TREE SPECIES DIVERSITY IN THE HOMESTEADS AND ITS IMPACT ON SOCIOECONOMIC CONDITION OF THE FARMERS IN NILPHAMARI DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled ***'TREE SPECIES DIVERSITY IN THE HOMESTEADS AND ITS IMPACT ON SOCIOECONOMIC CONDITION OF THE FARMERS IN NILPHAMARI DISTRICT'*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), 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* ***Md. Kamruzzaman Sumon****, Registration number:* ***13-05287,*** *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:
Place: Dhaka, Bangladesh

Dr. Jubayer-Al-Mahmud
Associate Professor
Supervisor

DEDICATED

TO

MY BELOVED

PARENTS AND SUPERVISOR

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ABSTRACT

Plant diversity has a broad socio-economic and agro-ecological role in home gardens, including food production and a wide range of other products. The recent study was conducted in eight villages of four unions under Kishoreganj and Saidpur upazilas in Nilphamari district to explore the tree species diversity and its impact on socio-economic condition of the farmers. The assessment was carried out using a purposive random sampling process. Based on the accumulation of 60 households from marginal, small, medium and large categories, information was concentrated. It identified a total of 1871 trees, representing 23 families. Determination of the relative abundance of the tree species showed that 21.17% of homestead agroforestry is *Mangifera indica* followed by *Artocarpus heterophyllus* (16.41%) and *Cocos nucifera* which occupies 8.93%. The Shannon-Wiener index (H) was used to evaluate the diversity of the trees and the evaluation showed that the area's diversity of tree species was 2.723. The Shannon-Wiener index (H) varies from 1.22 to 2.72 according to plant categorization. The diversity of tree species was positively influenced by livelihood conditions of farmers but adversely affected by gender. Socio-economic aspects of farmers had direct impact on livelihood status, farm size, homestead size, annual income and organizational participation. The results of this study may contribute to modifying agroforestry programs for the implementation of future tree planting activities in different economic and environmental circumstances for different target populations.

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

CHAPTER 1

INTRODUCTION

Bangladesh is one of the most densely populated nations on the planet with a population of 164.80 million struggling hard to feed her nation and with a yearly growth rate 1.37 (BBS, 2019). There are 35.20 million residences in Bangladesh and more than 74% of the population lives in the provincial territories (Statista, 2020). Approximately 7% of the total land area (0.53 million hectares) of 8.4 million hectares of cultivable land in Bangladesh is owned by properties which are remarkably profitable (BBS, 2005). As per Bangladesh Bureau of Statistics (BBS, 2011) and Forest Department (FD), the total area of 2.52 million hectares, which accounts for almost 17.4% of the land mass, is forest, including the homestead plantation. However it may be the true tree inclusion territory of Bangladesh is uniquely assessed at 9.10% of the country. Most of the forests are located in the southeast and southwestern regions of the country. Of the 64 districts of Bangladesh, 35 have no common forest (Bhuiyan, 1994).

In Bangladesh, forest productivity is also surprisingly poor (0.5-2.5m^3/ha/yr) for both plantation and characteristic backwoods (ADB, 1993). Forests provide wellsprings of earnings and means of benefits, provide work opportunities, and include supplies of monetary qualities that may help to improve family livelihoods –particularly in country territories. The FAO reports that forest industries contribute more than US$ 450 billion to national income, accounting for approximately 1 % of global GDP in 2008 and supplying 0.4% of the global labor force with formal employment (FAO, 2012).

A promising production system for maximizing yield is agroforestry, the integration of trees, crops and vegetables on the same land area (Nair, 1990). One of the oldest, most prospective and promising agroforestry systems in Bangladesh are homestead agroforestry among the various agroforestry systems. Homestead is a system of land use involving intimate association with

seasonal vegetables, the purposeful management of multipurpose trees and shrubs (Fernandes and Nair, 1986). Homestead has been regarded as an important social and economic unit of rural households, on which a diverse and stable supply of economic products and advantages is derived (Shackleton *et al.*, 2008). Over the past millennium, continued cultivation and use of home gardens have played a key role in achieving sustainable livelihoods and self-sufficiency successfully (Maroyi, 2009). In our country, there are approximately 25.49 million homesteads covering approximately 0.80 million ha of land (BBS, 2011).

Homesteads are, from a conservation point of view, in situ conservation areas of a wide variety of plant biodiversity (Mannan, 2000). Homegarden is a well-established land use system in Bangladesh, where natural forests cover less than 10% of homestead gardens that are established by at least 20 million households and represent one possible biodiversity conservation strategy (Kabir and Webb, 2008). On the other hand, Bangladesh's state forest covers 2.52 million hectares of land, accounting for 17 % of the country's land area and providing only 12 % of timber (Poffenberger, 2000). There are broad socio-economic and agro-ecological roles in the diversity of multipurpose tree species in the home garden, including food production and a wide range of products along with firewood, fodder, spices, medicinal plants and the avoidance of climate-related hazards generally associated with monoculture production systems. 70% of timber and 90% of fuel wood and bamboo are supplied by Multipurpose Tree Species in homestead forests (Singh, 2000). Multipurpose tree species cultivated in the home are a source of fruit, fuel wood, food crops and building materials. In the light of the prevailing fuel wood scarcity and excessive deforestation in Bangladesh, it is important to improve the system of homestead agroforestry (Leuschner and Khaleque, 1987).

