HOMESTEAD TREE SPECIES DIVERSITY AND IT'S IMPACT ON SOCIOECONOMIC CONDITION OF FARMERS IN CHANDPUR DISTRICT OF BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled **'HOMESTEAD TREE SPECIES DIVERSITY AND IT'S IMPACT ON SOCIOECONOMIC CONDITION OF FARMERS IN CHANDPUR DISTRICT OF BANGLADESH'** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science(MS) in Agroforestry and Environmental Science**, embodies the result of a piece of *bonafide* research work carried out by **Tuton Kumar Saha**, Registration number: **10-03961** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated: June, 2016
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Dedicated to

Who inspired and helped me to complete this paper & also who didn't help me because of their denied mode I have learned something new.

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The Author

ABSTRACT

Trees on homestead play a vital role in providing diverse goods and services. The purpose of this study was to assess the effects of tree diversity on different socioeconomic factors in homesteads in the study area. The study area covered four villages of two upazilas of Chandpur district, Bangladesh. Assessment was done by approach of random sampling. Information concentrated from an accumulation of 63 households ranging from marginal, small, medium and large categories. A total of 2604 trees representing 23 families were identified. Fuel wood (26.67%), fruit (23.81%) and timber (22.86%) species were the important plant use categories. Determination of the relative abudance of the divergent species revealed that *Artocarpus heterophyllus* constitutes 27.8% of homestead agroforestry followed by *Mangifera indica*, which occupies 16.59%. Shannon Wiener index (H) was used to evaluate the tree diversity and evaluation showed that tree species diversity of the area was 2.58 and species evenness index (E) was 1.62. According to the of plants catagorization, Shannon Wiener index (H) varies from 1.38 to 2.60. Tree species diversity was positively influenced by occupation, livlihood condition, farm size, homestead size, education and annual income, but negatively influenced by gender, age and family size. Results of this study can contribute to modify agroforestry programs for implementing future tree planting activities for different target populations in various economic and environmental circumstances.

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LIST OF ABBREVIATIONS

AEZ	:	**Agro-Ecological Zone**
ADB	**:**	Asian Development Bank
BAU	**:**	Bangladesh Agricultural University
BBS	**:**	Bangladesh Bureau of Statistics
DF	**:**	Forest Department
et al.	**:**	et alii (and others)
FAO	**:**	Food and Agriculture Organization Of the United Nations
GDP	:	Gross Development Product
Ha	:	Hectare
Kg	**:**	Kilogram
MPTs	**:**	Multipurpose Tree Species
Tk.	**:**	Taka
US$	**:**	United States Dollar

CHAPTER I

INTRODUCTION

The homestead has been described as an important social and economic unit of rural households, from which a diverse and stable supply of economic products and benefits are derived (Shackleton *et al.,* 2008). Continued cultivation and use of homegardens over the past millennium has played a key role in successful achievement of sustainable livelihoods and self-sufficiency (Maroyi, 2009). There are about 25.49 million of homesteads in our country covers about 0.80 million ha of lands (BBS, 2011). From the conservation point of view, homesteads are the *in situ* conservation sites of wide range of plant biodiversity (Mannan, 2000). In Bangladesh, homegarden represent a well-established land use system where natural forest cover less than 10% homestead garden which are maintained by at least 20 million household and represent one possible strategy for conservation of biodiversity (Kabir, 2008). On the other hand, state forest of Bangladesh covers 2.52 million ha of lands, representing 17% of the countries land area and supplying only 12% wood (Poffenberger, 2000).

In the last few decades increased human population has resulted directly and indirectly in depletion of the natural vegetation which in turn increases the pressure on the homestead forest especially in the developing countries (Alam and Masum, 2005). Record of 70% of timber, 90% of fuel wood, 48% sawn and veneer logs and almost 90% of bamboo requirement is available from homegardens of Bangladesh (Uddin *et al.,* 2002). The homesteads grow trees and other crops under an intensive and efficient system of agroforestry, through the traditional knowledge, combining multipurpose trees, food and forage plants, bamboo, palms, medicinal plants, and spices, which shows a productivity level 15 to 25 times greater than governmental forest lands in Bangladesh (ADB, 1993).

The homesteads of Bangladesh are a source of livelihood for many farmers and serve as safety net during the time of hardship and natural disaster. Farmers want to use his farm area for maximum production. But, there is no program to improve the overall productivity of homestead forests, nor to produce yield-increasing technology. Systematic research in these fields is a pressing need, as these would enable us to evaluate the role of this system with other modern production systems and to assess the sustainability of the system. Further study regarding homestead tree composition in the specific area of Bangladesh is necessary, which can be an important tool in sustainable homestead forestry (Millat-e-Mustafa *et al.,* 2000). Most of the previous studies provide information on homestead tree species resources only. Very few studies was found to investigate the tree resources in the district as a whole considering all factors which can lead the realistic figure on the tree species composition and structure. Thus, the present study aims at to identify the tree species diversity in the homesteads and influence of tree species diversity on socioeconomic condition of farmers around the four villages of two upazilas of Chandpur district which situated at eastern part of Bangladesh. More specifically, the study was conducted with the following objectives:

i) To assess demographic and socioeconomic characteristics of the farmers in Chandpur district;

ii) To assess the tree species diversity existed; and

iii) To find out the relationships between tree species diversity and socioeconomic condition of farmers.

CHAPTER II
REVIEW OF LITERATURE

2.1. The concept and definition of agroforestry

Nair (1993) stated that agro-forestry is a new name for a set of old practices.

Sen *et al.* (2004) stated that farmers have nurtured trees on their farm, pasture lands and around their homes. Therefore, neither the concept nor the practice of agroforestry is new.

Bandyopadhyay (2001) stated that agroforestry may be a traditional and/or introduced and can be defined as; a symbiosis of tree growing, crop production and livestock raising where each component is beneficial to each other.

World Agroforestry Center (2003) stated that it is also defined as; a dynamic, ecological based, natural resource management system through integration of trees on farms and agricultural landscapes that diversifies and sustains production for the purpose of increasing social, economic, and environmental benefits for land users at all levels.

Mesele Negash (2002) stated that these definitions imply that in agroforestry system: 1) there are two or more species of plants (and/or animals) at least one of which is woody perennial; 2) there should be biological and economical interaction with in the components; 3) the cycle of an agroforestry system is always more than one year.

2.2 Agroforestry systems and practices

Nair (1993) stated that the word “systems” and “practices” are often used synonymously in agroforestry literature. However, some distinction can be made between these two concepts. An agroforestry system consists of one or more agroforestry practices that are practiced extensively in a given locality or area; the system is usually described according to its biological composition and arrangement, level of technical management or socio- economic features.

Bene *et al.* (1977) stated that agroforestry is a sustainable management system for land that increases overall production, combines agricultural crops, tree crops and forest plants and/or animal simultaneously or sequentially and applies management practices that are compatible with the cultural patterns of a local population.

Gholz (1987) observed that an agro forestry practice denotes a specific land management operation on a farm or other management unit, and consists of arrangements of agro forestry components in space and/ or time. All agroforestry systems consist of at least two of the three major groups of agro-forestry components; trees (including shrubs), agricultural crops, and pasture/livestock, trees being present in all agro forestry system. Occasionally there may be other components also, such as fish, honey bees, etc. Depending on the nature and type of components involved, agro forestry system can be classified as agrisilvicultural (tree + crops), silvopastural (tree + pasture and /or livestock) and agrosilvopastural (all three types of components).

2.3 Traditional Agroforestry

Das and Das (2005) stated that homegardens are traditional agroforestry system with complex structure and multiple functions and the homegardens are the sites of conservation of a large diversity of plant both wild and domesticated, because of their uses to the households.

Leakey (1996) reported that agroforestry has been promoted as a sustainable and ecologically sound alternative approach to managing upland landscapes. It involves the integration of annual and perennial food crops as well as livestock, which renders social, economic and environmental benefits.

Grado and Husak (2004) observed that a number of studies have been undertaken to determine the financial viability of agroforestry systems. Many of these studies have sought to examine the financial costs of establishing, managing and producing various combinations of agricultural and timber crops as well as the potential gross revenues and profitability.

Franzel (2004) observed that analyzing the economics of agroforestry practices is more complicated than of annual crops because of the complexity of agroforestry systems and the time lag between tree establishment and harvest.

2.4 Importance of homestead agroforestry

Ahmed (1997) reported 31 minor fruits in the homesteads of Bangladesh. The minor fruits account for as many as two-thirds of the total number of fruits found to grow in homesteads.

Haque (1996) observed that to get fruits, fuel wood and timber as well as to bring back equilibrium in the ecosystem local/common fruit trees along with selected multipurpose trees (MPTs) in and around the homesteads should be grown. Moreover, vegetables, spices and ornamental herbs or shrubs etc. could be obtained from homegardens. Through practicing homestead agroforestry, the requirements of fruits, vegetables, forage, spices and fuel wood and timber could be fulfilled to a great extent by following the principles of agroforestry.

Abedin and Quddus (1990) reported that profitable introduction of swift growing exotic tree species and the increasing awareness of the multipurpose use of indigenous tree species, the strength of agroforestry for environmental emendation and in sustaining increasing yield of food and forest produced in the savanna region needs to be exploited.

Linda (1990) mentioned that the high diversity of plant species in village homegardens ensure continuous production of fruits and vegetables, fuel woods, timbers medicinal and cash crops.

Lai (1988) reported that application of appropriate technology in relation to production and management of trees and crops in the homesteads, better utilization of land can be achieved with the creation of better living environment there.

Okafor and Fernandes (1987) mentioned that homesteads provides numerous advantages including diversified production, risk minimizations, enhanced losses due to poor storage facilities, better nutrient cycling and nutrient use efficiency that mono-cropping systems and good conservation due to continuous ground cover.

Byron (1984) estimated that 30,400 hectare of homestead in Bangladesh provided 70 % of fuel wood and 90 % bamboo per year. Further, he showed that the annual harvest from the village was estimated to be 8.9 % of the standing volume and this was double the rate that the forests could sustain.

Doglas (1983) estimated that homestead forests provided about 85% of the all wood consumed, including nearly 90 % of all fuel wood and 80% of all timbers.

Michon *et al.* (1983) pointed that the ecological value that they represent in terms of genetic diversity and preservation of species in areas where original forest resource have been largely depleted.

Doglas and Hart (1973) mentioned that trees are integral part of homegarden as well as nature. Trees provide direct and also indirect benefits to human being and to be nature. It has the great potential for feeding men and animals, regenerating soil, restoring water systems, controlling floods and droughts, creating more benevolent micro-climates and more comfortable living conditions for humanity.

2.5 Area and land use of homestead agroforestry

Haque (1996) reported that the area of the homesteads in Bangladesh varies from 0.1 to 1.0 ha depending on the locality and the financial condition of the house owner. He stated that housing occupies about 10-25 % in urban areas. The remaining space is used for production of trees and vegetables following the principles of agroforestry.

Abedin and Quddus (1990) conducted a study at six agro-ecologically different locations of Bangladesh and reported that the small homestead, owned by the marginal and small farmers, have 20-21 % area under housing, 29-37 % under tree coverage and 9-14 % under vegetable cultivation. In bigger homesteads owned by big farmers, about 16 % land is under housing and 33 % under tree coverage and 12 % under vegetable cultivations.

Miah *et al.* (1990) reported that Ishurdi in Pabna district revealed that the average size of homesteads was very small, varying from 0.06 to 0.40 ha. They also found a positive correlation between size of farm and that of the homestead.

Chowdhury (1988) reported that a study at Pabna district and estimated that the number of plant per unit of homestead gradually decreased from 8 plants 10m-2 to 3 plants 10m-2 in the marginal farms. He observed that 77 % marginal, 25 % small and 42 % larger farmers felt trees cash in crisis period. Further, he found that 89 % farmer did not get any formal advice on planting and managing trees.

Hocking (1986) reported that some 15 million households of the country occupy about 0.3 million hectare under traditional agroforestry practice in homestead.

2.6 Species composition of homestead agroforestry

Egawa *et al.* (2004) reported that in West Java, Indonneisa to study the traditional culture methods adopted by farmers/villagers and the use of crops including legumes, vegetables and fruit trees. Farmers have cultivated based on their traditional methods called Pekarabgan (home garden), various kinds of fruit trees, medicinal trees, food crops and vegetables around their houses for their own home consumption and for cash income. In the highlands, modern varieties of the temperate vegetables including Irish potato, Chinese cabbage, cabbage, carrot and tomato were being cultivated, while indigenous crops were being well-preserved in home gardens. Medicinal plants cultivated in home gardens were turmeric, ginger and/or lemon.

Das and Oli (2001) observed that *Dalbergia sissoo* was the most preferred tree species by farmers followed by Bokain (*Melia azedarach*), Kadam (*Anthocephullus cadamba*) and *Populus spp.*, Bamboo (*Bambuse spp.*) plantation were also considered as suitable species for growing on farmland.

Alison (1994) mentioned that species density (number of species per hectare) was declining with increasing garden size.

Lawrence and Hardostry (1992) and Farnandes and Nair (1986) stated that the magnitude and rate of output of products as well as cash and rhythm of maintenance of the homegarden system depends on species composition. The choice of species was determined to a larger extent by environmental and socio-economic factors as well as dietary habits and local markets demands.

Abedin and Quddus (1990) reported that the recorded 28 different tree species in the homestead of the Barind Treat in Rajshahi district. *Mangifera indica* and *Phoenix sylvestris* were the most dominant species, whereas *Artocarpus heterophyllus* was only of minor occurrence. They also mentioned that the average tree density was higher in Potuakhali and Rangpur (1.5 and 1.4 trees $10m^{-2}$, respectively) than in Rajshahi (0.7) where the annual rainfall is the lowest in Bangladesh.

Maih *et al.* (1990) found that farmers generally prefer fruit trees over fuel or timber species in their homestead agroforestry.

Dasgupta *et al.* (1988) showed that farmers grew lemon, guava, jujube, papaya, amaranth, bitter gourd and eggplant in homestead. Coconut, date palm, betel nut and lemon were also grown. Vegetables grown in the homestead varied according to farm categories and homestead sizes. Large farmers grow a wide range of fruits and vegetables. Farmers were not interested in replacing perennial trees. The potential of the homestead was great which could be improved by replacing in the less productive trees/shrubs with fast-growing nitrogen-fixing species to provide more fuel, fodder and green manure.

Halim and Islam (1998) reported that the crucial role played rural women in homestead agricultural production and studies the constraints that impeded its proper development. They suggested some specific measures to overcome these constraints.

Khan *et al.* (1988) studied that vegetables grown in the homestead area are mostly creeper or climbing types. The climbing upon bamboo made platform, roof of the houses, perennial plant species, detached branch of the tree and fencing of the homestead etc. The perennial plant species were classified on the basis of growing i.e.; spontaneous and purposefully grown. They spontaneous grown speices provide mostly fire wood.

Kowero and Temu (1985) found that in a study in West Java homegardens in the citarum watershed an excess of 500 species in 350 gardens with Shannon diversity indices of greater than 2.7. In other areas of west central Java, high species counts and species diversity was also the normal. Again, the diversity indices were higher (3.71) in Sundanese than in Javanese (2.79) homegarden.

2.7 Structure of the homestead agroforestry

Millat-e-Mustafa (1997) stated that the homegardens displayed a broadly consistent vertical structure throughout the country and many important species are typical in all the regions. The homegardens have a multistoried canopy configuration.

Haque (1994) showed that trees of the homesteads can be given suitable structure of the canopy as desired by the house-owners under which vegetables, spices and some ornamental herbs and shrubs can be raised.

