International Journal of Agriculture and Crop Sciences.
Available online at www.ijagcs.com
IJACS/2014/7-7/364-372
ISSN 2227-670X ©2014 IJACS Journal

IJACS

Diversity and preference of agricultural crops in the cropland agroforests of southwestern Bangladesh

Md. Hasanuzzaman[1] , Mahmood Hossain[1] , Mustafa Saroar[2]

1. Forestry and Wood Technology Discipline
2. Urban and Rural Planning Discipline
Khulna University, Khulna-9208, Bangladesh

Corresponding author email: hasanfwt@gmail.com

ABSTRACT: Cropland agroforestry is an important production system of Bangladesh. This study focused on the diversity, composition, people's preferences, spatial variations and purpose of cultivation of agricultural crops in the cropland agroforestry practices of southwestern Bangladesh. A total of 313 cropland agroforests were randomly surveyed from Khulna, Jessore and Satkhira districts of this region. The highest (0.84 to 0.87) crop diversity index (CDI) was found for climber vegetables, followed by tuber vegetables (CDI - 0.78 to 0.81), spices (CDI - 0.75 to 0.81) and the lowest (CDI - 0.20 to 0.40) was found for cereal crops. Among these three districts maximum crop diversity was found in Jessore as the soil is more suitable as well as marketing and transportation facility is higher than the other two districts. Among the cereal crops maximum (95%) preferred paddy (*Oryzae sativa*). Among the cash crops maximum (68%) preferred jute (*Corchorus capsularis*). Among the tuber vegetables maximum (44%) preferred potato (*Solanum tuberosum*). Among the fruity vegetables maximum (42%) preferred brinjal (*Solanum melongena*). Among the leafy vegetables maximum (39%) preferred basil (*Basella alba*). Among the climber vegetables maximum (36%) preferred bean (*Lablab niger*). Among the pulses maximum (52%) preferred lentil (*Lens culinaris*). Among the spices maximum (42%) preferred green peeper (*Capsicum frutescens*). Among the flowers maximum (70%) preferred rose (*Rosa centifolia*). Among the annuals/perennials maximum (66%) preferred banana (*Musa spp.*). Overall diversity and preference of agricultural crops in southwestern Bangladesh were determined by the local demand and end product.

Key words: Bangladesh, Cropland agroforestry, Crop combinations, Diversity index, Relative preference.

INTRODUCTION

Bangladesh with a population of over 150 million within a territory of 144 thousand sq km is one of the densely populated countries of the world. About 80 percent of the total population lives in the rural areas whose livelihood are centered on agriculture and related activities (BBS, 2011; Hasanuzzaman et al., 2014a). More than 30 percent of the rural families are landless or functionally landless having land only less than 0.202 hectares although per capita availability of arable land is 0.045 hectares (Ericksen et al., 1997). Due to small size of land holding historically commercial farming is less practiced rather smallholders' subsistence agriculture is widely practiced. These smallholders utilize the limited amount of arable land for both food production and other land uses such as forestry, fisheries, and human habitation which put heavy pressure on productivity of land (Zashimuddin, 2004; Ericksen et al., 1997). Moreover, with the increased population and urbanization prime agricultural land is diminishing at an alarming rate. As there is limited scope to expand the amount of cultivable land and the economy of the nation heavily depends on the performance of agricultural sectors both intensification and diversification in agriculture have been observed in recent years (Ahmed et al., 2004). Therefore, wherever biophysical and morphological condition of soil permits, the smallholders go for intercropping (i.e. mixed crop farming) and agroforestry to maximize economic return from limited land. Other reasons of proliferation of agroforestry practice in Bangladesh are diminishing forestlands and limited scope of plantation in heavily dense home garden (Ahmed, 2001). Agroforestry practice is now an urgent issue to meet the ever increasing demand of agricultural and forest products as well as minimize the environmental degradation (Hasanuzzaman et al., 2006).

In cropland agroforestry system, various fast growing trees that demand less water and blocked minimum sunlight are planted alongside crops or some cases along the plot boundaries. In addition to cereal crops different vegetables, pulses, beans, spices and nontraditional cash crops are grown under the trees or using trees as trellis in the croplands (Chowdhury, 1997; Hasanuzzaman et al., 2014a). Crop diversification enhances nitrogen in the soil to replenish the soil fertility as well as more pest-resistant thus, increases the sustainability of arable land (Ahmed, 2001; Chakraborty, 2012). It generates more employment opportunities and has tremendous potential to alleviate rural poverty particularly in the lean period when smallholders await for maturing and harvesting of main crops, the short durational complimentary non-cereal crops act as a safety net (Gunasena, 2000; Gunasena, 2003). Therefore, agroforestry practice is gaining popularity is many parts of Bangladesh (Aktar, 1992; Quddus, 2001).

Given this development, many earlier studies have made strong assertion that a well-planned and well managed multi-layered cropping system of cropland agroforestry will play a great role in improving agricultural as well as forestry production in Bangladesh. Although some of these studies sporadically pointed that coastal Khulna region is lagging behind in this regards, however, none of them presented a comprehensive analysis of the situation of cropland agroforestry practice in Khulna region (Ahmed et al., 2004; Hasanuzzaman et al., 2014a). In this regards three gaps in knowledge and practice are very much striking. First, little is known about the diversity of products in cropland agroforestry system in Khulna region. Second, the linkages between agroforestry practices and macro spatial variations in terms of biophysical condition and soil morphology are still remain unclear. Third, whether the smallholders take their production decision in cropland agroforestry based on traditional cropping practices or based on informed choice taking consideration of the socio-environmental context is poorly understood.

This study taking coastal Khulna region of Bangladesh as a strong case of unexplored cropland agroforestry practice aims to address the points raised above. Khulna region comprises of Khulna, Jessore and Satkhira district (administrative unit, typical size: 2500 sq. km) is one of the regions where this transformation (i.e. agriculture to agroforestry) has been taking place for long but the progress has been slow. Therefore, the overarching goal of this research is to offer an in depth analysis of current situation of cropland agroforestry practices in Khulna region. This will be done by examining few dimensions of agroforestry. First, what is the extent of diversity of crop production in cropland agroforestry practice? Second, are spatial variations observed in cropland agroforestry practices that linked to biophysical and morphological conditions of local soil? Third, how do local traditions influence the cropland agroforestry practices in Khulna region? Exploring these research questions has great significance for rural development and poverty alleviation in coastal Khulna region. Therefore, the findings of this paper will help multiple stakeholders including the smallholders, policy makers, development practitioners to devise mechanism for intervention that would increase productivity in cropland agroforestry without undermining sustainability and environmental quality.