The diversity of MPTs associated with other species in the home garden contributes to soil structure formation and preservation, moisture conservation,

facilitates nutrient recycling, and also reduces the vulnerability of the environment to climate change. Multipurpose trees add nutrients to the surface of the subsoil; they provide shade and slow erosion. During times of hardship and natural disaster, the homesteads of Bangladesh are a source of livelihood for many farmers and serve as a safety net. Farmers want to use their farm area for maximum production. However, there is no program to improve the overall productivity of homestead forests or to produce yield-improving technology.

There is a pressing need for systematic research in these areas, as this would allow us to evaluate the role of this system in other modern production systems and to assess the sustainability of the system. Further studies on homestead tree composition in the specific area of Bangladesh are needed, which may be an important tool in sustainable homestead forestry (Millat-e-Mustafa *et al.*, 2000). Most of the previous studies provide information on native tree species only. Very few studies have been found to investigate tree resources in the district as a whole, taking into account all the factors that can lead to a realistic figure on tree species composition and structure. The present study therefore aims to identify the diversity of tree species in homesteads and the influence of the diversity of tree species on farmer's socio-economic conditions around the eight villages of two upazilas in the Nilphamari district, located in the northern part of Bangladesh. More specifically, the study was carried out with the following objectives:

i) To investigate the demographic and socio-economic characteristics of the farmers in Nilphamari district;
ii) To evaluate the tree species diversity existed in the district; and
iii) To find out the relationships between tree species diversity and the socio-economic condition of farmers in Nilphamari district

CHAPTER 2

REVIEW OF LITERATURE

This chapter offers a brief review of the previous studies and opinions of the study-related researchers collected from textbooks, journals, dissertations, reviews and other forms of publication. This study is primarily concerned with the diversity of multipurpose tree species in homestead agroforestry among farmers at different levels in a particular region of Bangladesh.

2.1 Concepts of Agroforestry

According to Nair (1983) "Agroforestry is a collective term for all land use systems and technology where woody perennials (trees, shrubs, palms, bamboo etc.) are cultivated purposely, either in spatial mixture or in temporal, in the same land management system as agricultural crops or animals."

In fact, agroforestry does not mean planting trees in fields or other areas, but rather having an efficient land management system that can ensure more development in a healthy ecological climate. It helps to resolve the lack of conventional agriculture, which is regularly represented as low production at the expense of relatively high investment, leading to environmental degradation (Khalid and Bora, 2000).

Saka *et al.* (1990) argued that there are ecological and economic interactions between the various components in agroforestry systems. Agroforestry can provide a sound ecological foundation for improved crop and animal production, more stable economic returns and greater variety of social benefits on a sustained basis.

According to Lundgren and Raintree (1982) agroforestry is a collective term for land use systems and technologies where forest perennials are purposely grown in

the same land management units as agricultural crops and/or animals in some sort of spatial arrangement or time series.

Nair (1993) claimed that in agroforestry literature, the terms "systems" and "practices" are sometimes used synonymously. However, between these two definitions, a certain distinction can be made. The agroforestry system consists of one or more agroforestry practices commonly practiced in a given locality or area, typically defined in terms of their biological composition and arrangement, technical management level or socio-economic characteristics.

MacDicken and Vergara (1990) stated that agroforestry is a way of overseeing or using land (e.g. land use) that combines trees or shrubs with agricultural/ horticultural crops or potentially domesticated animals.

2.2 Concept and importance of homestead Agroforestry

Haque (1996) noted that it is necessary to grow fruit, fuel wood and timber, as well as to restore harmony in the local / common fruit tree ecosystem along with selected multipurpose trees (MPTs) in and around the homesteads. In addition, fruits, spices and ornamental herbs or shrubs etc. may be collected from homegardens. By practicing homestead agroforestry, the requirements of fruit, herbs, forage, spices and fuel wood and timber may be met to a large degree in line with the principles of agroforestry.

Leuschner and Khaleque (1987) concluded that in Bangladesh’s economy, the homestead agroforestry system is very important. Agroforestry, in fact, is a concept that inevitably brings homesteads to the forefront. In a country such as Bangladesh, in particular, the mere act of focusing on homestead areas will cover more than three-fourths of all agroforestry issues at large.

Okafor and Fernandes (1987) suggested that various homesteads deliver various advantages including diversified production, risk minimization, increased losses

due to inadequate storage facilities, improved nutrient cycling and nutrient productivity that monocropping systems and good conservation due to continuous land cover.

Doglas and Hart (1973) noted that trees are an important part of both the home garden and the climate. Trees provide human beings and nature with direct and indirect advantages. It has a great potential to feed men and animals, regenerate soil, restore water systems, handle floods and droughts, and create more favorable microclimates and better living conditions for mankind.

Doglas (1983) reported that about 85 percent of all wood consumed, including almost 90 percent of all fuel wood and 80 percent of all timber, was produced by homestead forests.

According to the FAO (1986) homegardens are one of the most elaborate and most commonly used indigenous forest structures in tropical and sub-tropical regions.

Fernandes and Nair (1986) claimed that the home garden is a land use system involving the deliberate management of multipurpose trees and shrubs in an intimate relationship with annual and perennial agricultural crops as well as with invariable livestock within the compounds of a single property.

Das and Das (2005) argued that the homegardens are a typical agroforestry system with a complex structure and multiple roles, and that the homegardens are sites for the protection of a wide range of plants, both wild and domesticated, due to their use in households.

Grado and Husak (2004) noted that a number of studies have been conducted to assess the financial feasibility of agroforestry systems. The financial costs of setting up, maintaining and producing different combinations of agricultural and timber crops, as well as the possible gross revenues and profitability, have been analyzed in many of these reports.

2.3 Area and land utilization in homestead Agroforestry

Haque (1996) estimated that, depending on the location and the financial position of the house owner, the area of homesteads in Bangladesh ranges from 0.1 to 1.0 ha. He claimed that housing occupies around 10-25 percent of the area and that the remaining space is used according to the principles of agroforestry for the production of trees and vegetables.