Perare and Rajapakse (1989) stated that four canopy layers can be distinguished. The tallest being over 10 m of those studies, third layer 2.5-10 m, second layer 1.0-2.5 m and first layer is less than 1.0 m in Kandyan homestead. In addition, over 70% of the Kandyan homesteads in Srilanka had 50 % or more canopy cover.

Fernandes and Nair (1986) mentioned that homesteads are characterized by high species diversity and by usually three to four vertical canopy configuration and compatible species admixture are the most conspicuous characteristics of all homesteads. Contrary to the apparent appearance of random arrangement of species the gardens are carefully stroked system with every component having a specific place and function.

Richard (1979) mentioned that the homestead agroforestry has often been compared to a natural forest ecosystem in structure and function. The stratified nature of the forest is due to the high species diversity and as the forest continuously grown and regenerates and all the species pass through all the growth stages before altering the nature form, the stratification may often become discontinuous.

2.8 Socioeconomic uses of homestead trees

Tesfaye Abebe (2005) observed that farm trees of diverse tree species serve different socio- economic and ecological functions. Farmers have historically protected, planted and managed trees on their land in order to maintain supplies of sought-after products no longer readily available from the natural forest which is cleared, degraded or is no longer accessible. Many species of trees in the tropics are used for fodder, either for browse or stall feeding.

Wickens *et al.* (1985) estimate that 75% of the tree species (7,000-10,000) of tropical Africa are used as browse. Fodder trees contribute in several ways to the overall food security of households: they make a significant contribution to domestic livestock production which in turn influences milk and meat supply; in addition, fodder contributes to maintaining draught animals and producing manure for organic fertilizer, there by supporting agricultural production.

Pearson and Stevens (1989) opined that the energy problem as a choice between energy shortage, with their attendant loss of production or comfort and the sacrifices to be made elsewhere to overcome the energy shortage and it is the increased harshness of the consequences of the choices which create the crisis dimension of the duel wood problem.

Aearwal (2001) pointed out that the crisis of fuel wood relates to its country specificity, zone specificity and its rural-urban implications. Wood provides less than 1 % of the energy in most developed countries as compared to more than 90 % in the majority of the developing countries. From this statement, it is clear that the crisis of fuel wood is in the developing world.

Haq (1986) reported that the price of fuel wood has increased 10-15 times during the last 15 years because of increasing fuel wood shortage. In Bangladesh, the supply of forest products is decreasing while the demand is increasing over time, it is true, because the population is increasing and forest area is rather decreasing due to population pressure. There is no price regulation for the fuel wood.

2.9 Income from homestead production

Awal *et al.* (2002) observed that homestead fruit and vegetable practices earned substantial income for all categories of farmers. The women were involved in the household decision making process to a greater extent. The evidence was more spectacular in aspects like family planning, education of children, poultry rearing plantation of fruits and vegetables and marriages of son and daughters.

Strizaker *et al.* (2002) predicted that the success of a tree or crop mixture become less likely with declining crop season rainfall and increasing seasonal variability and likely when the tree products have a direct economic benefit.

Rahman (1995) showed the consequences of homestead crop production under homestead agroforestry (HAF) practices on the family income and women's status. The data form HAF practicing households revealed that these farms earned substantial income and production gains. The women of the households gamed of higher social status. The gender status in particular improved significantly on these households as evidenced by the increased participation of HAF practicing women in decisions marking on crucial socio-economic matters in the households.

Halim and Hossain (1994) reported the vegetable raising did not generate any significant income within homestead because the space for vegetable production was very limited and most of the homestead areas were shaded by the tree.

2.10 Management of homestead agroforestry

Sultana (2003) stated that homestead vegetables and fruits from on internal part of the family diet and a part of them, enter the commercial market. Although every member of the family has some contribution, the major labor input was seed preservation, land preparation, transplanting, watering and harvesting are done by women. Men usually help in fertilizer and pesticide application.

Sudmeye *et al.* (2004) found that subsequent root pruning of the eucalyptus did not improve crop yield. The root pruning lateral pine roots, tree growth was not significantly reduced. The principal cause of reduced crop yield near the trees appeared to be reduced soil moisture in the area occupied by tree roots.

Millat-e-Mustafa (1997) observed that women and older members of the family were involved in sowing, maintenance of vegetable garden, harvesting and other less laborious jobs.

Hossain and Bari (1996) reported that generally wives (39.8%) were more involved than husbands (34.8%) in the application of manure and fertilizers to homestead vegetable gardens. However, this pattern was prominent amongst fertility management than wives on small, medium and large farms.

Fokhrul and Fazlul (1994) studied that Bangladesh rural women play a significant role in homestead farming particularly at the production phase and in decision making. Their specific roles vary widely depending upon the ecological, socio-economic and religious factors. Women who possess different physiques and energy capabilities in comparatives in comparison to men have also wider range of daily activities than men do in homestead agricultural production systems. Women are more involved in poultry rising and pre and post-harvest activities of different homestead varied with subsystems requiring different amount of energy and depending on farm category.

Chowdhury and Satter (1993) found that the male heads of the families took most of the decisions by themselves. However in general, they consulted their wife and/or parents for selecting tree species, planting trees, harvesting products and felling trees. They also found that women in marginal and large farms were involve more than in the small and medium farms in decision making on management of trees and tree products.

Aireen (1992) revealed that homestead farming was generally carried out by women. On an average, women spent 30% of daytime in household activities and another 30% on homestead agricultural operations such as, land preparation, planting, seedling, weeding, irrigation and post-harvest activities.

Shalaby (1991) reported that in Egypt which revealed that women were engaged in gardening to supplement incomes and to provide food for the family. About 30 % of the farmers did not buy vegetables from the market and claimed to be totally self-sufficient in these products.

Halim and Islam (1998) reported the crucial role played by rural women in homestead agricultural production and studied the constraints that impeded its proper development. The paper suggested some specific measures to overcome these constraints.

Hossain *et al.* (1988a) concluded from a study that in Bangladesh women are mostly involved in the pre and post-harvest work of vegetable production while men play the key role in timber and fruit trees growing activities.

Hossain *et al.* (1988b) stated that participation of women in different activities of growing trees and vegetables in the homestead varied with the farm category. Wife, regardless of farm class, was more involved in vegetable production while husband played a dominant role in tree growing activities. Other family members like children and mother-in-law had recessive role in most of these actively of homestead plantation. The prevailing production system of homestead trees and crops primarily depended on indigenous technology.

Ahmad *et al.* (1980) found that most women spent 9.4% of their productive activities for working in the homegardens while spent only 2.3% productive activities in West Java.

Stoler (1978) reported that homestead cultivation occupies only 8 % of total working time of men and an insignificant amount of time for women.

2.11 Homestead tree species diversity and their role in biodiversity conservation

Vandermeer *et al.* (1998) reported that on many fronts throughout the word - in every biome at local, regional, national and global levels - biodiversity is declining and previously, efforts to preserve biodiversity have focused in natural ecosystems, despite the fact that these areas make up only about 5% of the terrestrial environment. In contrast, approximately 50% of worldwide land is currently under agricultural production and 20% is in commercial forestry.

Schelas and Greenberg (1996) stated that in the tropics, conservationists have focused their attention on the protection of natural forests and woodlands, and until recently have not given much attention to the widely dispersed farmland woody species. However, these patches are often critical components of a farmers' environment being a source of products and environmental services of importance to the farmers' livelihood and welfare.

Nikiema (2005) stated that it has been recognized that the part played by the woody species in these landscapes play an important role in maintaining biological diversity.

Sanchez *et al.* (1997) The integration of woody species into crop fields, has been proposed as one way of diversifying agro-ecosystems in a way that is beneficial to the environment and can maintain and perhaps enhance biodiversity. They could provide replenishment of soil fertility and could also provide marketable forest products.

Harvey and Haber (1999) revealed that remnant woody species in crop fields may play an important role in conserving biodiversity within agricultural systems because they provide habitats and resources that are otherwise absent from agricultural landscapes. They also serve as critical nesting, feeding, and roosting sites for a variety of bird and bat species. They also provide transient habitats for many migratory birds. The presence of woody species in crop fields also favors the survival of native forest plants.

Atta-Krah *et al.* (2004) stated that farm tree diversification provides biological assets for maximizing farm resources, thus lowering the cost of production. Farm trees, in the form of agroforestry, are uniquely suited to provide eco-agricultural solutions that successfully combine the objectives of increased food security and conservation gains, especially by promoting the greater use of native tree species.

2.12 Factors influencing homestead tree species diversity

Scherr (1995) stated that the number of tree species and number of individual trees on farms varies due to physical and socio-economic factors. The resources of the household, mainly land have an impact on tree species diversity. For instance, farmers with small land holding cannot have a large stock of trees since the available land is primarily used to produce crops for consumption. Large holders, on the other hand, could produce a large volume of wood.

Tesfaye Abebe (2005) showed that size of the farm (home-garden) affect tree species richness of farms.

CHAPTER III

MATERIALS AND METHODS

3.1 Description of the study area

3.1.1 Geographical location of the study area

The study was conducted in four villages under two upazilas in Chandpur district. The study area is located in the eastern part of Bangladesh. Chandpur district (Chittagong division) city stands on the bank of the Meghna river and located at 23°29′-23°40′ N 90°6’-90°9’ E. The total area of the district is 1,645.32 sq .km (635.00 sq.miles). It is bounded by munshiganj and comilla districts on the north, noakhali, lakshmipur and barisal districts on the south, Comilla district on the east, meghna river, shariatpur and Munshiganj districts on the west. River erosion is a common feature in this district. The Padma and the Meghna meet near Chandpur Town and take a vast expanse. Main tributaries of the Meghna are Dakatia, Dhanagada, Matlab and Udhamdi. Ghorgaon Jala is a beel. The district consists of 8 upazilas, 88 unions, 927 mauzas, 1230 villages, 7 paurashavas, 72 wards and 268 mahallas. The upazilas are Chandpur Sadar, Faridganj, Haimchar, Haziganj, Kachua, Matlab (Dakshin), Matlab (Uttor) and Shahrasti (Banglapedia, 2016). Chandpur Sadar and Kachua upazilas were under my study area. Stepwise locations of the study area were showed in the Figure 3.1.

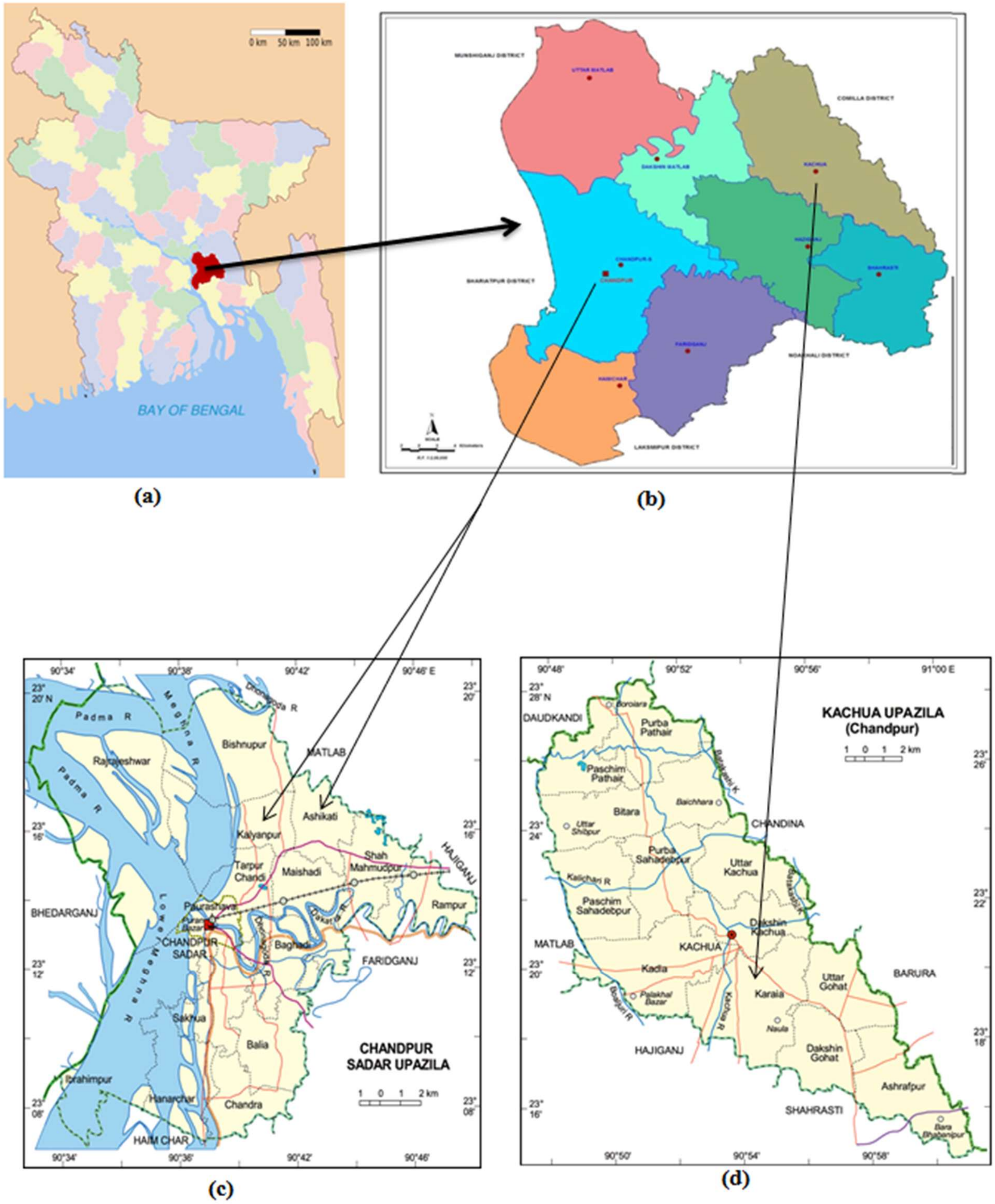


FIGURE 3.1 Stepwise locations of the study area where (a) Bangladesh (b) Chandpur district (c) Chanpur Sadar Upazila (d) Kachua Upazila (Source: http://www.thebangladesh.net)

3.1.2. Climate and agro-ecology

The Chandpur district belongs to the Agro-ecological Zone-16. It has complex relief pattern comprising broad and narrow flood plain ridges and linear depressions. Annual average temperature varies from maximum 34.3°C to minimum 12.7°C and annual rainfall is 2551 mm. Figure 3.2 indicated monthly rainfall (mm/d) of Chandpur district.

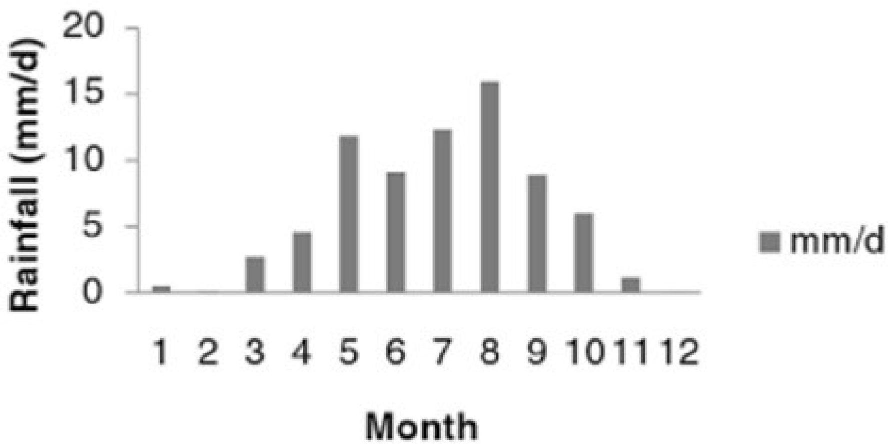


FIGURE 3.2 Mean daily rainfall histograms of Chandpur district in Bangladesh on a monthly basis (Source 203.208.166.84/mnislam/forecast-rf.htm)

3.1.3. Agriculture holding

An agriculture holding is a techno-economic unit of agricultural production under single management comprising all livestock kept and all land used wholly or partly for agricultural production purposes without regard to title, legal form or size. A holding may consist of one or more parcels (fragments of land) located in one or more areas or mauzas or in more than one administrative unit or division provided that all separate parcels of fragments form parts of same technical unit under operational control of same management (Table 3.1). The definition covers practically all holdings/households engaged in agricultural production of both crops and livestock. Some agriculture holdings may have no significant agricultural land, e.g. holdings keeping livestock, poultry and hatcheries for which land is not an indispensable input for production.