MATERIALS and METHODS

Description of the study site

Bangladesh is located between 20°34'-26°3' N and 88°01'-92°41' E. It is bordered by the Bay of Bengal on the South and by India on all other sides along with small part of Myanmar in the south-eastern edge (BBS, 2004). The study is conducted in coastal Khulna region which comprises of three administrative units i.e. Khulna, Jessore and Satkhira district. Study area covers an estimated area of 10,830 sq km) in the South-west corner of Bangladesh (BBS, 2011). The Khulna region is basically a low lying flat, and fertile deltaic plain, most parts of which are roughly one meter above the mean sea level (MSL) (BBS, 2004; Hasanuzzaman et al., 2014b). The world famous mangrove forest Sundarban's is located at the southern edge of this study site. Both calcareous and noncalcareous alluvium soils are found in this region (BBS, 2004). Tidal influence and salinity intrusion are pronounced in many parts of this region. In fact, strong salinity gradient in soil and water is observed from Jessore (located in the north edge) to Satkhira (located in the south edge). A tropical to subtropical humid monsoonal climate characterizes the entire area. The region experience about 1650 mm rainfall annually with high concentration during the month of June to August. Three distinct seasons such as summer (March–May), rainy (June– October), and winter (November–February) are pronounced in the entire area. The mean annual temperature is 26◦C (range: 19–32◦C). In some places, temperatures drop to 10◦C during the winter and reach 40◦C or more during the summer (Hasanuzzaman et al., 2014c). Cropland agroforestry practices are greatly shaped by many of these climatic factors and non-climatic factors in this region.

Sampling design and data collection

Every district consists of a number of smaller administrative units called sub-district. Twelve sub-districts (4 sub-districts from each district) were selected randomly. In the absence of systematically documented information on cropland agroforestry in each sub-district, cropland agroforestry plots were selected in an unbiased manner following Hasanuzzaman et al., (2014a). Every day a new local guide was hired to assist in selecting plots of cropland agroforestry. After selecting a cropland agroforestry plot, the guide was requested to stay away from the interview process in order to prevent bias while selecting the next plot of cropland agroforestry. Thus data and information were collected from a total of 313 plots of cropland agroforestry selected randomly during April –June 2013. The questionnaire broadly includes inquiry about the socio-demographic profile of the plot owners, various socio-environmental and ecological attributes of the plots employed for cropland agroforestry, species composition, management practices, and the problem encountered in the cropland agroforestry practices. Various descriptive and inferential statistics were used to analyze the situation.

Determination of crop diversity index

There exist a myriad of methods of computing diversity index. One of the most widely used diversity index is Shannon's index (a measure of biodiversity in an ecological community) which is an ideal one for computing diversity of a particular area but not suitable for comparison purpose. Shannon diversity index allows comparison among the species of two communities only if total sample sizes are equal for both communities. For three districts of Khulna region as the

sample sizes are not the same, therefore this index is not used to determine crop diversity. Another widely used diversity index is Simpson's diversity index which takes into account the number of species present, as well as the relative abundance of each species. However, to compute this index the number of species in any area, as well as the number of individuals of each species is required. As this study deals with the varieties of crops species (cereal, non-cereal, spices, vegetables etc.) which could not be counted rather amount of areas designated for each of these crops production could be computed, therefore the main Simpson diversity index could not be used. However, Gini-Simpson index which has similarities with The Gibbs-Martin index of diversity has solved this problem. Because Gini-Simpson index gives the probability those two randomly sampled individuals from the assemblage represent two different species. Therefore, for this research to compute the crop diversity, Gini-Simpson index is used. The Gini-Simpson Index for crop diversity computation can be expressed as

$$CDI_i = 1 - \sum_{j=1}^{n} \left(\frac{a_{ij}}{A_i}\right)^2$$

Where, CDI_i = crop diversity index of location i. a_{ij} = area planted to the jth crop in the ith location. A_i = total area planted under all crops. This research chooses to study the diversity of agricultural crops at the farm/plot level as data is collected for the number of crops cultivated and the area under each crop. From 313 sample plots a total of 150 ha land was included for the computation of crop diversity indexes (CDI) in the study region of Khulna.

Determination of physical properties and chemical indicators of soil

Top soils (up to 10 cm depth) from selected cropland agroforests of each districts was collected using core sampler of 5 cm diameter. Bulk density was determined by core method as described by Maynard and Curran (2007). Conductivity (EC) of soil was measured according to Mostara and Roy (2008). Soil p^H was measured according to Miller and Kissel (2010). Organic matter of soil was measured according to Allen (1974). The plant available form of nitrogen in soil was prepared following Mulvaney (1996) and the plant available form of phosphorus and potassium in soil was prepared following Allen (1989). Then the sample extracts were processed according to Weatherburm (1967) and Timothy et al. (1984) to measure nitrogen and phosphorus concentration in sample extracts respectively using UV-Visible Recording Spectrophotometer (U-2910, HITACHI, Japan). Potassium concentration in sample extracts was measured by Flame photometer (PFP7, Jenway LTD, England).

Statistical analysis

The statistical analysis (multiple responses, χ^2 test, ANOVA, descriptive statistics) was performed using SPSS (17.0) statistical software.

RESULTS and DISCSSION

Socioeconomic characteristics of farm owner

Among the respondents, who practice cropland agroforestry, maximum 38% are from Satkhira followed by 32% from Jessore and 30% from Khulna district. According to the farm size classification followed by Bangladesh government (BBS, 1998), about 79% of the cropland agroforestry owner are peasant farmer having farm size between 0.12-0.80 ha and 15% are marginal farmer having farm size below 0.12 ha. About 5% have medium farm size (0.80 to 2 ha) and only about 1% are large farmer having farm size bigger than 2 ha (Table 1). Therefore, it could be inferred that majority of the cropland agroforestry owners are substance farmer/producer.