Akter *et al.* (1989) conducted a study at six Bangladesh agro-ecologically deficient locations and recorded that the small farm, owned by marginal and small farmers, has a housing area of 20-21 percent, tree coverage of 29-37 percent and vegetable cultivation of 9-14 percent. Around 16 percent of the land is housed in larger homes owned by large farmers, 33 percent under tree cover and 12 percent under vegetable cultivation.

Miah *et al.* (1990) recorded that the average size of homesteads was very small, ranging from 0.06 to 0.40 ha, in Ishurdi upazila of Pabna district. They also discovered a strong link between farm size and homestead size.

Chowdhury (1988) recorded that a study in Pabna district estimated that the number of plants per homestead unit gradually decreased in the marginal farms from 8 plants $10m^{-2}$ to 3 plants $10m^{-2}$. He noted that in crisis times, 77 percent marginal, 25 percent small and 42 percent larger farmers felt trees cash. In addition, he found that no formal advice on planting and maintaining trees was given to 89 percent of farmers.

2.4 Species composition of homestead Agroforestry

A survey was conducted by Egawa *et al.* (2004) to investigate the traditional methods embraced by farmers / villagers and the use of crops, including legumes, vegetables and fruit trees, in West Java, Indonesia. For their own home consumption and cash income, farmers have cultivated different kinds of fruit

trees, medicinal trees, food crops and vegetables around their homes. Modern varieties of temperate vegetables, including Irish potatoes, were found in the highlands. Chinese cabbage, cabbage, carrot and tomatoes were cultivated in home gardens, while indigenous crops were well maintained. Turmeric, ginger and/or lemon were the medicinal plants grown in home gardens.

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

Alison (1994) reported that the density of species (number of species per hectare) decreased as the size of the garden increased.

Farnandes and Nair (1986) and Lawrence and Hardostry (1992) claimed that the magnitude and production rate of goods, as well as the cash and maintenance rate of the homegarden method, depends on the composition of the species. Environmental and socio-economic factors, as well as dietary preferences and local consumer demands, have largely influenced the choice of species.

Khan *et al.* (1988) studied that vegetables are often creeper or climbing forms grown in the homestead area. The climbing on the platform made up of bamboo, the houses roof, perennial plant species, the tree branch, etc. Perennial plant species were categorized according to cultivation i.e. random and deliberately cultivated. Spontaneous cultivated species are mainly wood for burning.

Dasgupta *et al.* (1988) showed that farmers in the homestead cultivated lemon, guava, jujube, papaya, amaranth, bitter gourd and eggplant. Coconut, date palm, betel nut and lemon have also been cultivated. Depending on farm categories and

homestead sizes, vegetables grown in the homestead varied. A large variety of fruits and vegetables are grown by large farmers. In replacing perennial trees, farmers were not interested. The ability of the homestead was high, which could be enhanced by replacing fast-growing nitrogen-fixing plants in the less efficient trees/shrubs with more fuel, fodder and green manure.

2.5 Homestead Agroforestry structures

Millat-e-Mustafa (1997) reported that a broadly consistent vertical structure has been shown in the homegardens throughout the country and many significant species are common in all regions. The homegardens have a canopy configuration that is multistoried.

Haque (1994) showed that homestead trees can be provided the required canopy structure as desired by the owners of the property, under which vegetables, spices and some ornamental herbs and shrubs can be grown.

Perare and Rajapakse (1989) reported that it is possible to distinguish four canopy layers. Of these studies, the highest is over 10 m, third layer 2.5-10 m, second layer 1.0-2.5 m and the first layer in Kandyan homestead is less than 1.0 m. Moreover, in Srilanka, over 70 percent of the Kandyan homesteads had 50 percent or more canopy cover.

Fernandes and Nair (1986) noted that homesteads are distinguished by high species diversity and the most conspicuous characteristics of all homesteads are typically three to four vertical canopy structure and compatible species admixture. Contrarily to the apparent appearance of random arrangement of species, the gardens are carefully laid out in a structure with each part having a particular place and purpose.

2.6 Socioeconomic uses of homestead Agroforestry

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**.**

Agarwal (2001) pointed out that the fuel wood crisis has to do with its country characteristics, zone characteristics and rural-urban implications. In most developed countries, wood accounts for less than 1% of electricity, compared to more than 90% in most developing countries. It is clear from this statement that the fuel-wood crisis is taking place in the developing world.

Wickens *et al.* (1985) reported that 75 percent of tropical Africa's tree species (7,000-10,000) are used for browsing. Fodder trees contribute in various ways to the overall food security of households: they contribute significantly to domestic animal production, which in turn affects the supply of milk and meat and contribute to the preservation by promoting agricultural production of draught livestock and manure produced for organic fertilizers.

Due to rising fuel wood shortages, Haq (1986) estimated that the price of fuel wood has risen 10-15 times over the past 15 years. The availability of forest products in Bangladesh decreases while demand rises over time, as the population increases and the forest area decreases due to population pressure. There is no price control for wood for fuel.

In Bangladesh, fuel timber shortage is very prevalent. The country's current annual demand for fuel wood stands at 2.04 million m^3 and for wood at 0.92 million m^3, resulting in a deficit of 1.42 million m^3 of fuel wood and 0.16 million

m^3 of wood. From the above, it is estimated that 88.5% of wood and 48.9% of fuel wood derive from homestead timber (Hossain and Shailo, 1987).