TABLE 3.1 Land area of Chandpur Sadar and Kachua upazila based on utilization.

Upazila	Total area (acre)	Permanent cropped area (acre)	Temporary cropped area (acre)	Permanent fallow area (acre)	Others (acre)
Chandpur Sadar	30526	3173	17291	0	10058
Kachua	40778	819	29424	0	10535

Source: Census of Agriculture 2008-Zila Series Chandpur

Area under temporary crops. It is the land area planted to crops having growing cycle or length of life less than one year. These are the temporary crops such as paddy, wheat, jute, cotton, tobacco, sugarcane, pulses, oil seeds, potato, vegetables and other seasonal crops. A list of temporary crops for which data were collected separately was given in back page of "Tally Sheet". The minimum area recorded for a temporary crop was 0.01 acre. Area under temporary crops and temporary-crops net area are equivalents.

TABLE 3.2 Land utilizations (temporary cropped area) of Chandpur Sadar and Kachua upazilas

Upazila	Current fallow (acre)	Temporary cropped area (ha)					Productivity of crop
		Single	Double	Triple	Net	Gross	
Chandpur Sadar	240	4816	60070	22998	17291	28608	49
Kachua	25	8000	45000	32880	29424	55277	48.27

Source: Census of Agriculture 2008-Zila Series Chandpur

3.1.4 Soil type

Meghna River Flood Plain occupies most of the land of the Chandpur district. Non-Calcareous Dark grey Floodplain soils are found in this district. The Characteristics of this soil are dark grey, finely mottled brown and brown soils with dark grey flood coatings, with seasonally acid top soils and near-neutral sub-soils. Mainly seasonally deeply flooded soils of the old Brahmaputra-Karatoya-Bangali (Part) and old Meghna estuarine. The soil of the district is mainly formed by olive grey silty loam and dark grey silty loam which is very rich and fertile in the southeast region. The brown silty clay of the recent piedmont aprons of hte Dakatia and Dhanagoda rivers is prevailing floodplains.

3.1.5. Vegetation

Chandpur is one of the coastal districts at the fringe Bengal with vast char land. the vast areas on both banks of the rivers of the district belong to the cultivators, continuously flooded almost every year and thus grow crops like paddy, jute, mustard seed, wheat, potato and sugarcane, pulses & oil seed. There is an organized forestry in the district. However the forest does not yield and revenue to the government. Almost every homestead area usually covered by wide variety of trees. A lush growth of variety of trees in homstead forest, embankments and the abandoned places are fruit bearing. The principal trees are Mango, jackfruit, banana, papaya, coconut, palm, guava, mahagony, rain tree, kul, supari and banyan tree.

3.1.6 Socioeconomic Situation

The economy of Chandpur is predominantly agricultural. Out of total 461,192 holdings of the district, 58.63% holdings are farms that produce varieties of crops namely local and HYV rice, wheat, vegetables, cash crops, spices, pulses and others. Fish of different varieties are abundant in this district. More varieties of fish are caught from river, channels and creeks and paddy fields during rainy season. Hilsha, a popular fish of the country, is abundantly available in the district. Catching fish is an important source of income to the fishermen of this district. The total population of Chandpur district is 24,16,018 (Male- 11,45,831 and Female- 12,70,187). Sex ratio is 90:100, population density 1468/Sq Km and annual growth rate is 0.61%. The Literacy Rate of Chandpur district is 56.80% (Male- 56.10% and Female- 57.30%). School attendance rate is 56.80% for 5 to 24 years age group. Urbanization rate of the district is 18.03% (BBS, 2011).

Main sources of income Agriculture 44.42%, non-agricultural laborers 3.12%, industry 0.91%, commerce 16.17%, transport and communication 3.05%, service 13.24%, construction 2.27%, religious service 0.40%, rent and remittance 4.35% and others 12.07% (BBS, 2011; Banglapedia, 2016).

3.2 Site selection and sampling procedure

This study was conducted in Chandpur district that was purposively selected. Chandpur district is consisting of 8 upazilas. Out of 8 upazilas, 2 upazilas namely Chandpur Sadar and Kachua was randomly selected. Chandpur Sadar and Kachua Upazila has 14 unions (Lowest unit of local government) and 12 unions respectively. Among 14 unions of Sadar Upazila, 2 unions namely Ashikathi and Kollanpur were randomely selected and out of 12 unions of Kachua Upazila, one union named Karia was randomly selected. Again from Ashikathi union of Chandpur Sadar upazila, one village named Aruli and from Kollanpur union, one village named Kurali was randomly selected. In the Karia union of Kachua upazila two villages named Paranpur and Kalthuri were randomly selected. There are total 1213 of different farm families in these selected villages. Out of 1213 farm families, a sample of 15%, i.e., 181 household were selected by stratified random sampling method. Then finally 63 representative farm families were selected for questionnaire survey and tree diversity assessment from each species rich homegardens. Final selection of homegarden has been done by using (Yamane, 1967) formula: $n = N / \{1 + N (e^2)\}$

Where,
n=Sampling size
N=Population
e=Error of precision

TABLE 3.3 Distribution of population and sample size in four selected villages.

Upazila	Union	Village	No. of total households	No. of households primary selected	No. of households finally selected for data collection
Chandpur Sadar	Ashikathi	Aruli	239	36	12
	Kollanpur	Kurali	287	43	15
Kachua	Karia	Paranpur	384	57	20
		Kalthuri	303	45	16
Total	3	4	1213	181	63

3.2.1 Household characteristics data

Initially, a questionnaire survey was conducted in 63 households. Field data collection was made by physical measurement directly from the study sites. Household demographic data (household age, head age, education, family size) were recorded with the help of family members. Household socioeconomic data such as homestead size (dwelling + homegarden), and agricultural land holding, annual income from homestead, income from agricultural land were also recorded. Homestead and agricultural land holdings size were recorded in decimal which further subsequently converted into hectare. For comparison the homesteads were categorized into four size group namely marginal or landless (<0.08ha), small (0.09-0.14 ha), medium (0.15-0.20 ha) and large (> 0.2ha).

3.3 Variables of the study and development of the research instruments

In social research, the selection and measurement of variables constitute a significant task. The independent variables were: age, sex, level of education, occupation, family size, farm size, homestead size, annual income and livelihood of the farmers. The farmer's opinion regarding the impact of tree species diversity of homestead agroforestry on socio-economic aspects was the dependent variable. Ultimately nine independent and one dependent variable were selected for this study. These variables are described below:

3.3.1 Measurement of independent variables

The following independent variables were included in the study:

i) Age
ii) Sex
iii) Education
iv) Occupation
v) Family size

vi) Farm size
vii) Homestead size
viii) Annual income; and
ix) Livelihood statusof the farmers

Age

The age was defined as the period of time from the birth of a respondent to the time of interview. It was operationally measured in terms of actual age in years.

Sex

Sex scores of the respondent farmers denoted by 1 for male and 2 for female.

Level of education

Education of a respondent was measured in terms of classes passed by him. For example, if a respondent passed the final examination of class V in the school, a score of 5 was taken for calculating his education score. If a respondent had education outside the school and if the levels of education was seemed to equivalent to that of class V of the school, then his education score was taken as 5. A respondent who did not know reading or writing had education score of zero (0).

Occupation

Occupation of a respondent was measured in terms of working by him and respondent to the time of interview. It was operationally measured in terms of actual occupation.

Family size

Family member of a respondent was determined in terms of the total number of members of each respondent. The family member included respondent himself, spouse, sons, daughters and other dependents.

Farm size

Land is the most important capital to a farmers and size influences on personal characteristic of farmer. Farm size was expressed as hectare and was computed by using the following formula:

Farm size = Homestead area + Own land under cultivation + Cultivated area taken under lease + ½ (Cultivated area given to others as *borga* + cultivated area taken from others as *borga*).

Homestead size

It was measured by the area of the raised land in which the household has its entire living room, livestock and poultry shed, yard under vegetable, home garden, fruit and timber trees, backyard, bushes, bamboo bunches, pond etc. It expressed in hectare.

Annual income

Annual income was measured by the sum of all income sources of a farmer in a year (agricultural income like framing, cropping etc. and non-agricultural income like business, service, saving, labour, other etc.). A score of 1 (one) was given for each thousand Taka.

Livelihood status

This section presents the livelihood status possessed by farmers in the study area. Two techniques such as calculation of cumulative percentage score, and the assessment of the perception of farmer on seven livelihood indicators, were used to determine the existing livelihood status.

Development of a cumulative livelihood status score (CLSS). To obtain valid and reliable data for the livelihood status of farmer, the CLSS was developed using both qualitative and quantitative data. It is necessary to combine the indicators into more complex indices in order to capture the meaning of any multi-dimensional phenomenon (Sharp, 2003). The CLSS thus aims at attaining a comprehensive view of the livelihood status of farmers.

The CLSS was determined in two steps. Firstly, a cumulative percentage score for each of the seven livelihood indicators was determined. After that, the cumulative livelihood status was computed based on the scores of these seven indicators. The procedure of measuring the cumulative percentage score and cumulative livelihood status score of a farmer is summarized below:

Computation of cumulative percentage score. The computation of 'cumulative percentage score' for each indicator was measured in two stages: (i) determination of an individual farmer's percentage score and (ii) determination of a cumulative percentage score.

(i) The individual farmer's field score was divided by the corresponding possible maximum score and expressed as a percentage. The following formula was used to determine the individual farmer's percentage score:

$$IFPS = IFFS/IFPMS \times 100$$

Where, IFPS = Individual farmer's percentage score

IFFS = Individual farmer's field score

IFPMS = Individual farmer's possible maximum score

(ii) The cumulative percentage score was obtained by dividing the sum of individual farmer's percentage score by the sample size. The following formula was used to determine the cumulative percentage score:

$$CPS = \Sigma IFPS/N$$

Where, CPS = Cumulative percentage score

ΣIFPS = Sum of individual farmer's percentage score

N = Sample size

Computation of cumulative livelihood status score. The cumulative livelihood status score of a farmer was measured by dividing the sum of cumulative percentage score of livelihood indicators by seven. The following formula was used to attain the cumulative livelihood status score:

$$CLSS = \Sigma CPS/LI$$

Where, CLSS = Cumulative livelihood status score

ΣCPS = Sum of cumulative percentage score of seven livelihood indicators

LI = Livelihood indicators (7)

The CLSS is further complemented by the perception of farmers based on the seven livelihood indicators. The quantitative data obtained from 100 farmers by administering a simple scale 0 - 3 for the score of seven livelihood indicators, whereby 0 stands for ‘do not know’, 1 for ‘lower situation’, 2 for ‘middle situation’ and 3 for ‘higher situation’.

In addition to the quantitative measurement, the qualitative data obtained through eight focus group discussions (FGDs) was analysed. In FGDs, farmers were asked to rate seven livelihood indicators by putting a specified numbers of seeds (ranging from 1 to 10, 1 indicate the lowest and 10 indicate the highest value) according to their perceived importance. All weights (number of seeds) were added together to get the total score for each indicator. A rank order of seven indicators was listed based on the total scores according to ascending order from least important to most important, whereby rank 1 denotes ‘least important’ and rank 7 denotes ‘most important’ (Table 3.4).

TABLE 3.4 Livelihood indicators and cumulative livelihood status score from both quantitative and qualitative data

<table>
<tr><th>Livelihood indicators</th><th>Qualitative rank [1]</th><th>Evaluation scale (0 - 3) [2]</th><th>CLSS range [3]</th><th>CLSS range [4]</th></tr>
<tr><td>Water facilities</td><td>1</td><td>0 - 3</td><td rowspan="7">0 - 21</td><td rowspan="7">43 - 73</td></tr>
<tr><td>Sanitation</td><td>2</td><td>0 - 3</td></tr>
<tr><td>Freedom in cash expenditure</td><td>3</td><td>0 - 3</td></tr>
<tr><td>Participation in social activities</td><td>4</td><td>0 - 3</td></tr>
<tr><td>Food availability</td><td>5</td><td>0 - 3</td></tr>
<tr><td>Health situation</td><td>6</td><td>0 - 3</td></tr>
<tr><td>Housing condition</td><td>7</td><td>0 - 3</td></tr>
</table>

[1] Rank orders was made based on total score obtained from FGDs, such as 7 = 78, 6 = 69, 5 = 62, 4 = 56, 3 = 49, 2 = 44 and 1 = 38

[2] Evaluation scale used to measure livelihood status for perception technique

[3] Cumulative livelihood status score (CLSS) was the sum of seven livelihood indicators score obtained from perception technique

[4] Cumulative livelihood status score (CLSS) was the sum of seven livelihood indicators score obtained from percentage technique

3.3.2 Measurement of dependent variable

Tree species diversity of homestead agroforestry was the dependent variable of the study. Tree species diversity of the homestead was estimated by the Shannon Wiener diversity Index (H).

Tree species were identification

Tree species were identified with their botanical names in the field and cross-checked by using different identification literature. The mentioned literature was also used to determine scientific names for a few species not identified in the field, but only recorded with their local names. In addition, the tree databases of ICRAF assisted in getting some of the scientific names of trees.

Tree diversity, richness and evenness measurement

Tree species diversity was assessed within the fixed boundaries of the sample homegardens acquiring common names that subsequently translated into botanical names. An index was setup based on the number of species and their frequency in homegardens. For this study, mainly Shannon-Wiener diversity index (H) was used due to its suitability for evaluating diversity of tree species. The Shannon–Wiener diversity characterizes the proportion of species abundance in the population being at maximum when all species are equally abundant and the lowest when the sample contained one species. The proportion of species (i) relative to total number of species (Pi) was calculated and then multiplied by the natural logarithm of the same proportion (ln Pi). The resulting product is summed across species, and multiplied by -1. With the help of Shannon-Wiener diversity index (H), Diversity Index (SDI) and Index of dominance (ID) were evaluated as a measure of diversity; Species Richness Index (R) and Species Evenness Index (E) were also calculated with the help of following formula (Michael, P., 1990, Odum, E.P., 1971 and Margalef, R., 1958).

1. Shannon-Wiener diversity index $H = -\sum P_i \, InP_i$

Where, Σ= Summation.

P_i = Proportion of total sample represented by species *i*. Total no. of individual species *i,* divided by total no. of plant species found in a sample community.

H = Shannon index

n = No. of species

2. Diversity index, $D = S/N$

Where, D = Diversity Index,

S = Total number of species,

N = Total number of individuals

3. Index of Dominance, ID= $\Sigma\ (Pi * Pi)$

Where, ID = Index of Dominance

P_i = Proportion of total sample represented by species i. Total no. of individual species i , divided by total no. of plant species found in a sample community.