Crop diversity

In cropland agroforestry broadly five types i.e. arable crops, vegetables, pulses, spices and flowers are practiced (Tables 3, 4 and 5). If a crop is cultivated in 5% or more area of a plot that crops is counted for this analysis. Varying degrees of diversity in cropping pattern were observed for different groups of cropland agroforestry produces (i.e. crops, vegetables, species, etc). Spatial variability was also observed for crop diversity index (CDI). The highest CDI (0.84 to 0.87) was found for climber vegetables followed by fruity vegetables (0.78 to 0.81) and spices (0.75 to 0.81). Conversely lowest CDI: (0.20 to 0.40) was observed for cereal crops (Table 2). Among these three districts maximum crop diversity was found in Jessore than the other two districts (Table 2). The value of CDI is bound to zero to one (Shahidullah et al., 2006). The index is zero when a land area grows only one crop i.e. complete specialization while the index is moving towards one showing increase in number of crops and in case of complete diversification the value is one (Singh et al., 2013). Theoretically, for a crop group a CDI of 0.60 means there is 60 percent probability that if two species/varieties of that crop were randomly choses they would be different species/varieties. Practically, higher CDI implies more diversified used of a single plot. For CDI below 0.25 is considered very low level of diversity and 0.6 or above is considered high level of diversity. The crop diversity indexes was the highest for climber vegetables (Table 2) as these vegetables are year round crop and needs very low investment as well as it can be produced in marginal lands including different fishery practices. Maximum respondents cultivate cash crops as poverty is the basic problem of rural peoples of Bangladesh

(Zashimuddin, 2004) and the lowest number of respondents cultivate flowers as flower culture is comparatively a new venture as well as the supply of different flowers is not sufficient enough to meet the market demands, so the commercial production of flowers and ornamental plants has started in Bangladesh. Initially the farmers started production of flowers and ornamental plants on commercial basis and now a day's they plant different timber and horticultural tree species for higher monetary benefit from the same piece of land (Mannan et al., 2007). One of the reason of more flower cultivation in Jessore may be the soil is more suitable for flower cultivation as well as better communication of Jessore and West Bengal of India than the other two districts. If the Mongla port of Khulna district performs as an international sea port then the export of flowers will be increased in a great scale and the adjacent areas can be under flower cultivation thus a lot of foreign currency can be earned through flower cultivation.

Arable crops

Among the arable crops respondents cultivate three (3) cereal crops and five (5) cash crops in the cropland agroforests (Table 3). Maximum (94.7%) cultivate *Oryzae sativa* followed by 10.5% *Triticum aestivum* and the lowest (9.6%) cultivate *Zea mays* as cereal crops among the cropland holders who cultivated cereal crops. While maximum (68.2%) cultivate *Corchorus capsularis* followed by 50.7% *Brassica campestris*, 35.8% *Sesamum indicum* and the lowest (0.7%) cultivate *Gossypium herbaceum* as cash crops among the cropland holders who cultivated cash crops (Table 3). It was also identified that, as a single crop maximum respondents cultivate *Oryzae sativa* (paddy) as the staple food of Bangladesh which covers 79.4 percent of the total cultivatable land area of Bangladesh and different salt tolerant varieties of paddy are also introduced in the saline areas of Bangladesh which causes unfavorable environment and hydrological situation that restrict the normal crop production throughout the year ((Zashimuddin, 2004; Islam, 2013; WFP, 2013). Maximum respondents cultivated *Corchorus capsularis* (jute) as cash crops as the raw materials of different jute industries. A large scale of population of this region are engaged for their livelihood in different jute industries as the areas have a conducive environment for jute industry, including low land price, availability of workers and fertile land for jute growth (Moazzem, et al., 2009; BSS, 2011). Jute dominates among fiber crops in Bangladesh [World Food Programme (WFP) 2013]. Zashimuddin, (2004) also reported that jute is one of the major cash crop of Bangladesh.

Vegetables

Among the vegetables respondents cultivate tubers, fruity, leafy and climber vegetables (Table 4). Seven (7) tuber vegetables are cultivated in this practice and maximum (43.9%) cultivate *Solanum tuberosum* followed by 33.3% *Colocasia esculenta* and the lowest (5.3%) cultivate *Brassica campestris* as tuber vegetables among the cropland holders who cultivated tuber vegetables (Table 4). Six (6) fruity vegetables are grown in the croplands and maximum (42.0%) cultivate *Solanum melongena* followed by 37.0% *Brassica capitata* and *Brassica botrytis* and the lowest (13.4%) cultivate *Brassica gongyloides* as fruity vegetables among the cropland holders who cultivated fruity vegetables (Table 4). Four (4) leafy vegetables are cultivated in the cropland agroforests and maximum (38.5%) cultivate *Basella alba* followed by 36.9% *Amaranthus lividus* and *Amaranthus tricolor* and the lowest (23.1%) cultivate *Spinacea oleraceae* as leafy vegetables among the cropland holders who cultivated leafy vegetables (Table 4). Eleven (11) climber vegetables are cultivated in the practices and maximum (36.4%) cultivate *Lablab niger* followed by 33.9% *Lagenaria siceraria*, 27.1% *Cucurbita maxima* and the lowest (5.9%) cultivate *Trichosanthes anguina* among the cropland holders who cultivated climber vegetables (Table 4). Maximum repondents cultivate *Solanum tuberosum* (potato) as under ground vegetables as potato is one of the food-stuff in Bangladesh which is primarily used as a vegetable but it is also considered as a staple food like many other countries also treated as the third major crop of Bangladesh after paddy and wheat (Mukul et al., 2013; WFP, 2013). Maximum respondents cultivate *Basella alba* (basil or malabar spinach) as leafy vegetables as basil is available year round (Anon, 2013). Maximum respondents cultivate *Capsicum frutescens* (green peeper) as spices as green peeper is the most prevalent spices in the southern coastal region of Bangladesh (Uddin et al., 2002). Maximum respondents cultivate *Solanum melongena* (brinjal) as above ground vegetables as brinjal is one of the most consumed vegetables in the country (Ahmad, 2013). Maximum respondents cultivate *Lablab niger* (bean) as climber vegetables as bean is the poor people's protein in Bangladesh where around 42% people are suffering from malnutrition as well as a good source of slowly digestible carbohydrate, fiber, vegetable protein and a valuable means of lowering the glycemic index (GI) of the diet (Zashimuddin, 2004; Curran, 2013).

Pulses, Spices, Flowers and others

Four (4) pulses are cultivated in the cropland agroforests and maximum (52.1%) cultivate *Lens culinaris* followed by 32.9% *Vigna radiate* and the lowest (6.8%) cultivate *Lathyrus sativum* as pulses among the cropland holders who cultivated pulses (Table 5). Seven (7) spices are cultivated in this practice and maximum (42%) cultivate *Capsicum frutescens* followed by 35.2% *Curcuma longa*, 23.1% *Alium cepa* and the lowest (5.5%) cultivate *Zingiber officinale* as spices among the cropland holders who cultivated spices (Table 5). Five (5) flowers are cultivated in the cropland agroforests of Jessore district only. Maximum (69.6%) cultivate *Rosa centifolia* followed by 21.7% *Gladiolus spp.* and the lowest (8.7%) cultivate *Polianthes tuberosa* as flowers among the cropland holders who cultivated flowers (Table 5). Six (6) annuals/perennials are cultivated in the cropland agroforestry practices and maximum (65.8%) cultivate *Musa spp.*