2.7 Income from homestead Agroforestry

Strizaker *et al.* (2002) projected that with decreasing crop season rainfall and increasing seasonal fluctuations, and possibly when tree products have a direct economic gain, the success of a tree or crop mixture is less likely.

Awal *et al.* (2002) found that for all groups of farmers, homestead fruit and vegetable practices gained considerable revenue. To a larger degree, women are active in the family decision-making process. Evidence was more striking in areas such as family planning, children's education, poultry growing fruit and vegetables and the marriage of sons and daughters.

Rahman (1995) demonstrated the effects of homestead crop production on family income and women's status under homestead agroforestry (HAF) practices. The data from households practicing HAF showed that these farms received major income and output gains. Higher social status was attained by the women of the households. In particular, the gender status of these households has improved dramatically, as demonstrated by the increased involvement of female HAF practitioners in decision-making on key socio-economic issues in households.

Halim and Hossain (1994) reported that no significant revenues were produced from vegetable production in this homestead because there is very little space for vegetable production and most of the tree-shaded areas.

2.8 Diversity of tree species in homestead Agroforestry and their importance in biodiversity conservation

Harvey and Haber (1999) have shown that remaining timber species in the field can play a key role in maintaining biodiversity within farming systems because of the absence of ecosystems and resources in the fields. For a number of bird and bat

species, they often serve as important nesting, feeding, and roosting sites. They provide many migratory birds with transient habitats as well. The presence in crop fields of woody species also favors the survival of native forest plants.

A country's biological resources can be measured in terms of its biological diversity. The total diversity of life forms (microbes, fungi, plants and animals) on earth is biological diversity or bio-diversity. To define the number, variety and variability of living organisms, the word bio-diversity is also widely used. Defining bio-diversity in terms of genes, habitats and ecosystems has become a common practice. Biodiversity is very commonly used as a synonym of species diversity, in particular species richness, which is the number of species in a habitat site. Perhaps the living world is most widely considered in terms of species (Global Biodiversity, 1992).

Hossain and Bari (1996) said that approximately 25 species of fruit trees and 30 species of timber, fuel wood and industrial wood trees are clustered in rural Bangladesh's homesteads. There are habitats for several species of herbs, shrubs and creepers. Homestead, therefore, is a diverse ecosystem and differs with small ecological changes from place to place. In order to determine the interactions of trees and crops and their relationship with social and economic parameters, it is therefore important to research the homestead agroforestry systems of each locality.

The incorporation of woody species into crop fields was proposed by Sanchez *et al.* (1997) as one way to diversify agro-ecosystems in a way that is beneficial to the environment and can maintain and possibly enhance biodiversity. They could provide soil fertility replenishment and could also provide forest products that are marketable.

Schelas and Greenberg (1996) noted that conservationists have based their attention in the tropics on the preservation of natural trees and forests, and have

not paid much attention to the widely scattered woody species of farmland until recently. However, these patches are often critical components of the farmer's environment as a source of products and environmental services that are of importance to farmers' livelihoods and welfare.

Nikiema (2005) claimed that the role of woody species in these ecosystems has been recognized to play an important role in preserving biological diversity.

2.9 Factors influencing homestead tree species diversity

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

Scherr (1995) noted that, due to physical and socio-economic factors, the number of tree species and the number of individual trees on farms differs. Household resources, especially ground, have an effect on the diversity of tree species. For example, farmers with limited land holdings, because the available land is mainly used to grow crops for consumption, cannot have a large stock of trees. On the other hand, large holders might produce a large volume of wood.

CHAPTER 3

MATERIALS AND METHODS

The study was conducted to explore the diversity of homestead tree species and their impact on the socio-economic status of the farmers in Nilphamari district. A chronological overview of the methodology used for this study is given below:

3.1 Description and geographical location of the study area

The study was conducted in eight villages under four unions of two upazila in Nilphamari district. The study area is located in the northern part of Bangladesh. The Nilphamari district is situated between 25º44' and 26º19' north latitudes and between 88º44' and 89º12' east longitudes. The total area of the district is 1546.59 sq. km. (597.00 sq. miles) of which 33.54 sq. km. (12.95 sq. miles) is riverine and 6.26 sq. km (2.42 sq. miles) is under forest. The district consists of 6 upazilas, 61 unions, 355 mauzas, 361 villages, 4 paurashavas, 42 wards and 83 mahallas. Administratively this district is divided into 6 upazilas namely Nilphamari Sadar, Dimla, Domar, Jaldhaka, Kishoreganj and Saidpur (Banglapedia, 2016). Kishoreganj and Saidpur upazilas were under the study. Location of the Nilphamari district and the study area were shown in the Figure 1 and the study area is shown in the Figure 2.