4. Species richness index, $R = (S\text{-}1)/\ log\ N$

Where, R = Species richness index,

S = Total no. of species,

N = Total no. of individuals of all the species

5. Species evenness index, $E = H\ /\ log\ S$

Where, E = Species evenness index,

H = Shannon-Winner index of diversity

S = Total no. of species

3.4 Collection of data

Data for the study were collected through personal interview by the researcher himself during 15 September to 25 December, 2016 using the interview schedule. To get actual and valid information from them, all possible efforts were made to explain the purpose of the study to respondents in order. The interview was conducted with the respondents in their house. Proper rapport was establishment so that they did not feel hesitation to furnish proper response to the questions and statements in the schedule. The questions were explained and clarified whenever any respondent felt difficulty in answering the question. Ten farmers were kept in the reserve list during final collection.

3.5 Compilation of Data

After completion of field survey all the data of the interview schedule were compiled. Local units were converted into standard unit. Appropriate coding and scoring technique was followed to convert the qualitative data into quantitative forms. The responses of the individual garden owner contained in the interview schedules were transferred to a master sheet for entering the data in the computer. As soon as the data entered into the computer, it was then analyzed in accordance with the objectives of the study.

3.6 Analysis of data

Bogdan and Biklen (2006) insist that data analysis is an on-going part of data collection. After compilation of data, data were coded, categorized and fed in computer and analyzed using computer software packages MS Excel 2010 and SPSS 21 versions. Local units were converted into standards units. The statistical measures such as number, percentage, range, rank, order, mean and standard were used in describing the variables of the study. For clarity of understanding tables and figures were also used for presentation the data. From the primary data, indices of diversification of plant species (species diversity index, species richness index) were calculated following Shannon and Weaver (1949). Regression analysis and Pearson's Product Moment Correction Co-efficient (r) were used to find out the relationship between homestead tree species diversity and selected characteristics of the farmers. At least 0.05 level of probability with an accompanying 95 percent confidence level was used as the basis for rejection of a null hypothesis throughout the study.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Demographic and socio-economic characteristics of the respondents of the study area

Nine characteristics of independent variables of the study have investigated and the descriptions of each of the individual characteristics are presented in Table 4.1.

TABLE 4.1 Description of farmers characteristics treated as independent variables of the study (N= 63).

Characteristics	Measuring unit	Observed range	Mean	Standard deviation
Age	Years	19-69	40.00	12.548
Sex	Numbers	1-2	1.35	0.481
Education	Level of class	0-16	7.43	3.359
Occupation	Numbers	1-7	2.95	2.196
Family size	Numbers	2-8	5.08	1.834
Farm size	Hectare	0.11-2.52	1.49	0.681
Homestead size	Hectare	0.01-0.25	0.15	0.068
Annual income	Thousand	16-289	72.37	50.31
Livelihood condition	Scale scores	10-30	16.92	5.45

4.1.1 Age

The age of the respondents ranged from 19 to 69 years. The respondents were grouped into three categories- young (up to 30 years), middle (31 to 50 years) and old (above 50 years) on the basis of their age. Number and percentage distribution of farmers according to their age group has been shown in the Table 4.2.

TABLE 4.2 Distribution of respondents according to their age.

Category	**Respondent (Number)**	**Percent**	**Average**	**Standard deviation**
Young age (up to 30 years)	20	31.7	40	12.16
Middle age(35 to 50 years)	30	47.6		
Old age (above 50 years)	13	20.6		
Total	63	100		

Data presented in Table 4.2 revealed that the majorities (47.6%) of the respondents were in the middle aged category, 31.7 % of the respondents were in the young aged and only 20.6 % were old aged category in the study area.

4.1.2 Sex

Sex scores of the respondent farmers denoted by 1 for male and 2 for female with a mean and standard deviation of 1.35 and 0.481 respectively. On the basis of observed scores, farmers were classified into three categories (Table 4.3).

TABLE 4.3 Distribution of sample farmers according to sex

Category	**Respondent (Number)**	**Percent**	**Average**	**Standard deviation**
Male	41	65.1	1.35	0.481
Female	22	34.9		
Total	63	100		

Table 4.3 indicated that major portion of the respondents (65.1 %) were male and low participation (34.9%) in comparison with male were female.

4.1.3 Education

The education level of the farmers ranged from 0-16 with an average of 7.43 and standard deviation of 3.359 of schooling. In this study 57.1% of the farmers had secondary level education, whereas 25.4 % of them were of secondary level education illiterate, 12.7 % were of primary level education and 4.8 % were illiterate (Table 4.4).

TABLE 4.4 Categorization of respondents according to their education

Category	Respondent (Number)	Percent	Average	Standard deviation
Illiterate (0)	3	4.8	7.43	3.359
Primary level (class 1 to 5)	8	12.7		
Secondary level (class 6 to 10)	36	57.1		
Higher level (11 or above)	16	25.4		
Total	63	100		

4.1.4 Occupation

The occupation of the farmers in the study area varied in distinct forms. However, on the basis of their occupation they are classified as agriculture, fishing, livestock and poultry, rickshaw/van pulling, boatman, service, others etc. Data presented in Table 4.5 and Figure 4.1 indicates that majority (47.6 %) of the respondents belonged to 'agriculture' as their major occupation while rest 52.4 % of them were occupied by fishing, livestock and poultry, rickshaw/van pulling, boatman, service and others.

TABLE 4.5 Distribution of the farmers on the basis of their occupation.

Categories of occupation	**Respondents (Number)**	**Percentage**	**Average**	**Standard deviation**
Agriculture	30	47.6	2.95	2.196
Fishing	3	4.8		
Livestock and poultry	5	7.9		
Rickshaw/van pulling	8	12.7		
Boatman	4	6.3		
Service	8	12.7		
Others	5	7.9		
Total	63	100.0		

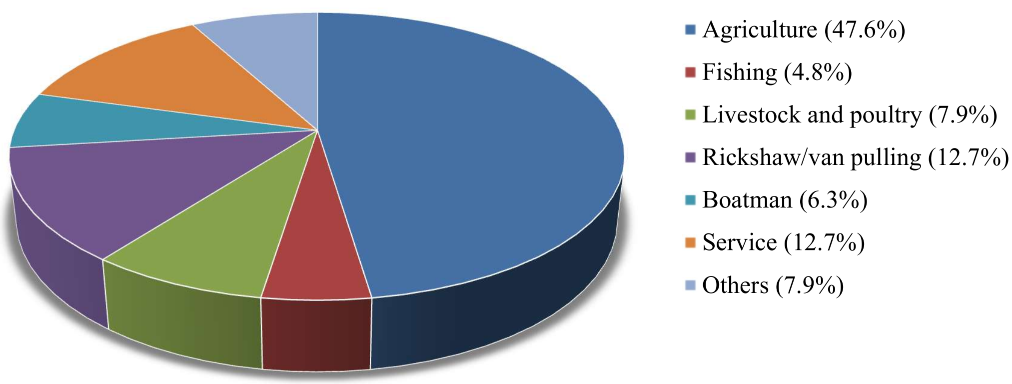


FIGURE 4.1. Composition of occupation of household respondent

4.1.5 Family size

Member of sampled farm households were categorized into three groups (Table 4.6). The categories and distribution of the respondents with their number, percent, mean and standard deviation are furnished below.

TABLE 4.6 Family sizes of sampled farmers.

Family size (Number)	Respondent (Number)	Percent	Mean	Standard deviation
Small (1-4)	32	50.8	5.08	1.834
Medium (5-6)	13	20.6		
Large (above 7)	18	28.8		
Total	63	100		

Data presented in Table 4.6 showed that majority of the farmers (50.8 %) belonged to small size family, 28.8 % of the respondents had large size family and 20.06 % of them belonged to medium family.

4.1.6 Farm size

The farm size of the respondents varied from 0.11 to 2.52 hectare with the mean of 1.49 and standard deviation of 0.681. There were four farm categories of the respondents on the basis of their farm holdings. Data presented in Table 4.7 showed that the highest proportion (44.4 %) of the respondents were medium while 28.6 %, 19.0 % and 7.9 % of large, small and marginal farm categories, respectively. The farmers having large farm size contain large homestead area whereas, the medium farmers have marginal farm size with small homestead size.

TABLE 4.7 Distribution of the farmers on the basis of their farm size.

Category	Respondent (Number)	Percent	Average	Standard deviation
Marginal (up to 0.50 ha)	5	7.9	1.49	0.681
Small (0.51 to 1.00 ha)	12	19.0		
Medium (1.00 to 2.00 ha)	28	44.4		
Large (above 2.00 ha)	18	28.6		
Total	63	100		

4.1.7 Homestead size

The homestead size of the farmer ranged from 0.01 - 0.25 hectare with an average of 0.15 hectare and standard deviation of 0.068. Among the farmers 31.7 % were medium, 28.6 % were large, 22.2 % were landless and marginal and 17.5 % were large. Homesteads sizes are given below (Table 4.8).

TABLE 4.8 Categorization of respondents according to their homestead size.

Category	**Respondent (Number)**	**Percent**	**Average**	**Standard deviation**
Landless/marginal (up to 0.08 ha)	14	22.2		
Small (0.09 to 0.14 ha)	11	17.5	0.15	0.068
Medium (0.15 to 0.20 ha)	20	31.7		
Large (above 0.21 ha)	18	28.6		
Total	63	100		

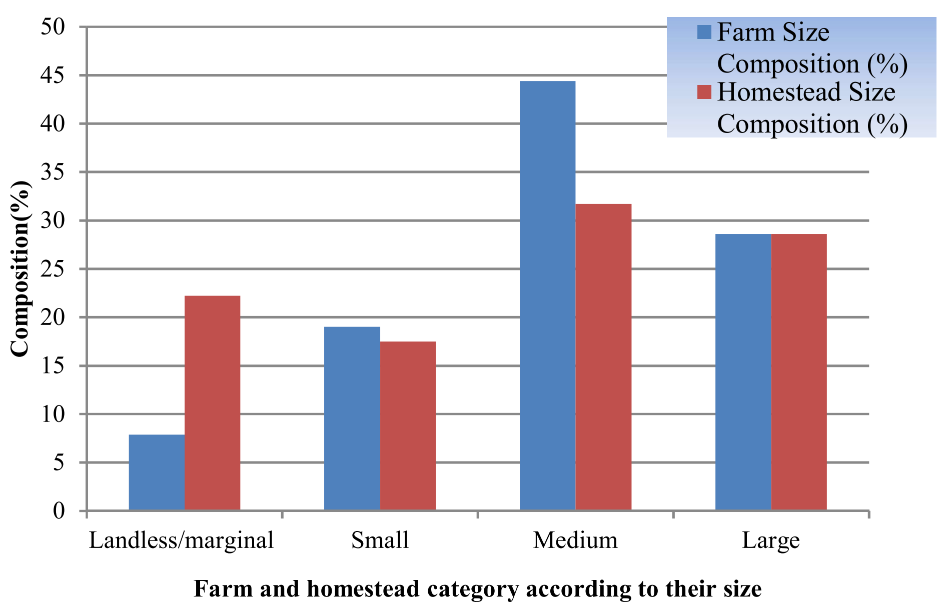


FIGURE 4.2 Distribution of farm size and homestead size of respondents in bar graph.

4.1.8 Annual income

Annual income of the farm families ranged from Tk. 16 thousand to Tk. 289 thousand with an average 72.37 thousand having standard deviation of 50.31. The respondents are classified three categories basis on their income e.g.; low income (up to Tk. 60 thousand) category, medium income (Tk. 60-120 thousand) and high income (above Tk. 120 thousands) categories. Data presented in Table 4.9 and figure 4.3 indicated that majority (55.6 %) of the respondents had low income category, 28.6 % of the respondents had medium income category and 15.9 % of the respondents in high income category.

TABLE 4.9 Distribution of respondents according to their annual income.

Category	Respondent (Number)	Percent	Average	Standard deviation
Low income(up to 60000)	35	55.6	72.37	50.31
Medium income(60001-120000)	18	28.6		
High income(above 120000)	10	15.9		
Total	63	100		

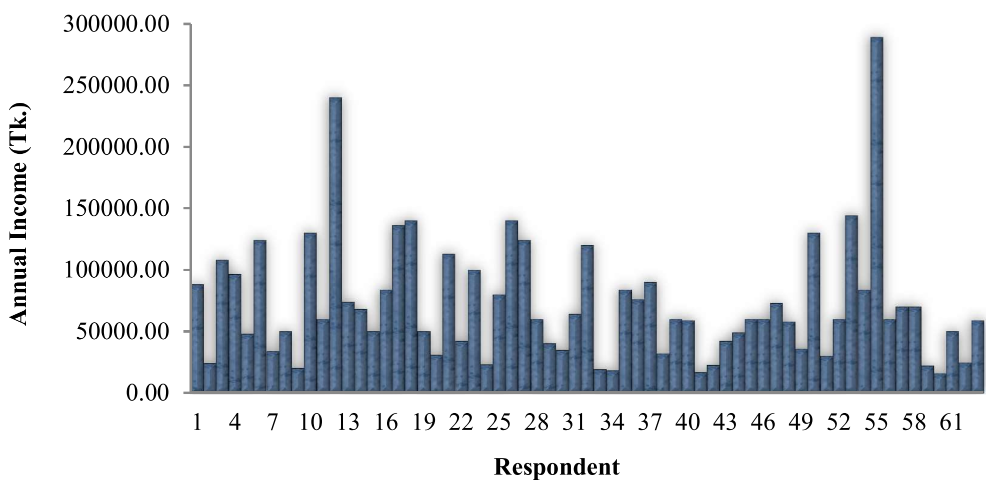


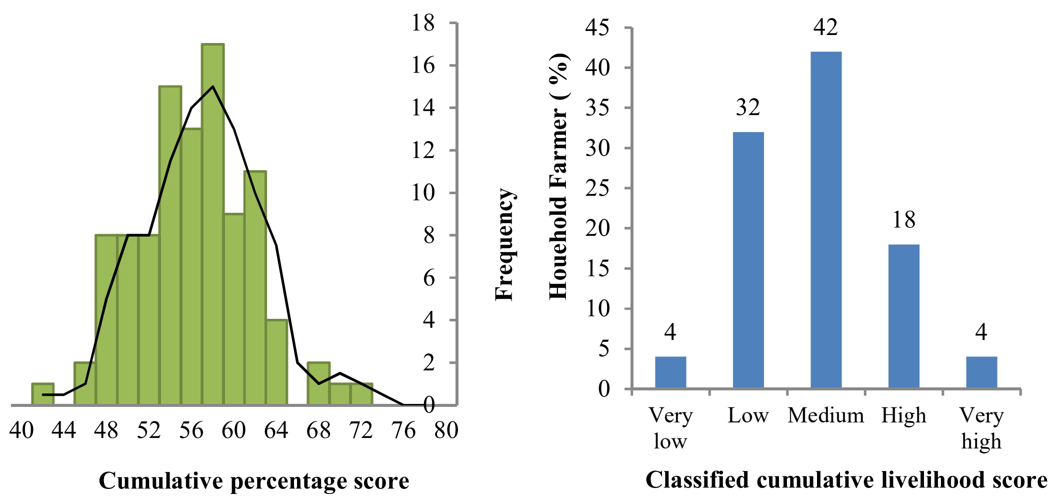
FIGURE 4.3 Distribution of annual income of respondents.

4.1.9 Livelihood status of farmer

This section presents the livelihood status possessed by farmers in the study area. Two techniques such as calculation of cumulative percentage score, and the assessment of the perception of farmer on seven livelihood indicators, were used to determine the existing livelihood status. In addition, the suggestions of farmer to improve their livelihood status are being presented at the end of this section.