followed by 34.2% *Carica papaya*, 10% *piper betel* and the lowest (2.5%) people cultivate *Elaeis guineensis* as annuals/perennials among the cropland holders who cultivated annuals/perennials (Table 5). Maximum respondents cultivate *Lens culinaris* (lentil) as pulses as lentil is the most important pulse, commonly known as poor man's meat in Bangladesh as well as in the Asia-Pacific region (Sarker et al., 2004). Lentil is richer in fiber, protein and micronutrients (Watson, 2013). Lentil is popular to all classes of people and is taken in almost all meals (WFP, 2013). Maximum respondents cultivate *Musa spp.* (banana) as annuals/perennials as banana is the most common native year round fruit which back the high and quick economic return to the farmers (Roy et al., 2012). Kibria and Saha (2011) reported that, banana agroforestry is financially more profitable than other systems. Maximum respondents cultivate *Rosa centifolia* (rose) as flower as rose is the most popular flower of Bangladesh which is now a profitable enterprise to the farmers in Bangladesh. Haque et al., (2013) reported that, the highest profit was obtained from rose cultivation compared to its competitive crops like potato, jute, lentil, sesame, mustard and mungbean.

Physical properties and chemical indicators of soil

The highest (0.172 µg/g) available form of nitrogen was found in the soil of Jessore district while the highest available form of phosphorus (40.38 µg/g) and potassium (2.77 µg/g) was observed in the soil of Khulna districts (Table 6). The highest bulk density (1.28 g/cm^3) and the highest p^H value (6.88 to 7.62) was observed in the soil of Jessore districts where as the highest organic matter content (6%) and highest conductivity (605.33 µS/cm) was detected in the soil of Khulna districts (Table 6). Among these three districts maximum crop diversity was found in Jessore may be the soil is more suitable and climatic conditions are favorable for agricultural crops production with fulfilling the marketing and transportation facility better than the other two districts. The another reason for observing highest crop diversity indexes in Jessore may be the soils of Jessore are non saline while the other two districts are belongs to coastal and offshore areas (saline belt) of Bangladesh having low soil fertility (Haque, 2006).

Tree crop combinations

Among the tree-crop combinations significant ($p<0.05$) combinations was found maximum for jute (Mango, Plum, Date and Palm) followed by paddy (Mahogany, Coconut and Jackfruit), turmeric (Akashmoni, Litchi and Jackfruit), rose (Ghora neem, Mango and Shirish) and the lowest was found for wheat, potato, tomato, mustard and papaya etc. (Appendix 1). On the contrary, highest significant ($p<0.05$) combination was found for Mango followed by Mahogany, Litchi, Plum, Coconut and the lowest was found for Akashmoni, Ghora neem and Eucalyptus with different agricultural crops (Appendix 1).The tree-crop combinations reveals that jute, paddy, turmeric, rose, brinjal, bottle gourd, parble, bean , lentil and green peeper among agricultural crops and Mango, Mahogany, Litchi, Plum and Coconut among tree species are most preferred by the respondents in cropland agroforestry practices of southwestern Bangladesh. These combinations also reveal that maximum respondents choose agricultural crops and tree species on the basis of local demand as well as increased production.

The income of both individuals and communities has been increased by practicing cropland agroforestry over pure agriculture and as result a large scale of croplands has been converting to cropland agroforests in the recent period of time. The agricultural crops combination with different horticultural tree species found more preferred by the respondents for more profitability. However, the sustainability of this practice is dependent on different management training and monitoring by the concern department.

ACKNOWLEDGEMENT

Authors wish to thank Bangladesh Academy of Sciences (BAS) and United States Department of Agriculture (USDA) for the financial support and Khulna University (KU) for the logistic supports during the study.

REFERENCES

Ahmad R. 2013. Brinjal modified: Bangladesh set to join elusive club of 28 GM crop growing countries. (available at www.thedailystar.net/beta2/news/modified-brinjal-finally-sees-light/).

Ahmed MFU, Rahman SML, Ahmed ASMM, Quebedeaux B. 2004. Agroforestry as it pertains to vegetable production in Bangladesh. Journal of Agronomy, 3: 282–290.

Ahmed MFU. 2001. Agroforestry in Bangladesh with special reference to northern Bangladesh. In: Haq MF, Hasan MK, Asaduzzaman SM, Ali MY (ed) Development of agroforestry research in Bangladesh. Proceedings of National Workshop on Agroforestry Research, Gazipur, Bangladesh. pp.1−10.

Aktar MS, Abedin MZ, Quddus MA. 1992. Trees in crop field under agroforestry system. Bangladesh J. Training and Development, 5(2): 115-119.

Allen SE. 1974. Chemical analysis of ecological materials. Oxford: Blackwell Scientific Publications.

Allen SE. 1989. Chemical analysis of ecological materials. 2nd edn. Oxford: Blackwell Scientific Publications.

Anon. 2013. Malabar Spinach information and facts. (available at www.specialtyproduce.com/produce/MalabarSpinach 8956.php #sthash.mTg7unYf.dpuf).

BBS. 1998. Statistical Year Book of Bangladesh, Bangladesh Bureau of Statistics. Dhaka, Government of Bangladesh, 140-144 pp.

BBS. 2004. Statistical Pocket Book of Bangladesh. Bangladesh Bureau of Statistics. Ministry of Planning. Dhaka, Bangladesh.

BBS. 2011. Population & Housing Census 2011 Preliminary Results. Bangladesh Bureau of Statistics. Ministry of Planning. Dhaka, Bangladesh.

