah	Civil Engineer	NASRI, Khumaltar
120	Mr. S.R. Ojha	Admin Officer	CPDD, Khumaltar
121	Mr. R. Shrestha	Admin Officer	CPDD, Khumaltar
122	Mr. G. Shrestha	Admin Officer	NARC
123	Mr. B.K. Yadav	Technical Officer	NARC
124	Mr. H. Neopane	Admin Officer	NARC
125	Ms. S. Neopane	Admin Officer	NARC
126	Ms. M. Chitrakar	Admin Officer	NARC
127	Mr. M.P. Pantha	Freelancer	Kathmandu
128	Mr. M.B. Nepali	Freelancer	Kathmandu
129	Mr. S. Phuyal	A-5	NARC
130	Mr. L.N. Pokharel	Journalist	Himalaya Times
131	Mr. P. Adhikari	Journalist	Avenues TV
132	Mr. M. Lama	Journalist	NTV
133	Mr. S.B. Ale	Goat Farmer	Tanahun
134	Mr. S. Dhike	Student	T.U., Kirtipur
135	Mr. K. Yoo	Korean Volunteer	SARP, Khumaltar