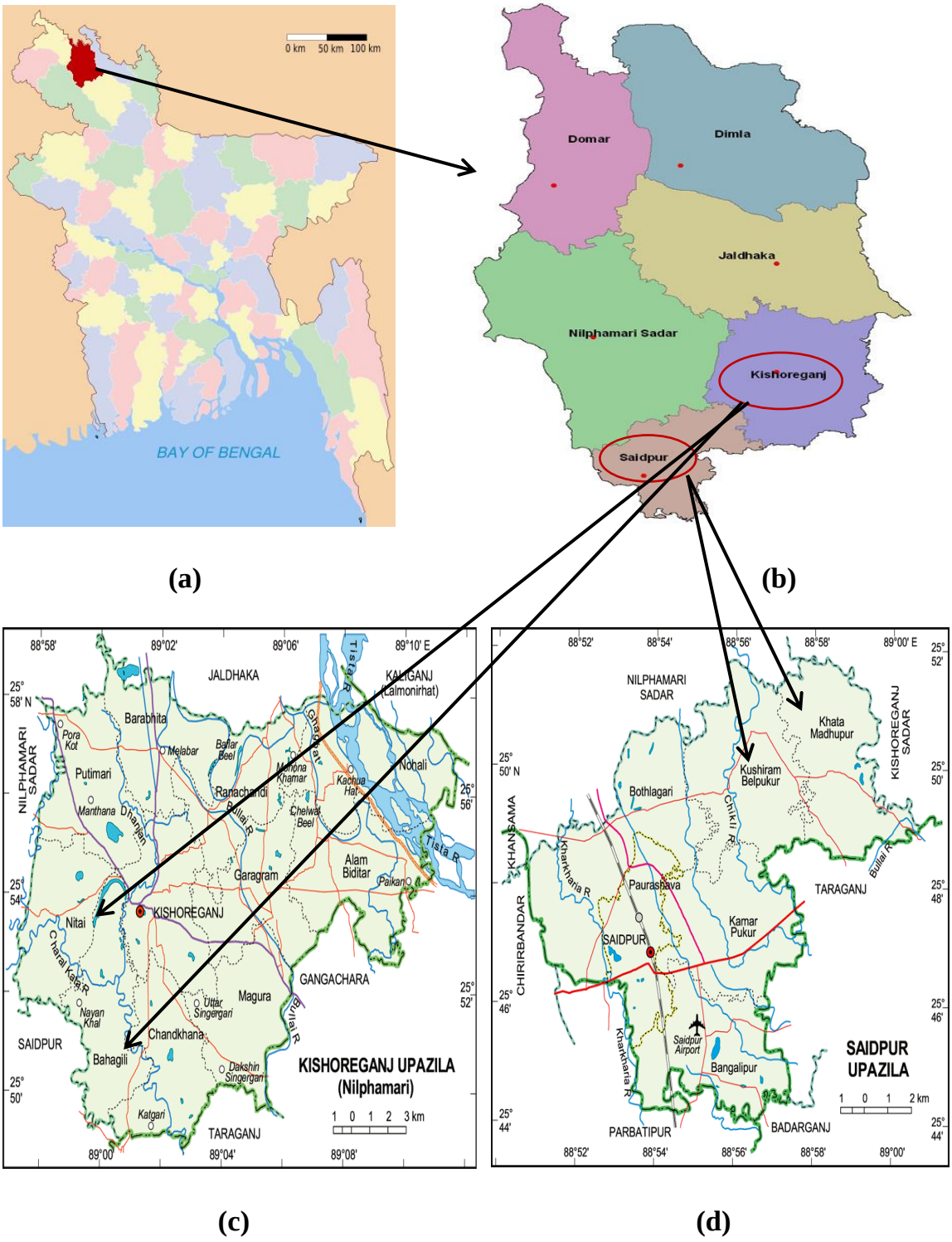

Figure 1: Stepwise location of the study area where (a) Bangladesh (b) Nilphamari district (c) Kishoreganj Upazila (d) Saidpur Upazila (Source: https://www.thebangladesh.net/nilphamari-district.html)

3.2 Physiography of the study area

The Nilphamari district belongs to the Agro-Ecological zone (AEZ)-3 i.e.; Tista Meander Flood Plain (FAO, 1988). Out of the total land 35% is high land, 51% medium high land and 14% others.

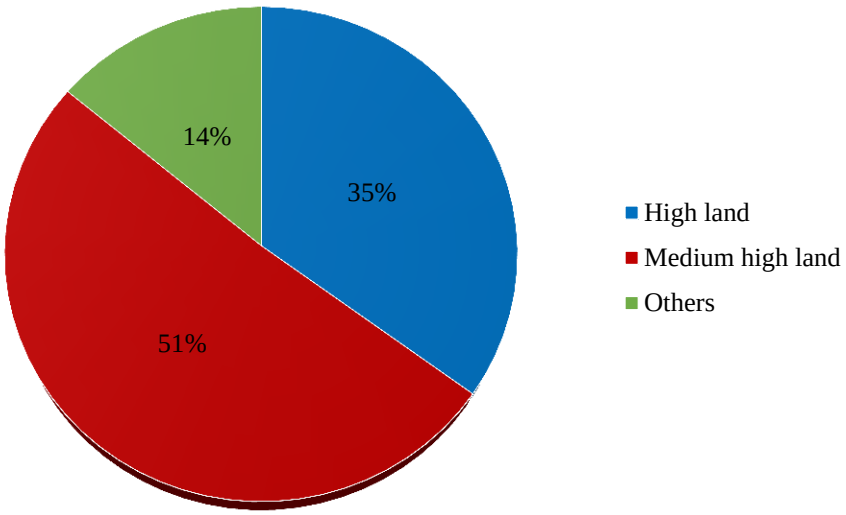

Figure 2: Land distribution of the study area

3.3 Agro-Ecological Zone (AEZ) of the study area

The Nilphamari districts belongs to the Agro-Ecological Zone- 3 i.e.; Tista Meander Floodplain (9,468 sq. km.). This region occupies the major part of the Tista floodplain as well as the floodplain of the Atrai, Little Jamuna, Karatoya, Dharla and Dudhkumar Rivers. Most areas have broad floodplain ridges and almost level basins. There is an overall pattern of olive brown, rapidly permeable, loamy soils on the floodplain ridges, and grey or dark grey, slowly permeable, heavy silt loam or silty clay loam soils on the lower land and parent materials medium in weatherable K minerals. Eight general soil types occur in the region, moderately acidic throughout, low in organic matter content on the higher land, but moderate in the lower parts. Fertility level is low to medium. Soils, in general, have good moisture holding capacity.