BSS. 2011. 14 new jute mills in Khulna region soon (available at www.theindependentbd.com/business/others/80980-14-new-jute-mills-in-khulna-region-soon.html).
Chakraborty A. 2012. Crop diversification in Murshidabad district, West Bengal: A spatio-temporal analysis. International Journal of Physical and Social Sciences. 2(7):1-11.
Chowdhury MK. 1997. Agroforestry in Homesteads and Croplands: Existing Practices and Potentials. In: Alam MK, Ahmed FU, Amin SMR (ed). Agroforestry: Bangladesh Perspectives. Bangladesh Agricultural Research Council. Dhaka. pp 68−84.
Curran J. 2013. Beans and Diabetes. (available at http://beaninstitute.com/health-benefits/beans-and-diabetes/#sthash.VaFe7Ub0.dpuf).
Ericksen NJ, Ahmad QK, Chowdhury AR. 1997. Socio-economic Implications of Climate Change for Bangladesh. Bangladesh Unnayan Parishad. Dhaka. (available at http://academic.research.microsoft.com/paper/4946231. aspx).
Gunasena HPM. 2000. Intensification of crop diversification in Asia Pacific Regions. Report of the Expert Consultation on Crop Diversification in the Asia-Pacific Region. FAO Corporate Document Repository. Produced by-Regional Office of Asia and Pacific RAP Publication. Bangkok, Thailand.
Gunasena HPM. 2003. Food and Poverty: Technologies for poverty alleviation. South Asia Conference on Technologies for Poverty Reduction, New Delhi.10 -11 October, 2003.
Haque MA, Miah MAM, Hossain S, Alam M. 2013. Profitability of Rose Cultivation in Some Selected Areas of Jessore District. Bangladesh Journal of Agricultural Research, 38(1): 165-174.
Haque SA. 2006. Salinity problems and crop production in coastal regions of Bangladesh. Pak. J. Bot., 38(5): 1359-1365.
Hasanuzzaman M, Mahmood H, Lemon SH, Islam MN. 2006. Nutrients (P, K and Na) leaching from leaf litter of *Dalbergia Sissoo* (Roxb.). Pakistan Journal of Forestry, 56: 22−29.
Hasanuzzaman M, Mahmood H, Saroar M. 2014a. Floristic composition and management of cropland agroforest in southwestern Bangladesh. Journal of Forestry Research. DOI 10.1007/s11676-014-0451-4.
Hasanuzzaman M, Mahmood H. 2014b. Litter production and nutrient return through leaf litter of selected cropland agroforest tree species in southwestern Bangladesh. Agriculture & Forestry, 60 (1): 221-233.
Hasanuzzaman M, Mahmood H. 2014c. Nutrient leaching from leaf litter of cropland agroforest tree species of Bangladesh. Journal of Forest and Environmental Science, 30 (2): 208-217.
Islam MM. 2013. Development of salt tolerant rice varieties through induced mutation and marker-assisted selection. Bangladesh Institute of Nuclear Agriculture. Mymensingh, Bangladesh. (available at www.bina.gov.bd/index. php?option=comcontent&view =article&id =102:salt-tolerant-rice-variety&catid=34: research-update&Item id=97).
Kibria MG, Saha N. 2011. Analysis of existing agroforestry practices in Madhupur Sal forest: an assessment based on ecological and economic perspectives. Journal of Forestry Research, 22(4): 533-542.
Mannan MA, Howlader U, Bahar MH, Rahman MM, Gain P. 2007. Present Status of Flower Cultivation and Problems Confronted by the Farmers at Jhikargachha Upazilla of Jessore. South Asian J. Agric., 2(1&2):89-94.
Maynard DG, Curran MP. 2007. Bulk density measurement in forest soils. Pp 868-869. In: Carter, M.R. Gregorich, EG, eds. Soil sampling and methods of analysis. 2nd edn. Boca Raton, FL: CRC press.
Miller RO, Kissel DE. 2010. Comparison of soil p^H methods on soils of North America. Soil Science Society of America Journal 74(1): 310-316.
Moazzem KG, Rahman MT, Sobhan A. 2009. Jute Manufacturing Sector of Bangladesh: Challenges, Opportunities and Policy Options. Centre for Policy Dialogue. Dhaka, Bangladesh. p 78.
Motsara MR, Roy RN. 2008. Guide to laboratory establishment for plant nutrient analysis. FAO fertilizer and plant nutrition bulletin 19, Food and Agriculture Organization of the United Nations, Rome.
Mukul AZA, Rayhan SJ, Hassan MM. 2013. Farmer's profitability of potato cultivation at Rangpur district: the socio-economic context of Bangladesh. International Journal of Economics, Finance and Management Sciences, 1(3): 136-144.
Mulvaney RL. 1996. Nitrogen- Inorganic Forms. In Methods of Soil Analysis: Chemical Methods. Part 3. D.L. Sparks, editor. Soil Science Society of America, Madison, USA. pp 1123-1184.
Roy B, Rahman MH, Fardusi MJ. 2012. Impact of Banana Based Agroforestry on Degraded Sal Forest (Shorea robusta C.F. Gaertn) of Bangladesh: a Study from Madhupur National Park. Journal of Biodiversity and Ecological Sciences, 2 (1): 62-72.
Sarker A, Erskine W, Bakr MA, Rahman MA, Afzal MA, Saxena MC. 2004. Lentil Improvement in Bangladesh. Asia-Pacific Association of Agricultural Research Institutions. Bangkok, Thailand. (available at www.apaari.org/wp-content/uploads/2009/05/ss_2004_01.pdf).
Shahidullah SM, Talukder MSA, Kabir MS, Khan AH, Elahi NE. 2006. Cropping patterns in the south east coastal region of Bangladesh. Journal of Agriculture and Rural Development, 4(1 &2): 53-60.
Singh J, Yadav HS, Singh N. 2013. Crop Diversification in Punjab Agriculture: A Temporal Analysis. Journal of Environmental Science, Computer Science and Engineering & Technology, 2(2): 200-205.
Timothy RP, Yoshiaki M, Carol ML. 1984. A manual of chemical and biological methods for seawater analysis. Oxford: Pergamon press.
Uddin M, Rahman MJ, Mannan MA, Begum SA, Rahman AFMF, Uddin MR (2002). Plant biodiversity in the homesteads of saline area of southeastern Bangladesh. Pakistan Journal of Biological Sciences, 5: 710−714.
Watson E. 2013. Beans, peas, lentils: From "poor man's meat" to the hottest gluten-free ingredients?. (available at www.foodnavigator-usa.com/R-D/Beans-peas-lentils-From-poor-man-s-meat-to-the-hottest-gluten-free-ingredients).
Weatherburm MW. 1967. Phenol-hypochlorite reaction for determination of ammonia. Analytical Chemistry 39: 971-974.
WFP. 2013. Agricultural Production & National Food Balance. (available at www.foodsecurityatlas.org/bgd/country/availability/agricultural-production).
Zashimuddin M. 2004. Community forestry for poverty reduction in Bangladesh. In: H.C. Sim, S. Appanah, W.M. Lu, eds. Can community forestry make money? Proceedings on of the regional workshop on forest for poverty reduction held Beijing, China. FAO, Bangkok, Thailand. (available at www.fao.org./docrep /007/ad511e/ad511e00.htm#Contents).