Livelihood status of farmer measured by cumulative percentage score

The livelihood status of farmer obtained by calculation of percentage scores of seven livelihood indicators. Here, farmers are classified into five categories. Figure 4.4 shows a positive skew (0.12), as the mean (57.05) was higher than the median (56.68), indicating that a large proportion of the farmer (74%) was concentrated in the low to middle classes in livelihood distribution.



Very low livelihood status (43 -48), Low livelihood status (49 -54), Medium livelihood status (55 -60), High livelihood status (61 -66), Very high livelihood status (67 -73) Range = 43 -73, Mean= 57.05, Median = 56.68 and Skewness= 0.12

FIGURE 4.4**:** Distribution of respondents based on their cumulative livelihood status score.

Livelihood status of farmer according to their perception

According to the perception of farmer, the livelihood status score (LSS) varied from 0 to 21. Based on the obtained score farmer are classified into three categories such as 'low livelihood status' (0 - 7), 'medium livelihood status' (8 - 14) and 'high livelihood status' (15 - 21). The distribution based on livelihood status score is presented in figure 4.5, which shows a positive skew (0.24), as the mean (12.14) was higher than the median (11). The majority of the farmers were distributed under low to medium livelihood status classes (77%), while 23% belonged to high livelihood status. This finding is almost similar to the result obtained from the calculation of cumulative percentage score of the present study where 74% of farmer had low to medium livelihood status.

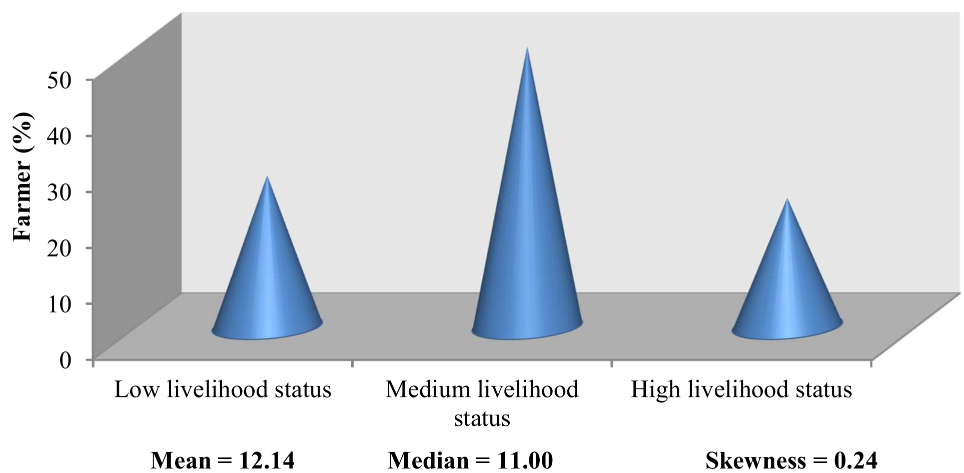


FIGURE 4.5 Distribution of respondents based on their cumulative livelihood status score according to the perception.

Existing situation of seven livelihood indicators based on cumulative percentage score

The situation in the study area regarding seven livelihood indicators has been shown in figure 4.6. The highest cumulative percentage score was obtained for water facilities (87) followed by food availability (84), freedom in cash expenditure (67), housing conditions (52), sanitation (51), health situation (34) and participation in social activities (24). The results indicate that housing conditions, sanitation and the health situation were not satisfactory in the study area, and the participation of women in social activities was very low. Water facilities, food availability and freedom in cash expenditure did not attain their highest level (100 percent), but their status was relatively better than other livelihood indicators. Therefore, priority should be given to assist facilities for the improvement of housing conditions, the sanitation and health situation which would play key role to increase the livelihood status of the study area. Furthermore, an initiative needs to be taken by GOs and NGOs for bringing attitudinal changes, which ensure higher participation of farmer in different social activities.

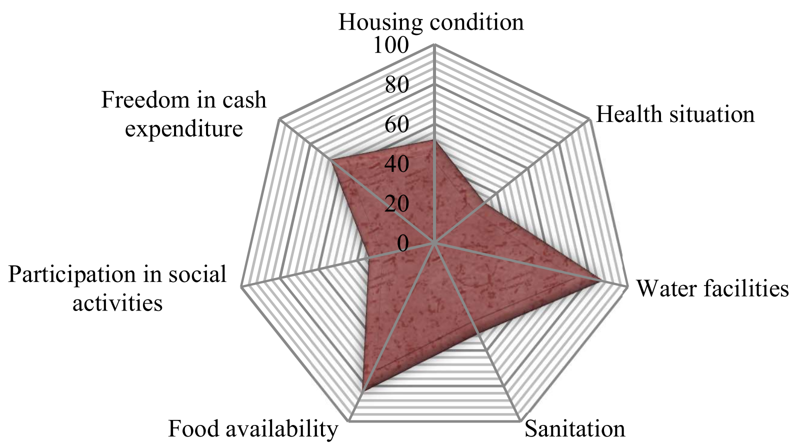


FIGURE 4.6 Existing situations of seven livelihood indicators.

Existing situation of seven livelihood indicators based on farmer's perception

Analysis of the responses of farmer to the questions concerning the situation of seven selected livelihood indicators is shown in Table 4.10. The situation of the livelihood indicators is reflected by mean scores, which ranged from the highest 2.81 to the lowest 1.69. This indicated a difference of 1.12, suggesting a relatively high discrepancy between the mean scores of the seven livelihood indicators.

TABLE 4.10 Perceptions of farmer considering seven livelihood indicators compared by mean values.

Livelihood indicators	Existing situation of livelihood indicators (%)				Mean*
	Do not know	Low	Medium	High	
Housing condition	1	13	74	12	1.98
Health situation	1	10	82	7	1.96
Water facilities	1	4	8	87	2.81
Sanitation	2	35	52	11	1.72
Food availability	1	17	53	29	2.11
Participation in social activities	0	14	67	18	2.03
Freedom in cash expenditure	0	46	43	10	1.69

*Mean value of each indicator ranging from 0 to 3 and scales: 0 = do not know; 1 = low situation; 2 = medium situation; 3 = high situation

The livelihood indicator "water facilities" received the highest mean score of 2.81 and was considered as "high" by 87% of the surveyed women. The lowest mean score (1.69) was recorded for the indicator "freedom in cash expenditure" and this was identified as "low" by 47% of the farmer and "medium" by 43%. The overall mean of seven livelihood indicators was 2.04, slightly higher than medium. Mean values of the five following livelihood indicators were found to be less than medium: freedom in cash expenditure (1.69), sanitation (1.72), health situation (1.96), and housing condition (1.98). Two indicators such as water facilities and food availability had higher mean value than medium (2.81 and 2.11, respectively) and none of the indicator possessed its highest value 3.

This result indicates that all of the seven livelihood indicators are need to be developed in order to obtain sustainable livelihood situations for the surveyed farmer. Therefore, the selected seven livelihood indicators of the present study should be emphasized in the planning program of GOs and NGOs.

4.2 Tree species diversity

4.2.1 Abundance of tree species

Homesteads of selected study area composed with multiple tree species. A total of 39 plant species 23 families were recorded from the set of 63 homesteads surveyed. The name of species, their abundance in homesteads, Percentage of abundance, life form, conservation status and uses were arranged by the alphabetical order of species family name (Table 4.11). Tree species in the homesteads are used for mainly fruit, fuel, and timber purposes. Non wood products and services such as vegetables, oil, medicines, resins etc. are provided by different tree species. Among 39 plant species major six species found in dominancy than others and the highest percent of occurrence was found *Artocarpus heterophyllus* (27.80%) followed by *Mangifera indica* (16.59 %), *Cocos nucifera* (8.52%), *Musa spp.* (7.60 %), *Borassus flabellifer* (6.76%) and *Phoenix sylvestris* (5.99%) respectively.

TABLE 4.11 List of homestead tree species with conservation status and uses in Chandpur District.

Sl. No.	Family	Common Name	Scientific name	Abundance (Total no. of individuals)	Percentage of abundance	Life form[1]	Conservation status[2]	Uses[3]
1.	Anacardiaceae	Mango	*Mangifera indica*	432	16.58986175	Tr	LC(6)	1, 2, 3, 5
2.	"	Amra/Hog pulm	*Spondias spp.*	3	0.115207373	ST	LC(11)	1, 5, 6
3.	Arecaceae	Betelnut	*Areca catechu*	37	1.420890937	Tr	LC(11)	1, 2, 4, 7
4.	"	Coconut/Narkel	*Cocos nucifera*	222	8.525345622	Tr	LC(11)	1, 2, 7
5.	"	Khejur/Date Palm	*Phoenix sylvestris*	156	5.99078341	Tr	LC(11)	1, 2, 3, 6
6.	"	Tal/Palmyra Palm	*Borassus flabellifer*	176	6.758832565	Tr	LC(11)	1, 2, 3, 7
7.	"	Bet	*Calamus spp.*	18	0.69124424	H	LC(7)	1, 7
8.	Caesalpiniaceae	Tamarind/Tetul	*Tamariandus indica*	3	0.115207373	Tr	LC(7)	1, 3
9.	Caricaceae	Papaya	*Carica papaya*	66	2.534562212	Sh	LC(7)	1
10.	Dipterocarpaceae	Garjan	*Dipterocarpus turbinatus*	8	0.307219662	Tr	LC(10)	2,3
11.	Dilleniaceae	Chalta	*Dilenia indica*	6	0.230414747	Tr	LC(7)	1, 3
12.	Ebenaceae	Gab(Deshi)	*Diospyros precatorices*	3	0.115207373	Tr	LC(11)	1, 2, 3
13.	Elaeocarpaceae	Jalpai	*Elaeocarpus tectorius*	4	0.153609831	Tr	LC(7)	1, 2, 3
14.	Fabaceae	Mandar	*Erythrina variegate*	6	0.230414747	Tr	LC(8)	2, 3, 4, 5
15.	"	Sissu	*Dalbergia sisso*	2	0.076804916	Tr	LC(10)	2, 3, 6
16.	"	Arhar	*Cajanus cajan*	3	0.115207373	H	LC(11)	1, 5
17.	Lythraceae	Jarul	*Lagerstroemia speciosa*	12	0.460829493	Tr	LC(9)	2, 3
18.	Meliaceae	Mahogany	*Swietenia macrophylla*	82	3.149001536	Tr	LC(10)	2, 3
19.	"	Neem	*Azadirachta indica*	36	1.382488479	Tr	LC(9)	2, 3, 6
20.	"	Rana/Petraj	*Aphanamixis polystachya*	6	0.230414747	Tr	LC(8)	2, 3
21.	Malvaceae	Shimul/Cotton	*Bombax ceiba*	5	0.192012289	Tr	LC(9)	2, 3, 6

TABLE 4.11 (Continued)

Sl. No.	Family	Common Name	Scientific name	Abundance (Total no. of individuals)	Percentage of abundance	Life form[1]	Conservation status[2]	Uses[3]
22.	Mimosaceae	Koroi	*Albizzia procera*	56	2.150537634	Tr	LC(9)	2, 3
23.	"	Shil Koroi/Raintree	*Albizia saman*	24	0.921658986	Tr	LC(9)	2, 3
24.	Moraceae	Kathal/Jackfruit	*Artocarpus heterophyllus*	724	27.80337942	Tr	LC(11)	1, 2, 3, 5
25.	"	Banyan/Bat	*Ficus benghalensis*	31	1.19047619	Tr	LC(11)	2, 3, 5, 6
26.	"	Aswatha	*Ficus religiosa*	22	0.844854071	Sh	LC(7)	1, 3, 6
27.	Moringaceae	Sajna	*Moringa oleifera*	2	0.076804916	ST	LC(10)	1, 5, 6
28.	Musaceae	Kola/Banana	*Musa spp.*	198	7.603686636	Sh	LC(11)	1, 4, 5
29.	Myrtaceae	Jam/Black Berry	*Syzygium cumini*	11	0.422427035	Tr	LC(9)	1, 2, 3
30.	"	Payera	*Psidium guajava*	60	2.304147465	ST	LC(9)	1, 2
31.	Oxalidaceae	Kamranga	*Averrhoa carambola*	6	0.230414747	Tr	LC(9)	1, 3
32.	"	Amrul	*Oxalis corniculata*	50	1.920122888	H	LC(9)	6
33.	Rhamnaceae	Kul	*Zizyphus mauritiana*	40	1.53609831	ST	LC(10)	1, 5
34.	Rubiaceae	Kadam	*Neolamarckia cadamba*	21	0.806451613	Tr	LC(9)	2,3,4
35.	Rutaceae	Bel/Wood Apple	*Aegle marmelos*	11	0.422427035	Tr	LC(10)	1, 3
36.	"	Jambura/Pummelo	*Citrus grandis*	16	0.614439324	Tr	LC(10)	1, 3
37.	"	Lebu/Lemon	*Citrus limon*	13	0.499231951	Sh	LC(10)	1, 6
38.	Sapindaceae	Litchi	*Litchi chinensis*	30	1.152073733	Tr	LC(9)	1, 2, 3, 5
39.	Verbenaceae	Teak/Segun	*Tectona grandis*	3	0.115207373	Tr	LC(10)	2, 3
Total				2604	100			

[1]Life form: Tr: tree, H: herb, Sh: shrub and ST=herb+shrub
[2]C.S: conservation status, LC: least concern, NT: near threatened, NE: not evaluated, and V: vulnerable.
[3]Uses: 1: food/fruit, 2: timber, 3: fuel wood, 4: fence, 5: fodder, 6: medicine and 7: others.

4.2.2. Species diversity, richness and evenness

In total, 39 different plant species were found from 23 families in the selected households and total 2604 trees were measured. It was found that kathal/jackfruit tree ranks top of the list which was 724 nos. of the total plant population followed by mango (n= 432), coconut (n= 222), kola/banana (n= 198), tal//palmyra palm (n= 176) and khejur/date palm (n= 156) respectively. Tree diversity described by the Shannon-Wiener diversity index (H) results 2.58. Diversity Index (SDI), Index of dominance (ID), Species Richness Index (R) and Species Evenness Index (E) were also calculated and shown on Table 4.12. The complete floristic list is appended. Data obtained from Species Diversity Index (2.58) show higher value than Index of Dominance (0.13) which represents less dominancy of the tree species with more diversity. The calculated value of Species Richness Index and Species Evenness Index was 11.13 and 1.62 respectively which represent the more richness of tree species (corroborated with the previous findings) and more evenly the total number of individuals is distributed among all possible tree species.

TABLE 4.12 Various diversity related parameters

Parameters	Result
No. of Species= S	39
No. of individuals= N	2604
Shannon Winner index of diversity, H= - ΣPi * Ln(Pi)	2.577014
Diversity Index, SDI= S/N	0.014976959
Index of Dominance, ID= $\Sigma(Pi * Pi)$	0.130364841
Species Richness Index, R= (S-1)/Log N	11.12529104
Species Evenness Index, E= H/Log S	1.619679043

4.2.3 Species family Composition

Among 23 families shown on Table 4.11, nine families were accumulated according to their number of abundance. Moraceae (777 individuals), Arecaceae (609 individuals), Anacardiaceae (435 individuals) and Musaceae (198 individuals) families represented the highest numbers abundances followed by Meliaceae (124 individuals), Mimosaceae (80 individuals), Myrtaceae (71individuals), Caricaceae (66 individuals) and Oxalidaceae (56 individuals). These nine family contained 2416 nos. tree. Left 14 families carried only 188 nos. of tree. Shannon-Weiner Index (H) value was 1.78. Broad calculation list of nine families with their percentages were shown on Table 4.13 and bar graphical representations were also shown on figure 4.7.