3.4 Soil type of the study area

Tista Meander Flood Plain occupies most of the land of the Nilphamari district. There is an overall pattern of olive brown, rapidly permeable, loamy soils on the floodplain ridges, and grey or dark grey, slowly permeable, heavy silt loam or silty clay loam soils on the lower land and parent materials medium in weatherable K minerals. Eight general soil types occur in the region, moderately acidic throughout, low in organic matter content on the higher land, but moderate in the lower parts. Fertility level is low to medium. Soils, in general, have good moisture holding capacity.

3.5 Climate

Annual average temperature varies from maximum 32.3°C to minimum 11.2°C and annual rainfall is 2931 mm.

3.6 Land use

Main cereals are rice and then wheat. Other cereals are jab, barley, cheena, maize, kaun, bajra and joar. Main and common pulses are gram, mung, lentil, arhar, gari kalai, khesari and pea. Main oil seeds are rape and mustard, sesamum, linseed, groundnut, soybean**,** sunflower and castor. Farmers grow both summer and winter vegetables. Main vegetables are potato, brinjal, raddish, arum, lady's finger, cauliflower, cabbage, bean, tomato, patal, gourd, cucumber, pumpkin, knoll-kal-turnip, dhundal, barbati, khirai, chichinga, carrot, kakrol and sak. Main cash crops are jute, mesta, sunhemp, cotton, sugarcane and tobacco. The main spices include turmeric, ginger, chillies, onion, garlic, corriander, black cumin and ani seed. Dhaincha and other smaller plants used as cooking-fuel.

3.7 Agriculture holding

An agricultural holding is a single-management techno-economic unit of agricultural production containing all livestock held and all land wholly or

partially used for agricultural production purposes, irrespective of title, legal type or scale. Either an individual holder or two or more individuals or holders together or a judicial person such as a corporation, cooperative or government agency may practice single management. A holding can consist of one or more parcels (land fragments) situated in one or more areas or mauzas, or in more than one administrative unit or division, given that all separate fragment parcels form part of the same technical unit under the same management's operational control. The term encompasses virtually all holdings/households engaged in both crop and livestock agricultural production. Some agricultural holdings do not have significant agricultural property, such as livestock holdings, poultry and hatcheries for which property is not an indispensable input for production.

Table 1: Land area of Kishoreganj and Saidpur upazila based on utilization

Upazila	Total area (ha)	Permanent cropped area (ha)	Temporary cropped area (ha)	Permanent fallow area (ha)	Others (ha)
Kishoreganj	17716	145	14592	57	2978
Saidpur	26176	55	8501	28	2036

Source: Census of Agriculture 2008-Zila Series Nilphamari

Area under temporary crops: It is the land area planted for crops of less than one year with an increasing period or length of life. Paddy, wheat, jute, cotton, tobacco, sugarcane, pulses, oil seeds, potatoes, vegetables and other seasonal crops are the temporary crops. Areas under temporary crops and a temporary net crop area are similar.

Table 2: Land utilizations (temporary cropped area) of Kishoreganj and Saidpur upazila

Upazila	Current fallow	Temporary cropped area (ha)					Productivity of crop
		Single	Double	Triple	Net	Gross	
Kishoreganj	34	842	9150	4599	14591	32941	226
Saidpur	25	514	5579	2649	8742	19137	225

Source: Census of Agriculture 2008-Zila Series Nilphamari

3.8 Socio-economic situation

The economy of Nilphamari is predominately agricultural. Out of total 3,84,629 households of the district 53.09 % holdings are farms which produce varieties of crops namely local and HYV rice, wheat, jute, tobacco, potato vegetables, spices, pulses etc. Various fruits like mango, jackfruit, litchi, jam, palm betelnut etc are the main fruits of the district. Varieties of fish are caught from rivers, beels and paddy fields during rainy season. The most common fishes are ruhi, katla, mrigal, magur, singi, koi, puti, shoil, gazar, boal etc. All these fishes are economically valuable. Besides these common varieties some other well-known varieties of fish are pangash, airh, bacha, rita, batasi, khalisha and chingri or prown are found. Besides crops, livestock and poultry are the subsidiary source of household income of the district.

Main sources of income: Agriculture 68.51%, non-agricultural labourer 3.93%, industry 0.66%, commerce 11.77%, transport and communication 3.06%, service 5.93%, construction 0.89%, religious service 0.23%, rent and remittance 0.17% and others 4.85% (BBS, 2011).

3.9 Site selection and sampling procedure

The study was conducted in Nilphamari district that consists of 6 upazilas. Among them, Kishoreganj and Saidpur upazilas were randomly selected for the study. Kishoreganj and Saidpur upazilas consists of 9 unions (lowest unit of local government) and 6 unions respectively. Among 9 unions of Kishoreganj upazila, 2 unions namely Nitai and Bahagili were selected randomly and out of 6 unions of Saidpur upazila, 2 unions namely Kushiram Belpukur and Khata Madhupur were randomly selected. From Nitai union, 2 villages namely Nitai Dangapara and Nitai Koranipara and from Bahagili union, 2 villages namely Shah para and Nayan khal were randomly selected. From Kushiram Belpukur union, 2 villages namely Satpai darani and Hazarihat and from Khata Madhupur union, 2 villages namely Kachari para and Boshunia para were randomly selected. There are total of 4168 different homesteads in this selected area. Out of 4168 homesteads, a sample of 12%, i.e., 500 homesteads were selected by random sampling method and finally 60 representative homesteads were selected for questionnaire survey, to find out the impact of homestead tree species on the socio-economic condition of the farmers and tree diversity measurement. Final selection of homesteads had been done by using Yamane formula (Jahan, 2010);

$$n = N / \{1 + N (e^2)\}$$

Where,

n= Sampling size

N= Population

e= Error of precision

Table 3: Distribution of population and sample size in eight selected villages

Upazila	Union	Village	No. of total households	No. of households primary selected	No. of households finally selected for data collection
Kishoreganj	Nitai	Nitai Dangapara	581	70	8
		Nitai Koranipara	416	50	6
	Bahagili	Shah para	354	42	5
		Nayan khal	614	74	9
Saidpur	Kushiram Belpukur	Satpai darani	673	80	10
		Hazarihat	522	63	8
	Khata Madhupur	Kachari para	490	59	7
		Boshunia para	518	62	7
Total	4	8	4168	500	60