Table 1. Size of cropland agroforests in southwestern Bangladesh [after Hasanuzzaman et al. (2014a)]

Size of cropland agroforests	Area (ha)	Respondent (%)
Marginal	Below 0.12	15.00
Small	00.12-00.80	78.60
Medium	00.80-02.00	05.40
Large	Above 2.00	01.00

Table 2. Crop diversity indexes of agricultural crops in southwestern Bangladesh

Types of agricultural crops	Crop diversity index		
	Khulna	Satkhira	Jessore
Cash crops	0.64	0.57	0.67
Tuber vegetables	0.72	0.77	0.79
Annuals/perennials	0.49	0.69	0.69
Fruity vegetables	0.78	0.81	0.81
Climber vegetables	0.86	0.87	0.84
Cereal crops	0.20	0.33	0.40
Spices	0.75	0.80	0.81
Pulses	0.44	0.65	0.65
Leafy vegetables	0.74	0.74	0.72
Flowers	n/a	n/a	0.77

Table 3. Arable crops in southwestern Bangladesh

Types	Name of species	% respondent				χ^2 value (Significant level)
		Khulna	Satkhira	Jessore	Total*	
Cereal crops	Paddy (*Oryzae sativa*)	34.2	31.6	28.9	94.7	2.820 (0.245)
	Wheat (*Triticum aestivum*)	3.5	4.4	2.6	10.5	0.254 (0.881)
	Maize (*Zea mays*)	1.8	5.3	2.	9.6	1.440 (0.486)
Cash crops	Jute (*Corchorus capsularis*)	10.1	37.2	20.9	68.2	22.44 (0.000)
	Mustard (*Brassica campestris*)	13.7	21.9	15.1	50.7	0.502 (0.778)
	Sesame (*Sesamum indicum*)	11.5	12.2	12.2	35.8	0.448 (0.799)
	Sugarcane (*Saccharum officinarum*)	1.4	2.7	2.0	6.1	0.311 (0.856)
	Cotton (*Gossypium herbaceum*)	0.7	00	00	0.7	2.300 (0.316)

*Results are multiple responses from the respondents

Table 4. Vegetables in southwestern Bangladesh

Types	Name of species	% respondent				χ^2 value (Significant level)
		Khulna	Satkhira	Jessore	Total*	
Tuber vegetables	Potato (*Solanum tuberosum*)	11.4	19.7	12.9	43.9	1.46 (0.481)
	Arum (*Colocasia esculenta*)	8.3	16.7	8.3	33.3	3.13 (0.209)
	Elephant foot yam (*Alocasia indica*)	4.5	4.5	7.6	16.7	2.22 (0.329)
	Mud potato (*Amorphophallus campanulatus*)	4.5	3.8	1.5	9.8	2.25 (0.325)
	Carrot (*Dioscorea alata*)	1.5	4.5	3.8	9.8	1.44 (0.487)
	Radish (*Daucus carota*)	1.5	3.0	6.1	10.6	4.61 (0.100)
	Turnip (*Raphanus sativus*)	0.8	3.0	1.5	5.3	1.32 (0.517)
Fruit vegetables	Brinjal (*Solanum melongena*)	13.4	16.0	12.6	42.0	0.10 (0.950)
	Cabbage (*Brassica capitata*)	11.8	12.6	12.6	37.0	0.34 (0.843)
	Cauliflower (*Brassica botrytis*)	12.6	10.9	13.4	37.0	1.57 (0.457)
	Lady's finger (*Abelmoschus esculentus*)	4.2	7.6	5.9	17.6	0.48 (0.788)
	Tomato (*Lycopersicon esculentum*)	5.9	5.9	6.7	18.5	0.42 (0.809)
	Kohlrabi (*Brassica gongyloides*)	1.7	5.0	6.7	13.4	3.57 (0.168)
Leafy vegetables	Basil (*Basella alba*)	10.8	12.3	15.4	38.5	0.91 (0.634)
	Red leafy (*Amaranthus tricolor*)	9.2	16.9	10.8	36.9	0.71 (0.700)
	Amaranph (*Amaranthus lividus*)	10.8	13.8	12.3	36.9	0.04 (0.981)
	Spinach (*Spinacea oleraceae*)	4.6	10.8	7.7	23.1	0.88 (0.644)
Climber vegetables	Bean (*Lablab niger*)	10.2	14.4	11.9	36.4	0.14 (0.932)
	Parble (*Trichosanthes dioica*)	6.8	9.3	8.5	24.6	0.16 (0.922)
	Bottle gourd (*Lagenaria siceraria*)	9.3	11.0	13.6	33.9	1.51 (0.471)
	Pumpkin (*Cucurbita maxima*)	8.5	7.6	11.0	27.1	1.84 (0.399)
	Balsam apple (*Momordica charantia*)	2.5	7.6	3.4	13.6	2.46 (0.293)
	Ridge gourd (*Luffa cylindrica*)	3.4	2.5	2.5	8.5	0.50 (0.779)
	Cucumber (*Cucumis sativus*)	1.7	5.1	1.7	8.5	2.12 (0.347)
	Green cucumber (*Benincasa hispida*)	1.7	2.5	2.5	6.8	0.17 (0.920)
	Sweet bitter gourd (*Momordica cochinchinensis*)	0.8	2.5	2.5	5.9	0.94 (0.626)
	Asparagus bean (*Vigna unguicalata*)	2.5	2.5	0.8	5.9	1.09 (0.579)
	Snake gourd (*Trichosanthes anguina*)	3.4	1.7	0.8	5.9	2.54 (0.281)

*Results are multiple responses from the respondents

Table 5. Pulses, Spices, Flowers and other crops in southwestern Bangladesh

Types	Name of species	% respondent				χ^2 value (Significant level)
		Khulna	Satkhira	Jessore	Total*	
Pulses	Lentil (*Lens culinaris*)	13.7	21.9	16.4	52.1	0.420 (0.810)
	Bean(mug) (*Vigna radiata*)	8.2	9.6	15.1	32.9	2.440 (0.2950)
	Green pea (*Pisum sativum*)	2.7	4.1	1.4	8.2	0.680 (0.7110)
	Grass pea (*Lathyrus sativum*)	1.4	1.4	4.1	6.8	1.910 (0.3860)
Spices	Green peeper (*Capsicum frutescens*)	14.3	16.5	11.0	41.8	0.620 (0.733)
	Turmeric (*Curcuma longa*)	14.3	9.9	11.0	35.2	2.160 (0.340)
	Onion (*Alium cepa*)	5.5	9.9	7.7	23.1	0.480 (0.788)
	Garlic (*Allium sativum*)	4.4	6.6	5.5	16.5	0.100 (0.951)
	Aniseed (*Foeniculum vulgare*)	2.2	8.8	5.5	16.5	2.490 (0.288)
	Coriander (*Coriandrum sativum*)	2.2	2.2	1.1	5.5	0.380 (0.828)
	Ginger (*Zingiber officinale*)	2.2	2.2	1.1	5.5	0.380 (0.828)
Flowers	Rose (*Rosa centifolia*)	00	00	69.6	69.6	30.21 (0.000)
	Gladiolus (*Gladiolus spp.*)	00	00	21.7	21.7	5.730 (0.057)
	Marie gold (*Tagetes patula*)	00	00	17.4	17.4	12.09 (0.002)
	Gerbera (*Gerbera aurantiaca*)	00	00	8.7	8.7	3.990 (0.136)
	Tube rose (*Polianthes tuberosa*)	00	00	8.7	8.7	9.950 (0.007)
Annuals/ Perennials	Banana (*Musa spp.*)	20.0	24.2	21.7	65.8	0.100 (0.950)
	Papaya (*Carica papaya*)	13.3	10.0	10.8	34.2	2.120 (0.347)
	Bettle-leaf (*Piper betel*)	00	9.2	0.8	10.0	15.38 (0.000)
	Drum stick (*Moringa oleifera*)	2.5	2.5	4.2	9.2	1.070 (0.585)
	Napier grass (*Pennisetum purpureum*)	00	00	5.0	5.0	13.22 (0.001)
	Oil palm (*Elaeis guineensis*)	00	00	2.5	2.5	6.550 (0.038)