TABLE 4.13 Most important nine families according to their number of abundance

Sl no.	Family Name	No. of trees	Pi	LnPi	Pi*LnPi	Percentage (%)
1.	Moraceae	777	0.32160596	-1.134428209	-0.364838873	32.1606
2.	Arecaceae	609	0.252069536	-1.378050291	-0.347364498	25.2069
3.	Anacardiaceae	435	0.180049669	-1.714522528	-0.308699213	18.0049
4.	Musaceae	198	0.081953642	-2.501601528	-0.205015357	8.19536
5.	Meliaceae	124	0.051324503	-2.969586993	-0.152412577	5.13245
6.	Mimosaceae	80	0.033112583	-3.407841924	-0.112842448	3.31125
7.	Myrtaceae	71	0.029387417	-3.527188682	-0.103654965	2.93874
8.	Caricaceae	66	0.027317881	-3.600213817	-0.098350212	2.73178
9.	Oxalidaceae	56	0.023178808	-3.764516868	-0.087257014	2.31788
Total		2416			H=1.7804352	100

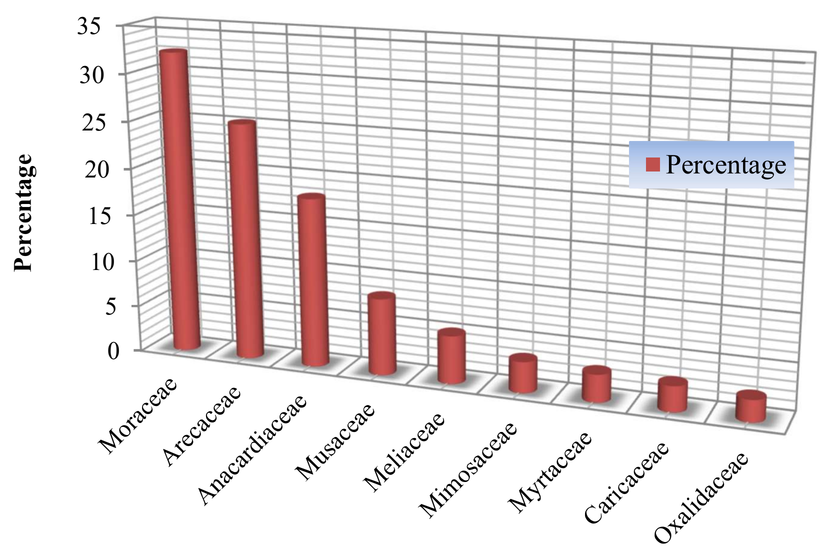


FIGURE 4.7 Abundance (%) of nine important families are shown by bar graph.

4.2.4 Categorization of tree species

In homestead agroforestry, tree species have direct impact on income of the farmers. Farmers are classified into four categories on the basis of tree species number with Shannon Weiner Index (H), mean and standard deviation. Categorization was done by small tree species number (1–10) under category I, medium tree species number (11–50) under category II, large tree species number (51–100) under category III and vary large tree species number (>100) under category were shown on Table 4.14 and figure 4.8.

TABLE 4.14 Categorization of tree species according to their number.

Category	Respondent (Number)	Percent	Number of plants	Shannon Weiner Index, H	Mean	Standard deviation
1-10	14	35.9	60	2.55298	6.77	36.701
11-50	15	38.5	372	2.599612		
51-100	4	10.3	264	1.375386		
Above 101	6	15.4	1908	1.613977		
Total	39	100	2604			

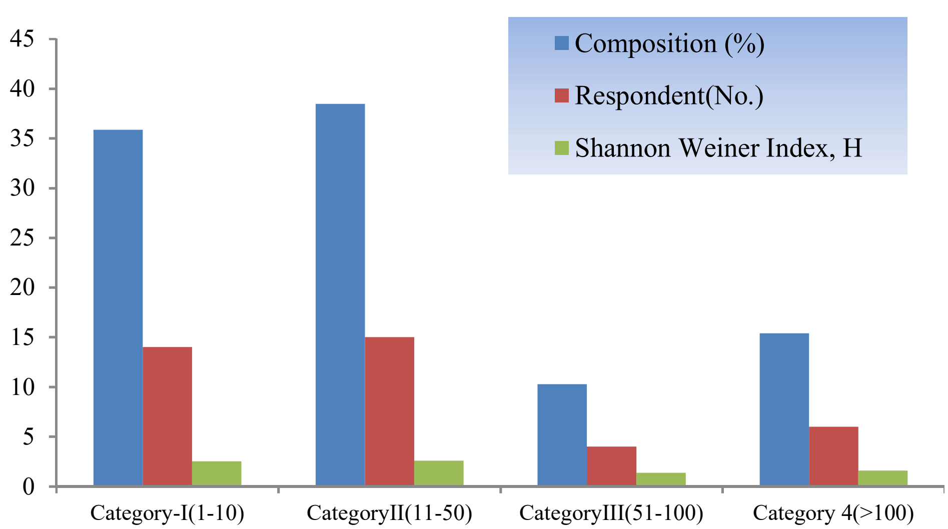


FIGURE 4.8 Composition, respondent nos. and Shannon Weiner Index of 4 categories.

4.2.5 Socioeconomic uses of trees species

Different tree species were observed in the homestead area as diversified condition. Based on the last column of table 4.11, socioeconomic uses of trees species were recorded by accumulation. From the accumulation, 28 fuel wood tree species (26.67%), 25 fruit/food species(23.81%), 24 timber species(22.86%), 10 medicinal species (9.52 %), 10 fodder species (9.52 %), 4 fence species (3.81 %) and 4 others species (3.81 %) were found (Table 4.15 and Figure 4.9) in study area.

TABLE 4.15 Categorization of tree species according to their socioeconomic uses.

Category by uses	**Species Value**	**Percentage (%)**
Food/Fruit	25	23.81
Timber	24	22.86
Fuel Wood	28	26.67
Fence	4	3.81
Fodder	10	9.52
Medicine	10	9.52
Others	4	3.81
Total	105	100.00

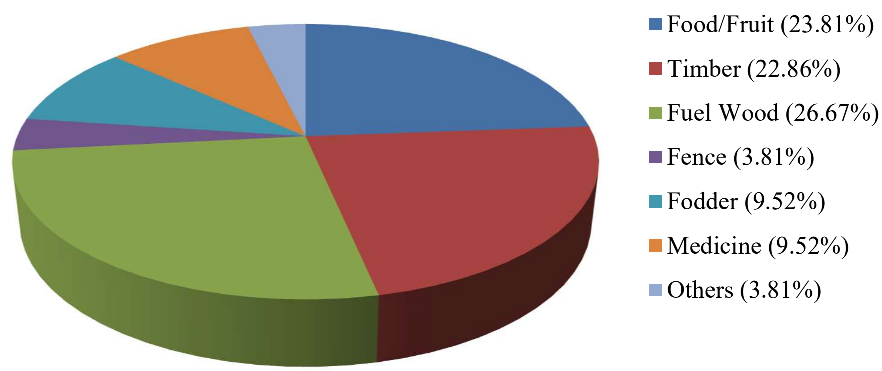


FIGURE 4.9 Percentage of fruit, timber, fuel wood, fence, fodder, medicinal and other tree species in the study area.

4.3 Relationship between tree species diversity and the socio-economic characteristics of the of the farmers in the homestead agroforestry

This section deals with relationship between tree species diversity and the socio-economic characteristics of the of the farmers in the homestead agroforestry. The dependent variable was tree species diversity and the independent variables were age, sex, education, occupation, family size, farm size, homestead size, annual income and livelihood status of the farmers in the homesteads. To explore the relationships regression analysis and Pearson's Product Moment Co-efficient of Correlation (r) has been used. The relationships of the selected socio-economic characteristics of the respondents and homestead tree species diversity have been shown in Table 4.16.

Table 4.16 Computed co-efficient of correlation (r) between Dependent variable and Independent variables (N = 63)

Dependent variable	Independent variables	Correlation co-efficient 'r'	'p' value
Tree species diversity	Age	-0.078^{NS}	0.544
	Sex	-0.03^{NS}	0.813
	Education	0.391^{**}	0.002
	Occupation	0.958^{**}	0.000
	Family size	0.114^{NS}	0.373
	Farm size	0.586^{**}	0.000
	Homestead size	0.584^{**}	0.000
	Annual income	0.277^{*}	0.028
	Livelihood status	0.741^{**}	0.000

**Correlation is significant at the 0.01 level

*Correlation is significant at the 0.05 level

^{NS} = Non-significant

4.3.1 Relation between age of the farmers and tree species diversity

The age of the farmers and tree species diversity was examined against the null hypothesis as "there is no relationship between the age of of the farmers and tree species diversity". The relationship between age of the farmers and tree species diversity was measured and shown in figure 4.10. It is shown a linear equation as: Y = -2.11x+ 44.16 (R^2 = 0.006), where R^2 value was positive, r = - 0.078 and p= 0.544 (> 0.05). So it indicated that the relationship between age of the farmers and tree species diversity was non-significant and at the same time there was a very weak relationship between them. Aearwal (2001) also observed same relation in northern Bangladesh.

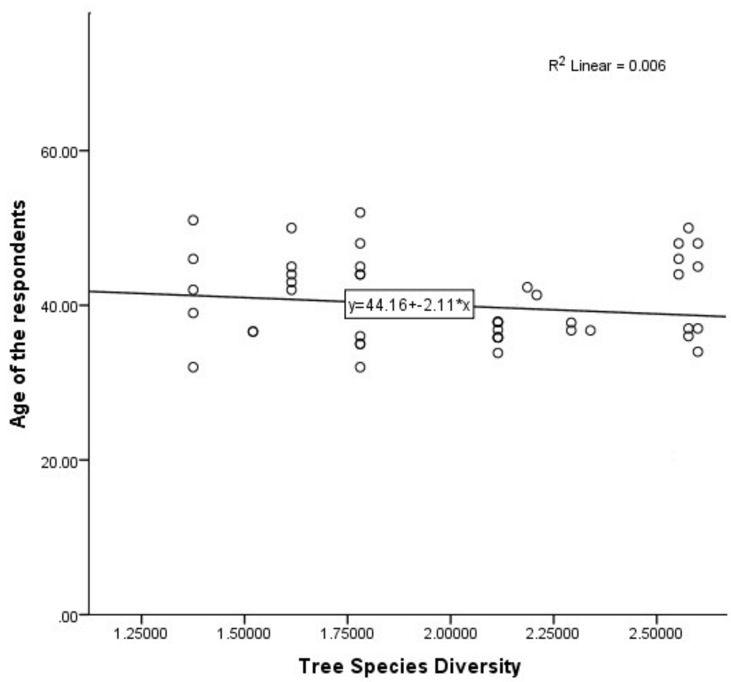


FIGURE 4.10 The relationship between age of the farmers and tree species diversity

4.3.2 Relation between sex of the farmers and tree species diversity

The sex of the farmers and tree species diversity was examined against the null hypothesis as "there is no relationship between the sex of of the farmers and tree species diversity". The relationship between age of the farmers and tree species diversity was measured and shown in figure 4.11. It is shown a linear equation as: Y = -0.03x+1.41 (R^2 = 0.00009), where R^2 value was positive, r = - 0.03 and p= 0.813 (> 0.05). So it indicated that the relationship between sex of the farmers and tree species diversity was non-significant. Thus the concerned null hypothesis could not be rejected. The findings indicated that sex of the respondents had no relationship with tree species diversity.

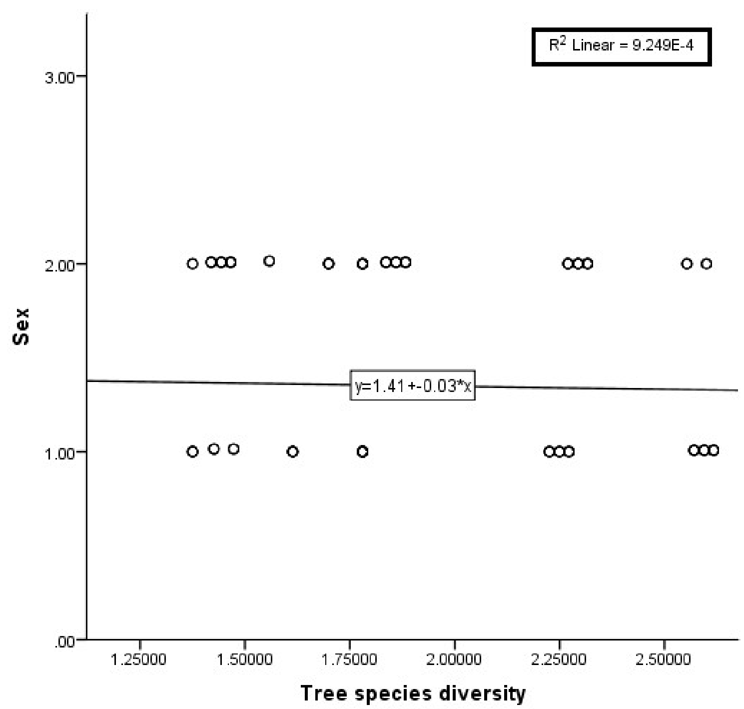


FIGURE 4.11 The relationship between sex of the farmers and tree species diversity

4.3.3 Relation between education of the farmers and tree species diversity

The education of the farmers and tree species diversity was examined by testing the following null hypothesis: "there is no relationship between the education of the farmers and tree species diversity". Figure 4.12 indicated a linear equation as: Y = 2.83x+ 1.84 (R^2 = 0.153), where R^2 value was positive, r = 0.391 and p= 0.002 (< 0.05). So it indicated that there was a significant and moderate positive correlation between tree species diversity and level of education of the respondents. This implies that farmers with higher education had higher tree species diversity in his/her homestead. Sudmeye *et al.* (2004) also observed the same result in Rangpur district.

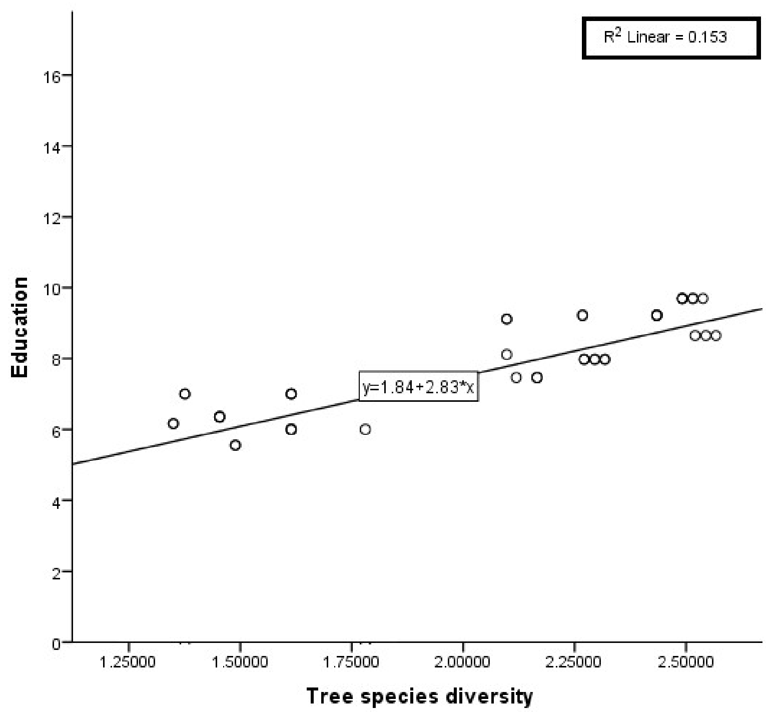


FIGURE 4.12 The relationship between education of the farmers and tree species diversity

4.3.4 Relation between occupation of the farmers and tree species diversity

The relation between occupation of the farmers and tree species diversity was examined by testing the null hypothesis: “there is no relationship between occupation of the farmers and tree species diversity”. Figure 4.13 indicated a linear equation as: Y = 0.71x+ 4.218 (R^2 = 0.919), where R^2 value was positive, r = 0.958 and $p < 0.05$. So it indicated that there was a significant and strongly positive correlation between the two concerned variables. It means that a person having higher tree species diversity in his/her homstead was likely to higher level of occupation.