After randomly selection of sampled farmers, they were classified into the following groups on the basis of farm size in terms of hectare according to Abedin and Quddus (1990). These categories were as follows:

Farm categories	**Farm size (ha)**
Landless	Up to 0.20
Marginal	In between 0.21 – 0.50
Small	In between 0.51 – 1.00
Medium	In between 1.01 – 2.00
Large	Above 2.00

3.10 Variables in the study and development of research instruments

Selection and measurement of variables is an important task in social research. 11 independent and 1 dependent variables were selected for this study. The following variables are described:

3.11 Measurement of independent variables

The following independent variables were included in the study:

i) Age
ii) Education
iii) Occupation
iv) Sex
v) Family size
vi) Farm size
vii) Homestead size
viii) Annual income
ix) Organizational participation
x) Problem confrontation
xi) Livelihood condition

Age

The age was defined as the period of time from the birth of a respondent farmer to the time of interview. It was operationally measured in terms of actual age in years. The respondents were grouped into three categories- young aged (up to 30 years), middle aged (31 to 50 years) and old aged (above 50 years) on the basis of their age.

Level of education

The education of the respondent farmer was assessed against the classes he / she passed. For example, if the respondent farmer passed the final exam of class V in the school, a score of 5 was taken to measure his educational score. If the respondent had out-of-school education, and if the level of education appeared to

be equal to that of class V of the school, then his educational score was taken to be 5. A respondent who did not know how to read or write had an education score of zero (0).

Occupation

The occupation of the respondent farmer was measured by the work of the respondent and the time of the interview. It was measured operationally in terms of actual occupation.

Family member

The family member of the respondent was determined by the total number of members of each respondent. The family member included the respondent, the spouse, the sons, the daughters and the other dependents.

Farm size

Land is the main capital for farmers and determines the farmer's personal characteristics. Farm size was expressed as hectare and was computed by using the following formula (Moontasir, 2009):

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 had its entire living room, the livestock and poultry shed, the garden under the vegetables, the home garden, the fruit and timber trees, the backyard, the bushes, the bamboo bundles, the pond, etc. It was expressed in hectare.

Annual income

Annual income was determined by the amount of all sources of income of a farmer in one 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. The respondents are classified into 3 categories on the basis of 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.

Organizational participation

Organizational participation of respondents was calculated on the basis of the essence of its presence and duration of participation in various formal and informal local groups or organizations in the study area (Chandra, 2011). For computing organizational participation score, the formula is given below:

Organization participation score = $\sum (A \times D)$

Where,

A = Activity score

D = Duration score

Participation scores were allocated to the farmer's activities in each group or organization in the following manner.

Nature of involvement	Score assigned
No involvement	0
Ordinary	1
Executive member	2
Executive officer	3

Duration score was assigned in the following manner:

Nature of involvement	Score assigned
Nil period	0
One year	1
Two years and above	2

The respondent's organizational participation score is obtained by adding the score for his activities in the respective group or organization in accordance with the above formula.

Problem confrontation

Problem was measured in one way, such as using the closed form of questions as shown in item 17 of the interview schedule. Respondents were asked to give their opinion on the questionnaires, together with their degree of confrontation in the use of homestead agroforestry practices. The four-point scale was used to calculate the problem confrontation score of the respondent. Weights were allocated to 3 (three) for 'high,' 2 (two) for 'medium,' 1 (one) for 'low,' and 0 (zero) for 'not at all.' The issue confrontation scores of the respondents could range from 0 to 51. Zero indicates no problem and 51 indicate a high level of problem confrontation.

Livelihood status

The livelihood status of farmers in the study area is presented in this section. Two techniques were used to determine the existing livelihood status of farmers, such as the calculation of the cumulative percentage score and the assessment of the farmer's perception of seven livelihood indicators.

Development of the Cumulative Livelihood Status Score (CLSS): The CLSS was developed using both qualitative and quantitative data in order to obtain valid and reliable data on the livelihood status of farmers. To capture the meaning of any multi-dimensional phenomenon, it is necessary to combine the indicators into more complex indices (Sharp, 2003). Therefore, the aim of the CLSS is to obtain a comprehensive view of farmers' livelihood status. In two steps, the CLSS was determined. First, for each of the seven indicators of livelihood, a cumulative percentage score was determined. After that, based on the scores of these seven indicators, the cumulative livelihood status was computed. The measurement process for a farmer's cumulative percentage score and cumulative livelihood status score is summarized below:

Calculation of the cumulative percentage of score. The calculation of the 'cumulative percentage score' for each indicator was measured in two stages: (i) the determination of the percentage score of the individual farmer and (ii) the determination of the cumulative percentage score.