*Results are multiple responses from the respondents

Table 6. Physical properties and chemical indicators of soil in southwestern Bangladesh

Name of districts	Nitrogen concentration (µg/g)	Phosphorus concentration (µg/g)	Potassium concentration (µg/g)	Organic matter (%)	Bulk density (g/cm^3)	Conductivity (µS/cm)	P^H
Khulna	0.133	40.38	2.77	6	1.30	605.33	6.39-6.70
Satkhira	0.085	34.54	1.49	5	1.46	591.75	5.95-7.66
Jessore	0.172	25.46	1.21	4	1.52	516.67	6.88-7.62

Appendix 1. Significant test of tree-crop combinations in cropland agroforests of southwestern Bangladesh

Tree species	χ^2 value (Significant level)																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Mahogany	3.89	0.65	0.39	0.11	0.29	0.43	6.24	0.29	2.87	1.07	0.10	0.28	3.85	4.82	1.11	0.15	2.83	0.70	0.27	2.46	1.20	2.27	0.58	0.01	0.001
	(0.05)	(0.42)	(0.53)	(0.74)	(0.59)	(0.51)	(0.01)	(0.59)	(0.09)	(0.30)	(0.76)	(0.60)	(0.05)	(0.03)	(0.29)	(0.70)	(0.09)	(0.40)	(0.61)	(0.12)	(0.27)	(0.13)	(0.45)	(0.93)	(0.98)
Lombu	1.85	0.67	3.02	0.78	1.67	0.41	0.85	0.86	0.10	0.77	2.93	0.07	0.65	0.18	0.02	0.29	0.55	0.50	1.21	0.85	0.55	0.29	0.05	0.47	0.38
	(0.17)	(0.41)	(0.08)	(0.38)	(0.20)	(0.52)	(0.36)	(0.37)	(0.76)	(0.38)	(0.09)	(0.79)	(0.42)	(0.67)	(0.88)	(0.59)	(0.46)	(0.48)	(0.27)	(0.36)	(0.46)	(0.59)	(0.83)	(0.49)	(0.54)
Neem	2.51	0.94	2.15	0.18	0.003	0.38	0.003	0.003	0.10	1.79	0.33	0.38	3.47	0.54	1.69	0.30	1.28	1.20	0.18	0.003	1.28	0.03	3.55	1.93	0.63
	(0.11)	(0.33)	(0.14)	(0.67)	(0.95)	(0.54)	(0.95)	(0.96)	(0.77)	(0.18)	(0.57)	(0.54)	(0.06)	(0.46)	(0.19)	(0.58)	(0.26)	(0.27)	(0.67)	(0.96)	(0.26)	(0.87)	(0.06)	(0.17)	(0.43)
Ghora neem	1.03	0.63	0.43	1.06	0.46	1.47	2.58	0.71	1.02	0.96	1.31	1.37	0.53	0.31	0.67	0.22	2.18	0.40	1.13	0.79	2.18	0.22	15.09	0.001	1.18
	(0.31)	(0.43)	(0.51)	(0.30)	(0.50)	(0.23)	(0.11)	(0.40)	(0.31)	(0.33)	(0.25)	(0.24)	(0.47)	(0.58)	(0.42)	(0.64)	(0.14)	(0.53)	(0.29)	(0.37)	(0.14)	(0.64)	(0.00)	(0.98)	(0.28)
Akashmoni	0.47	0.20	2.42	1.04	0.15	0.01	0.83	0.83	0.97	0.38	1.09	0.44	0.74	0.52	0.81	0.58	0.29	0.68	0.37	0.26	0.70	4.91	2.32	0.77	0.07
	(0.49)	(0.65)	(0.12)	(0.31)	(0.70)	(0.93)	(0.36)	(0.36)	(0.33)	(0.54)	(0.30)	(0.51)	(0.39)	(0.47)	(0.37)	(0.45)	(0.59)	(0.41)	(0.55)	(0.61)	(0.40)	(0.03)	(0.13)	(0.38)	(0.79)
Sissoo	0.21	0.08	0.96	0.41	0.33	0.46	2.15	2.15	0.38	0.15	0.17	0.18	0.30	0.21	0.32	0.23	2.71	2.82	0.15	0.10	0.28	0.23	0.11	0.30	0.68
	(0.64)	(0.78)	(0.33)	(0.52)	(0.57)	(0.50)	(0.14)	(0.15)	(0.54)	(0.67)	(0.68)	(0.68)	(0.59)	(0.65)	(0.57)	(0.63)	(0.10)	(0.09)	(0.70)	(0.75)	(0.60)	(0.63)	(0.74)	(0.58)	(0.41)
Mango	0.18	0.98	5.04	2.91	1.78	8.19	0.45	0.44	5.91	4.17	4.24	0.08	1.51	0.007	6.19	0.39	2.35	0.37	0.27	0.19	2.35	1.02	7.47	0.55	0.86
	(0.67)	(0.32)	(0.03)	(0.09)	(0.18)	(0.01)	(0.50)	(0.51)	(0.02)	(0.04)	(0.04)	(0.78)	(0.22)	(0.93)	(0.01)	(0.53)	(0.13)	(0.54)	(0.60)	(0.66)	(0.13)	(0.31)	(0.01)	(0.46)	(0.36)
Plum	0.46	0.64	5.90	0.14	0.12	0.13	1.65	0.04	0.24	0.37	1.33	1.06	1.34	1.49	0.92	0.27	6.02	6.46	0.004	0.20	9.20	0.27	0.25	0.001	0.63
	(0.50)	(0.42)	(0.02)	(0.71)	(0.73)	(0.72)	(0.20)	(0.85)	(0.62)	(0.54)	(0.25)	(0.30)	(0.25)	(0.22)	(0.54)	(0.60)	(0.01)	(0.01)	(0.95)	(0.67)	(0.01)	(0.60)	(0.62)	(0.97)	(0.43)