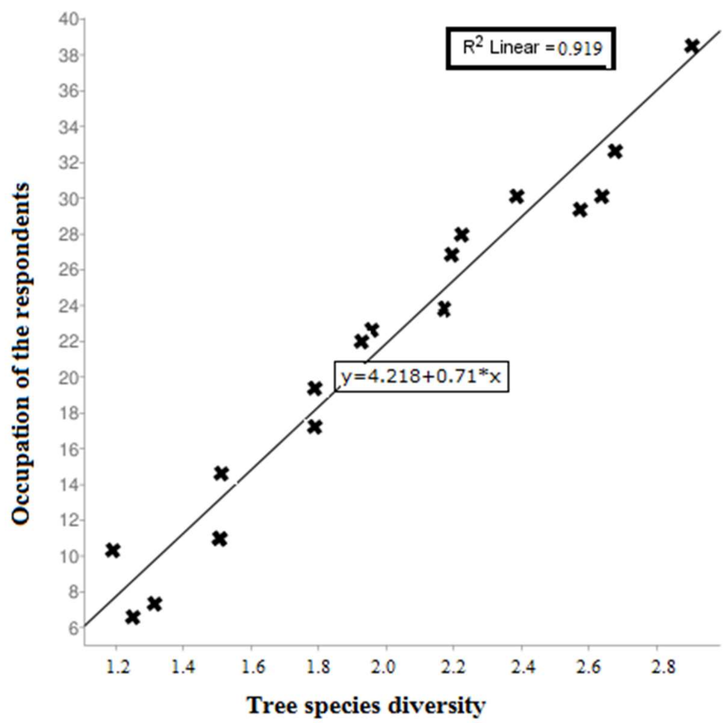


FIGURE 4.13 The relationship between occupation of the farmers and tree species diversity

4.3.5 Relation between family size of the farmers and tree species diversity

The family size of the farmers and the tree species diversity was examined by testing the following null hypothesis: “there is no relationship between the family size of the farmers and tree species diversity”. Figure 4.14 indicated a linear equation as: Y = 0.45x+ 4.19 (R^2 = 0.013), where R^2 value was also positive, r = 0.114 and p= 0.373(> 0.05). So it indicated that the relationship between the family size of the farmers and tree species diversity was non-significant and at the same time there was a very weak relationship between them. Halim and Hossain (1994) also observed the same result in Tangail district.

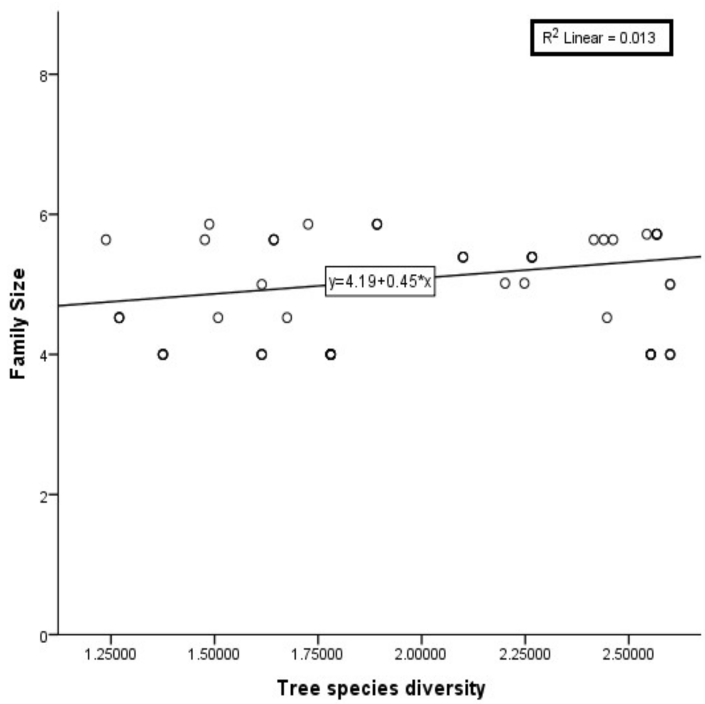


FIGURE 4.14 The relationship between family size of the farmers and tree species diversity

4.3.6 Relation between farm size of the farmers and tree species diversity

The farm size of the farmers and tree species diversity was examined by testing the following null hypothesis: "there is no relationship between the farm size of the farmers and tree species diversity". Figure 4.15 indicated a linear equation as: Y = 0.86x+ 0.21 (R^2 = 0.344), where R^2 value was positive, r = 0.586 and $p < 0.05$. So it indicated that there was a significant and moderate positive correlation between tree species diversity and farm size of the respondents.

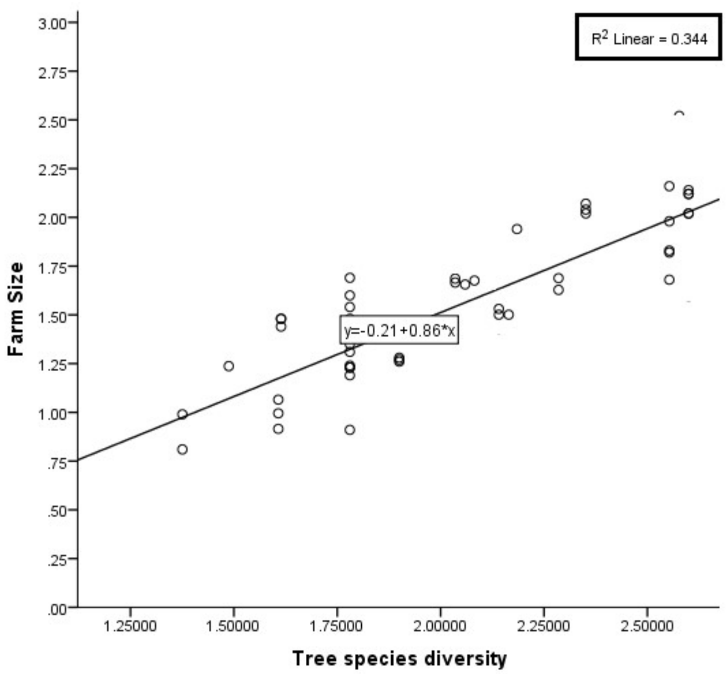


FIGURE 4.15 The relationship between farm size of the farmers and tree species diversity

4.3.7 Relation between homestead size of the farmers and tree species diversity

The homestead size of the farmers and tree species diversity was examined by testing the following null hypothesis: “there is no relationship between the homestead size of the farmers and tree species diversity”. Figure 4.16 indicated a linear equation as: Y = 0.09x + 0.02 (R^2 = 0.341), where R^2 value was positive, r = 0.584 and $p < 0.05$. So it indicated that there was a significant and moderate positive correlation between tree species diversity and homestead size of the respondents.

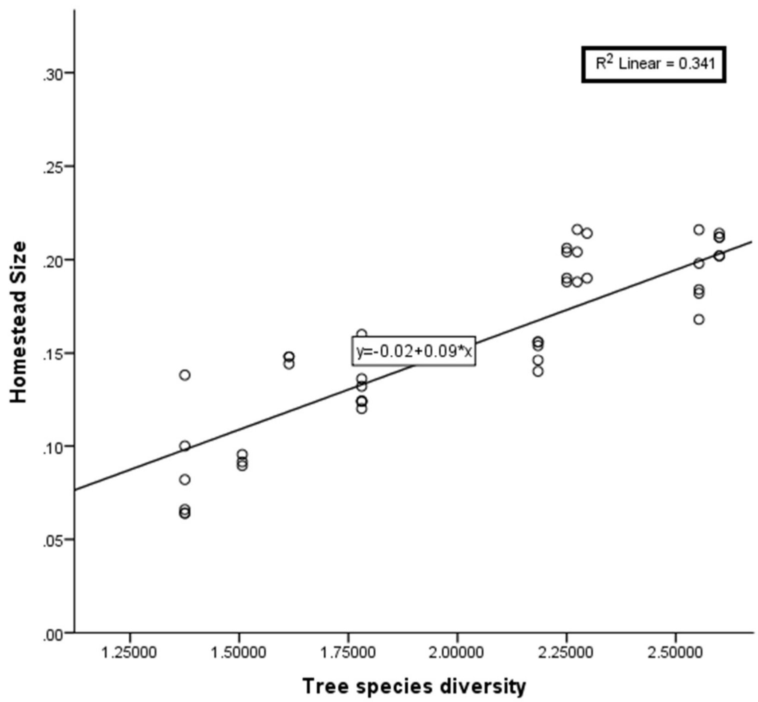


FIGURE 4.16 The relationship between homestead size of the farmers and tree species diversity

4.3.8 Relation between annual income of the farmers and tree species diversity

The relation between annual income of the farmers and tree species diversity was examined by testing the null hypothesis: "there is no relationship between annual income of the farmers and their attitude towards tree species diversity". Figure 4.17 indicated a linear equation as: Y = 0.003x+ 1.131 (R^2 = 0.077), where R^2 value was also positive, r = 0.277 and p=0.028 (> 0.01; < 0.05). which was significant at 0.01 level of probability. The relationship between the two concerned variables also showed positive trend. Hence, the concerned null hypothesis could be rejected. The findings indicate that annual income of the respondents had a significant relationship with tree species diversity and they were weakly correlated with each other in. Halim and Hossain(1994) also observed the same result in Tangail district.

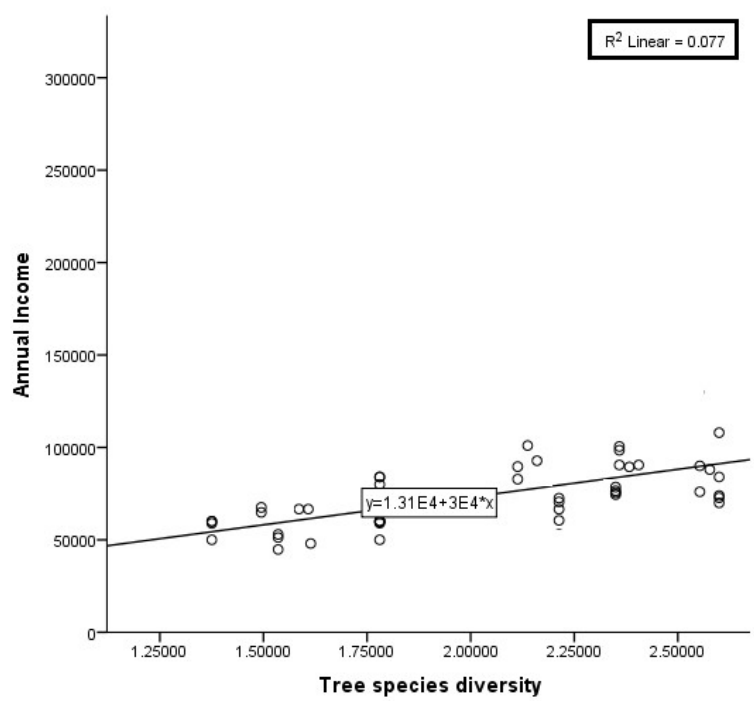


FIGURE 4.17 The relationship between annual income of the farmers and tree species diversity

4.3.9 Relation between livelihood condition of the farmers and tree species diversity

The relation between livelihood status of the farmers and tree species diversity was examined by testing the null hypothesis: "there is no relationship between livelihood status of the farmers and tree species diversity". Figure 4.18 indicated a linear equation as: Y = 0.34x+ 16.49 (R^2 = 0.549), where R^2 value was positive, r = 0.741 and $p < 0.05$. So it indicated that there was a significant and strongly positive correlation between the two concerned. It means that a person having higher tree species diversity in his/her homestead was likely to higher livelihood condition.

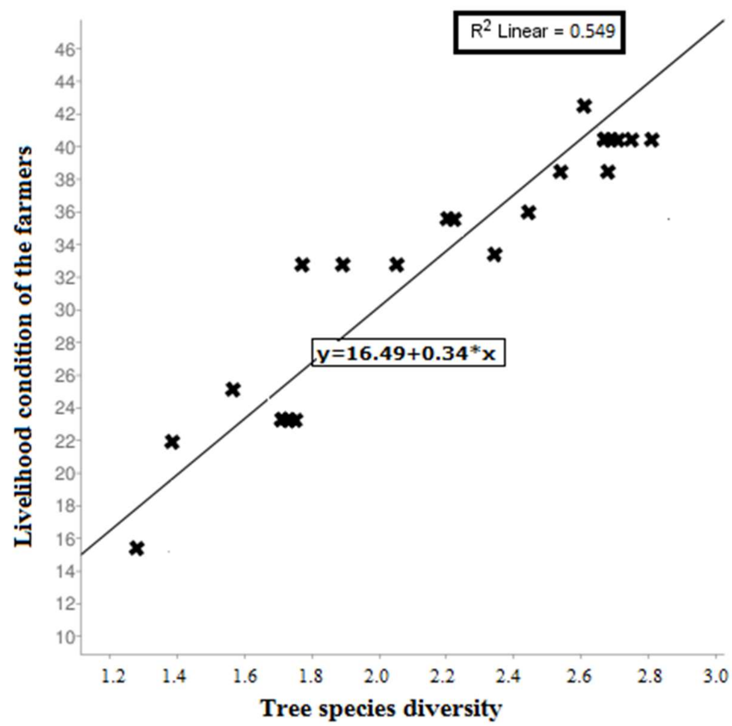


FIGURE 4.18 The relationship between livelihood condition of the farmers and tree species diversity

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

SUMMARY

The field survey was conducted in randomly selected four villages of the Chandpur district, namely Aruli, Kurali, Paranpur and Kahlthuri from 15 September to 25 December, 2016. These four villages are more or less similar in terms of the agricultural farming system, nature and condition of living, language, infrastructural facilities, organizational environment, and economic activities. A total of 63 households with farm were identified as representative of my study area. From each village, 12-20 farmers were randomly selected for face-to-face interviewing and data collection. In this study, structured and semi-structured interview schedules as well as several tools of the participatory rural appraisal were used to obtain necessary information. The collected data from respondents were analyzed using the Statistical Package for Social Science (SPSS, version 21.0) program and Microsoft Excel 2010. Both descriptive and analytical methods were employed in order to analyze the data. Nine characteristics were considered as independent variables to test the dependent variable – tree species diversity. The selected independent variables were measured through computing scores based on either scale or appropriate methodology which are followed by previous researchers. Both regression and correlation analysis were employed to find out the significant impact of tree species diversity on socioeconomic condition of farmers.

Different tree species were observed in the homestead area as diversified condition. From the accumulation of recorded species, fuel wood (26.67%), fruit/food (23.81%), timber (22.86%), medicinal (9.52 %), fodder (9.52 %), fence (3.81 %) and others species (3.81 %) were found (Table 4.15 and Figure 4.9). Data obtained from Species Diversity Index (2.58) show higher value than Index of Dominance (0.13) which represents less dominancy of the tree species with more diversity. The calculated value of Species Richness Index and Species Evenness Index was 11.13 and 1.62

respectively which represent the more richness of tree species and more evenly the total number of individuals is distributed among all possible tree species (Table 4.12).

Different types of relationship were shown between independent variables and tree diversity. Every relationship was shown by scatter diagram by plotting a linear line on graph for the better understanding of the findings. Among these the relationship between tree diversity and occupation showed highest positive significant correlation. The relationship of tree species diversity among different parameters varied from one to another.