Litchi	0.02	1.04	0.11	1.20	2.58	1.95	0.71	0.71	0.009	1.19	0.86	2.26	3.81	0.32	5.22	0.15	1.84	0.01	0.27	1.31	4.03	6.18	1.40	0.29	2.24
	(0.90)	(0.31)	(0.74)	(0.27)	(0.11)	(0.16)	(0.40)	(0.41)	(0.92)	(0.28)	(0.35)	(0.13)	(0.05)	(0.57)	(0.02)	(0.70)	(0.18)	(0.92)	(0.60)	(0.25)	(0.05)	(0.01)	(0.24)	(0.59)	(0.14)
Coconut	6.46	0.01	0.39	0.36	0.04	0.98	1.73	0.31	1.19	0.14	0.39	0.23	1.84	0.88	0.07	0.53	0.20	0.13	0.00	2.22	1.38	0.53	2.90	12.97	2.39
	(0.01)	(0.93)	(0.53)	(0.55)	(0.84)	(0.32)	(0.19)	(0.58)	(0.28)	(0.71)	(0.53)	(0.63)	(0.18)	(0.35)	(0.79)	(0.47)	(0.65)	(0.72)	(0.99)	(0.14)	(0.24)	(0.47)	(0.09)	(0.00)	(0.12)
Date	0.02	0.04	12.18	0.14	0.16	2.09	1.37	0.62	6.02	2.49	1.68	0.11	0.14	2.54	0.09	0.31	0.33	0.03	2.22	0.79	1.17	3.6	0.99	0.46	0.92
	(0.89)	(0.85)	(0.00)	(0.71)	(0.69)	(0.15)	(0.24)	(0.43)	(0.01)	(0.11)	(0.20)	(0.74)	(0.71)	(0.11)	(0.77)	(0.58)	(0.58)	(0.87)	(0.14)	(0.38)	(0.28)	(0.06)	(0.32)	(0.50)	(0.34)
Jackfruit	0.00	1.27	0.02	2.29	0.27	0.48	0.27	2.69	3.21	0.001	1.69	0.90	0.03	0.21	1.26	1.72	0.10	0.07	2.30	1.61	2.19	3.81	0.18	0.01	2.73
	(0.99)	(0.26)	(0.88)	(0.13)	(0.61)	(0.49)	(0.61)	(0.10)	(0.07)	(0.98)	(0.19)	(0.34)	(0.86)	(0.64)	(0.26)	(0.19)	(0.76)	(0.80)	(0.13)	(0.21)	(0.14)	(0.05)	(0.67)	(0.91)	(0.10)
Palm	2.03	1.52	5.49	0.72	0.01	0.37	0.17	0.01	0.61	2.88	0.90	0.23	3.31	5.82	0.13	2.20	0.39	0.33	2.74	1.92	3.03	0.78	2.06	1.88	3.41
	(0.15)	(0.22)	(0.02)	(0.40)	(0.91)	(0.54)	(0.68)	(0.91)	(0.44)	(0.09)	(0.34)	(0.63)	(0.07)	(0.02)	(0.72)	(0.14)	(0.53)	(0.57)	(0.10)	(0.17)	(0.08)	(0.38)	(0.15)	(0.17)	(0.07)
Lemon	1.76	0.00	1.39	0.58	1.24	0.35	0.34	0.39	0.54	1.77	1.04	1.08	0.17	1.27	0.09	0.05	0.17	0.28	0.90	0.63	0.17	0.05	0.67	1.55	1.79
	(0.19)	(0.00)	(0.24)	(0.45)	(0.27)	(0.56)	(0.57)	(0.56)	(0.46)	(0.18)	(0.31)	(0.30)	(0.68)	(0.26)	(0.76)	(0.83)	(0.68)	(0.60)	(0.34)	(0.43)	(0.68)	(0.83)	(0.41)	(0.21)	(0.18)
Bettle-nut	0.13	0.53	0.01	0.07	0.38	0.27	0.38	0.001	1.03	1.70	0.11	0.32	1.30	0.54	0.34	0.73	0.10	1.13	1.62	1.13	1.15	2.56	1.21	3.39	0.13
	(0.72)	(0.82)	(0.91)	(0.79)	(0.54)	(0.60)	(0.54)	(0.98)	(0.31)	(0.19)	(0.74)	(0.57)	(0.26)	(0.46)	(0.56)	(0.39)	(0.76)	(0.29)	(0.20)	(0.29)	(0.28)	(0.11)	(0.27)	(0.07)	(0.72)
Shirish	0.64	0.05	0.86	0.08	0.65	0.86	0.07	0.07	0.21	0.03	0.10	0.09	1.36	0.39	1.69	1.96	4.93	1.06	2.56	1.79	0.004	0.03	8.12	1.47	0.21
	(0.42)	(0.83)	(0.35)	(0.77)	(0.42)	(0.35)	(0.79)	(0.78)	(0.65)	(0.86)	(0.75)	(0.76)	(0.24)	(0.54)	(0.19)	(0.16)	(0.03)	(0.30)	(0.11)	(0.18)	(0.95)	(0.87)	(0.01)	(0.23)	(0.64)
Eucalyptus	1.60	0.12	0.002	0.58	6.94	0.44	0.50	0.50	0.58	0.23	2.82	0.26	0.44	2.09	0.48	0.35	0.42	1.35	0.22	0.15	0.42	1.76	0.16	0.46	0.11
	(0.21)	(0.73)	(0.97)	(0.45)	(0.01)	(0.51)	(0.49)	(0.48)	(0.45)	(0.63)	(0.09)	(0.61)	(0.51)	(0.15)	(0.49)	(0.56)	(0.52)	(0.25)	(0.64)	(0.70)	(0.52)	(0.18)	(0.67)	(0.50)	(0.75)

Note: 1=paddy, 2=wheat, 3=jute, 4=sesame, 5=arum, 6=potato, 7=cauliflower, 8=cabbage, 9=brinjal, 10=tomato, 11=Red leafy , 12=Basil , 13=Bottle gourd , 14=Parble , 15=Bean , 16=Pumpkin , 17=Lentil , 18=Mustard , 19=Onion , 20=Garlic , 21=Green peeper , 22=Turmeric, 23=Rose , 24=Papaya, 25=Banana.