CONCLUSION

Even though, there had no national forest in Chandpur district in Bangladesh, farm land trees could be exist trough passing various challenges, results of the present study showed that studied farmlands had considerable species richness and diversity. A total of 2604 trees, representing 39 genera and 23 families were recorded in the 63 farm plots of study sites.

Tree species diversity was positively significant by occupation, livelihood condition, farm size, homestead size, education and annual income. Tree species diversity didn't show significant relationship among gender, age and family size.

The impact of diversity of trees on farmer's socioeconomic condition is beyond of question as trees are the integral part of nature as well as human society. Most of the trees, in homestead are not planted in a planned way. There is enough scope to improve productivity in the homestead by replacing the existing tree species with the improved and/or exotic ones, planting trees in planned ways and improving management practices. Therefore, there is a great opportunity to improve the prevailing homestead agroforestry practices with modem agroforestry technologies for maximization of income towards promoting socioeconomic conditions of farmer.

RECOMMENDATIONS

In order to improve prevailing socioeconomic condition of the studied farmer, comprehensive initiatives are needed to be taken by the government organizations (GOs), non-government organizations (NGOs), development agencies, as well as rural society. By considering the overall aspect of this present study the following points can be recommended:

i. This type of research findings will be helpful to facilitate similar research in other district/area in Bangladesh. In this regard if all district/area carried out under similar research then it will represent the overall socioeconomic condition as well as pattern of tree species diversity in Bangladesh.

ii. To meet growing demand for tree products, many fruits and forest species can grow voluntarily without any management from the seeds sources of mother trees.

iii. Increasing awareness, facilitating need-based training and improving and encouraging of homestead plantings become a vital activity as such activities already common and practiced by most of farmers.

iv. Utilizing labor, family income earners and cultivable land,

Generally, designing appropriate management strategies and approaches should be required for domestication and integration of improved trees by diversifying and intensifying a wide range of priority species for meeting the needs of farmers and environmental services. It can assist policy makers and planners in finding solutions for engaging farmer in tree plantation program for improving socioeconomic condition and reducing poverty.

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APPENDICES

APPENDIX I: Interview schedule used in this study to assess farmer's socioeconomic condition

English version of an interview schedule

Department of agroforestry and environmental science

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Dhaka-1207

Interveiw schedule for data collection for the research on

'HOMESTEAD TREE SPECIES DIVERSITY AND IT'S IMPACT ON SOCIOECONOMIC CONDITION OF FARMERS IN CHANDPUR DISTRICT OF BANGLADESH''

(The interview schedule is entitled for a research study)

Serial no. :
Date:
Upazila:
Union:
Village:

"Please answer the following questions"

1. Age
How old are you?..................... Years

2. Education
Please state your level of education
a. Can read and write ( )
b. Can sign only ( )
c. I read upto…………… class
d. I've passed ………..…class

3. Occupation
a. Main occupation……………………..
b. Others………………………………

4. Family member

Sl. No.	Sex	Number
1.	Male	
2.	Female	
	Total	

5. Farm Size: Please furnish information on your land ownership

Sl. No.	Pattern of ownership of land	Area	
		Local unit	Hectare
1.	Homestead		
2.	Own land under own cultivation		
3.	Land taken from others on borga		
4.	Land given to others on borga		
5.	Land taken from others on lease		
6.	Others (specify)		
	Total		

6. Homestead Size

Sl. No.	Description	Area	
		Local Unit	Hectare
1.	Housing		
2.	Cowshed/courtyard		
3.	Area under Vegetation		
4.	Area covered with trees		
5	Fellow		
6.	Pond		
7.	Others(specify)		
	Total		

7. Annual Income

Sl. No.	Source of Income	Amount(Tk.)
1.	Agriculture	
2.	Non-agricultural	
3.	Labourer	
4.	Business	
5.	Transport and communication	
6.	Service	
7.	Construction	
8.	Religious Service	
9.	Rent and remittance	
10	Others	
11	Total	

8. Tree species in homestesd: Please list of tree species in your homestead

Sl. No.	Name of tree species	Amount(No.)	Uses
1.			
2.			
3.			
4.			
5.			

Thank you giving me your valuable time

APPENDIX II

Interveiw schedule for data collection for the research on

'HOMESTEAD TREE SPECIES DIVERSITY AND IT'S IMPACT ON SOCIOECONOMIC CONDITION OF FARMERS IN CHANDPUR DISTRICT OF BANGLADESH''

Instructions for Focus Group Discussions (FGDs)

Serial no. :
Upazila:
Union:
Village :

1. **Food availability[Give tick mark under the following parameter]**

Adequate = 3	Inadequate = 2	Shortage = 1

2. **Housing condition**

3 = Brick	2 = Tin	1 = Straw/ Clay

3. **Health situation**

Good = 3	Average = 2	Weak = 1

4. **Water facilities**

Tube well= 3	Shallow well = 2	Pond/Qup/Rivers = 1

5. **Sanitation**

Adequate = 3	Inadequate = 2	Scarcity= 1

6. **Participation in social activities**

Regularly= 3	Irregular = 2	Not at all = 1

7. **Freedom in cash expenditure**

Frequently= 3	Seldom= 2	Not at all= 1

APPENDIX III

Descriptive Statistics of Independent Variable

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation
AgeGroups	63	50.00	19.00	69.00	2520.00	40.0000	12.54797
Sex	63	1.00	1.00	2.00	85.00	1.3492	.48055
Education	63	16	0	16	468	7.43	3.359
Occupation	63	6	1	7	186	2.95	2.196
Family Size	63	6	2	8	320	5.08	1.834
Farm Size	63	2.41	.11	2.52	93.84	1.4895	.68105
Homestead Size	63	.24	.01	.25	9.41	.1494	.06803
Annual Income	63	272998	16000	288998	4559400	72371.43	50310.600
Livelihood status	63	20	10	30		16.92	5.45

APPENDIX-IV

Tree diversity measurement (Shannon-Weiner Index Calculation Table)

Sl_No	Species	Number	Pi	LnPi	Pi*LnPi	Percentage(%)
1.	*Mangifera indica*	432	0.165898618	-1.79638	-0.298016696	16.58986175
2.	*Spondias spp.*	3	0.001152074	-6.76619	-0.007795152	0.115207373
3.	*Areca catechu*	37	0.014208909	-4.25389	-0.060443082	1.420890937
4.	*Cocos nucifera*	222	0.085253456	-2.46213	-0.209904804	8.525345622
5.	*Phoenix sylvestris*	156	0.059907834	-2.81495	-0.168637438	5.99078341
6.	*Borassus flabellifer*	176	0.067588326	-2.69432	-0.182104578	6.758832565
7.	*Calamus spp.*	18	0.006912442	-4.97443	-0.034385476	0.69124424
8.	*Tamariandus indica*	3	0.001152074	-6.76619	-0.007795152	0.115207373
9.	*Carica papaya*	66	0.025345622	-3.67515	-0.093148944	2.534562212
10.	*Dipterocarpus turbinatus*	8	0.003072197	-5.78536	-0.017773771	0.307219662
11.	*Dilenia indica*	6	0.002304147	-6.07304	-0.01399319	0.230414747
12.	*Diospyros precatorices*	3	0.001152074	-6.76619	-0.007795152	0.115207373
13.	*Elaeocarpus tectorius*	4	0.001536098	-6.47851	-0.009951628	0.153609831
14.	*Erythrina variegate*	6	0.002304147	-6.07304	-0.01399319	0.230414747
15.	*Dalbergia sisso*	2	0.000768049	-7.17166	-0.005508185	0.076804916
16.	*Cajanus cajan*	3	0.001152074	-6.76619	-0.007795152	0.115207373
17.	*Lagerstroemia speciosa*	12	0.004608295	-5.3799	-0.024792154	0.460829493
18.	*Swietenia macrophylla*	82	0.031490015	-3.45808	-0.108895142	3.149001536
19.	*Azadirachta indica*	36	0.013824885	-4.28129	-0.059188273	1.382488479
20.	*Aphanamixis polystachya*	6	0.002304147	-6.07304	-0.01399319	0.230414747
21.	*Bombax ceiba*	5	0.001920123	-6.25537	-0.012011072	0.192012289
22.	*Albizzia procera*	56	0.021505376	-3.83945	-0.082568867	2.150537634
23.	*Albizia saman*	24	0.00921659	-4.68675	-0.043195854	0.921658986
24.	*Artocarpus heterophyllus*	724	0.278033794	-1.28001	-0.355886763	27.80337942
25.	*Ficus benghalensis*	31	0.011904762	-4.43082	-0.052747819	1.19047619
26.	*Ficus religiosa*	22	0.008448541	-4.77376	-0.040331319	0.844854071
27.	*Moringa oleifera*	2	0.000768049	-7.17166	-0.005508185	0.076804916
28.	*Musa spp.*	198	0.076036866	-2.57654	-0.195911797	7.603686636
29.	*Syzygium cumini*	11	0.00422427	-5.46691	-0.0230937	0.422427035
30.	*Psidium guajava*	60	0.023041475	-3.77046	-0.086876946	2.304147465

Sl_ No	Species	Number	Pi	LnPi	Pi*LnPi	Percentage(%)
31.	*Averrhoa carambola*	6	0.002304147	-6.07304	-0.01399319	0.230414747
32.	*Oxalis corniculata*	50	0.019201229	-3.95278	-0.075898253	1.920122888
33.	*Zizyphus mauritiana*	40	0.015360983	-4.17592	-0.064146306	1.53609831
34.	*Neolamarckia cadamba*	21	0.008064516	-4.82028	-0.038873238	0.806451613
35.	*Aegle marmelos*	11	0.00422427	-5.46691	-0.0230937	0.422427035
36.	*Citrus grandis*	16	0.006144393	-5.09222	-0.031288573	0.614439324
37.	*Citrus limon*	13	0.00499232	-5.29985	-0.026458568	0.499231951
38.	*Litchi chinensis*	30	0.011520737	-4.46361	-0.051424039	1.152073733
39.	*Tectona grandis*	3	0.001152074	-6.76619	-0.007795152	0.115207373
Total		**2604**			**-2.57701369**	**100**

APPENDIX-V

Tree diversity Measurement(Shannon-Weiner Index) after categorization

Category	Species	Number	Pi	LnPi	Pi*LnPi
1	Sissu	2	0.03333333	-3.4011974	0.11337325
	Sajna	2	0.03333333	-3.4011974	0.11337325
	Amra/Hog pulm	3	0.05	-2.9957323	0.14978661
	Tamarind/Tetul	3	0.05	-2.9957323	0.14978661
	Gab(Deshi)	3	0.05	-2.9957323	0.14978661
	Arhar	3	0.05	-2.9957323	0.14978661
	Teak/Segun	3	0.05	-2.9957323	0.14978661
	Jalpai	4	0.06666667	-2.7080502	0.18053668
	Shimul/Cotton	5	0.08333333	-2.4849066	0.20707555
	Chalta	6	0.1	-2.3025851	0.23025851
	Mandar	6	0.1	-2.3025851	0.23025851
	Rana/Petraj	6	0.1	-2.3025851	0.23025851
	Kamranga	6	0.1	-2.3025851	0.23025851
	Garjan	8	0.13333333	-2.014903	0.26865374
	Total	**60**			**2.55297957**
2	Jam/Black Berry	11	0.02956989	-3.5209986	0.10411555
	Bel/Wood Apple	11	0.02956989	-3.5209986	0.10411555
	Jarul	12	0.03225806	-3.4339872	0.11077378
	Lebu/Lemon	13	0.03494624	-3.3539445	0.11720774
	Jambura/Pummelo	16	0.04301075	-3.1463051	0.13532495
	Bet	18	0.0483871	-3.0285221	0.14654139
	Kadam	21	0.05645161	-2.8743714	0.1622629
	Aswatha	22	0.05913978	-2.8278514	0.16723852
	Shil Koroi/Raintree	24	0.06451613	-2.74084	0.17682839
	Litchi	30	0.08064516	-2.5176965	0.20304004
	Banyan/Bat	31	0.08333333	-2.4849066	0.20707555
	Neem	36	0.09677419	-2.3353749	0.22600402
	Betelnut	37	0.09946237	-2.3079759	0.22955675
	Kul	40	0.10752688	-2.2300144	0.23978649
	Amrul	50	0.1344086	-2.0068708	0.26974071
	Total	**372**			**2.59961234**
3	Koroi	56	0.21212121	-1.5505974	0.3289146
	Payera	60	0.22727273	-1.4816045	0.3367283
	Papaya	66	0.25	-1.3862944	0.34657359
	Mahogany	82	0.31060606	-1.1692299	0.36316988
	Total	**264**			**1.37538638**
4	Khejur/Date Palm	156	0.08176101	-2.5039548	0.20472587
	Tal/Palmyra Palm	176	0.09224319	-2.3833269	0.21984566
	Kola/Banana	198	0.10377358	-2.2655438	0.2351036
	Coconut/Narkel	222	0.1163522	-2.1511335	0.25028911
	Mango	432	0.22641509	-1.4853853	0.33631364
	Kathal	724	0.37945493	-0.9690195	0.36769921
	Total	**1908**			**1.6139771**

APPENDIX-VI

Computed co-efficient of correlation (r) between Dependent variable and Independent variables (N = 63)

Correlations											
		Diversity	**Age Groups**	**Sex**	**Education**	**Occupation**	**Family Size**	**Farm Size**	**Homestead Size**	**Annual Income**	**Livelihood**
Diversity	Pearson Corr.	1	-.078	-.030	.391**	.958**	.114	.586**	.584**	.277*	.741**
	Sig. (2-tailed)		.544	.813	.002	.000	.373	.000	.000	.028	.000
Age Groups	Pearson Corr.	-.078	1	.048	-.052	-.102	.055	.028	.029	-.038	-.102
	Sig. (2-tailed)	.544		.708	.688	.427	.670	.830	.824	.765	.427
Sex	Pearson Corr.	-.030	.048	1	-.174	-.091	-.032	-.057	-.057	-.308*	-.091
	Sig. (2-tailed)	.813	.708		.172	.478	.804	.656	.658	.014	.478
Education	Pearson Corr.	.391**	-.052	-.174	1	-.019	.285*	.250*	.250*	.474**	-.019
	Sig. (2-tailed)	.002	.688	.172		.882	.024	.048	.048	.000	.882
Occupation	Pearson Corr.	.958**	-.102	-.091	-.019	1	-.115	.005	.004	.081	-.102
	Sig. (2-tailed)	.000	.427	.478	.882		.369	.972	.977	.528	.427
Family Size	Pearson Corr.	.114	.055	-.032	.285*	-.115	1	-.126	-.126	.108	-.091
	Sig. (2-tailed)	.373	.670	.804	.024	.369		.325	.327	.401	.478
Farm Size	Pearson Corr.	.586**	.028	-.057	.250*	.005	-.126	1	1.000**	.090	-.019
	Sig. (2-tailed)	.000	.830	.656	.048	.972	.325		.000	.482	.882
Homestead Size	Pearson Corr.	.584**	.029	-.057	.250*	.004	-.126	1.000**	1	.089	.005
	Sig. (2-tailed)	.000	.824	.658	.048	.977	.327	.000		.489	.972
Annual Income	Pearson Corr.	.277*	-.038	-.308*	.474**	.081	.108	.090	.089	1	.004
	Sig. (2-tailed)	.028	.765	.014	.000	.528	.401	.482	.489		.977
Livelihood	Pearson Corr.	.741**	-.102	-.091	-.019	-.102	-.091	-.019	.005	.004	1
	Sig. (2-tailed)	.000	.427	.478	.882	.427	.478	.882	.972	.977	