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

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

Where, IFPS = Individual farmer's percentage score

IFFS = Individual farmer's field score

IFPMS = Individual farmer's possible maximum score

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

$CPS = \Sigma IFPS/N$

Where, CPS = Cumulative percentage score

ΣIFPS = Sum of individual farmer's percentage score

N = Sample size

Cumulative livelihood status score computation. A farmer's cumulative livelihood status score was measured by dividing the sum of the livelihood indicator's cumulative percentage score by seven. To achieve the cumulative livelihood status score, the following formula was used:

$CLSS = \Sigma CPS/LI$

Where, CLSS = Cumulative livelihood status score

ΣCPS = Sum of cumulative percentage score of seven livelihood indicators

LI = Livelihood indicators (7)

The perception of farmers based on the seven livelihood indicators is further complemented by the CLSS. For the score of seven livelihood indicators, the quantitative data obtained from 60 farmers by administering a simple scale 0 - 3, whereby 0 stands for ‘do not know’, 1 for ‘lower situation’, 2 for ‘middle situation’ and 3 for ‘higher situation’ The qualitative data obtained through six focus group discussions (FGDs) was analyzed in addition to the quantitative measurement. Farmers in FGDs were asked to rate.

By setting a specified number of seeds (ranging from 1 to 10, 1 indicating the lowest and 10 indicating the highest value) according to their perceived importance, seven livelihood indicators were used. To get the total score for each indicator, all the weights (number of seeds) were added together. A rank order of seven indicators was listed based on the total scores from least important to most important according to ascending order, whereby rank 1 denotes ‘least important’ and rank 7 denotes ‘most important’.

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

Livelihood condition	Qualitative rank[1]	Evaluation scale[2]	CLSS range[3]	CLSS range[4]
Organizational participation	1	0-3	0-21	36-76
Freedom in cash expenditure	2	0-3		
Water facilities	3	0-3		
Sanitation condition	4	0-3		
Health situation	5	0-3		
Food availability	6	0-3		
Housing condition	7	0-3		

1 Rank orders was made based on total score obtained from FGDs, such as 7 = 76, 6 = 69, 5 = 64, 4 = 56, 3 = 49, 2 = 42 and 1 = 36

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

3.12 Measurement of dependent variable

Tree species diversity index, richness and evenness measurement

Species diversity is the diversity of species on earth. The total number of species in the area under study is measured. The diversity of species can be expressed in the index of species diversity (both in species richness and abundance). The Shannon-Wiener index (H) that is given below is the most commonly used method of species diversity; 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, 1990; Odum, 1971 and Margalef, 1958).

It is calculated as follow:

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

Where, P*i* is the proportional abundance of the *i*th species such that P*i* =n/N (n is the number of individuals in the *i*th species and N is the total number of individuals of all species in the community).

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= Σ $(Pi \times Pi)$

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-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

Change in socio-economic aspect

The change in the socio-economic aspect of farmers has been defined as the improvement of both social and economic status. Farmers were asked to give their opinion on the improvement of their livelihoods as a result of the direct or indirect contribution of MPTs to homestead forestry. On the basis of the opinion received from the respondents on 18 statements containing information on improving the socio-economic aspect of their livelihoods, it was measured. The A-4 point

modified Liked type scale was used to measure the extent of farmers' agreement with the statement, such as strongly agree, agree, disagree and strongly disagree. For each of the 18 statements, the score assigned to each of the scales for measuring the extent of agreement was 3, 2, 1 and 0, respectively. Cell with its consideration score of the scale of individual impact such as 3 for ‘strongly agree’, 2 for ‘agree’, 1 for ‘disagree’ and 0 for ‘strongly disagree’. Finally, the value was calculated adding all the frequency count of each of the cell of the scale.

3.13 Analysis of data

After the data collection was completed, the data was coded, tabulated and analyzed in accordance with the study objectives. Local units have been converted into standard units. The response to the questions in the interview schedules have been transferred to the master sheet for easier tabulation. Necessary tabulation and cross tabulation were also calculated.

3.14 Statistical analysis

Statistical measures such as number, percentage, range, rank, order, mean and standard were used to describe the study variables. Tables and graphs for the presentation of the data were also used for clarity of understanding. Pearson's Product Moment Correction Co-efficient (r) was used to determine the relationship between the selected characteristics of the farmers and their opinion on the effectiveness of the farmers. The five percent (0.05) probability level was used throughout the study as the basis for the rejection of any null hypothesis. The statistical analysis was carried out using the SPSS program.

3.15 Hypothesis

The research hypothesis was put forward to test the relationship between the effect of tree species diversity in homestead agroforestry on socio -economic condition and each of 11 selected characteristics of the farmers. The null hypothesis is, “There is no relationship between the impact of tree species diversity in homestead

agroforestry on socio-economic condition and each of the selected characteristics of the farmers".

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Demographic and socio-economic attributes of the respondents of the selected study area

Eleven attributes of independent variables of the study have investigated and the descriptions of each of the individual attributes are presented in Table 4.

Table 4: Description of farmers characteristics treated as independent variables of the study (N= 60)

Attributes	Measuring unit	Observed range	Mean	Standard deviation
Age	Years	19-68	44.30	12.78
Education	Level of class	0-16	8.52	3.69
Occupation	Numbers	1-8	3.58	2.55
Sex	Numbers	1-2	1.18	0.39
Family size	Numbers	3-10	5.37	1.98
Farm size	Hectare	0.13-2.73	1.00	0.76
Homestead size	Hectare	0.06-0.30	0.15	0.06
Annual income	Thousand	31-204	84.42	40.67
Organizational participation	Scale scores	4-15	8.40	3.05
Problem confrontation	Scale scores	10-35	20.57	7.34
Livelihood condition	Scale scores	7-21	12.37	4.22

4.1.1 Age

The age of the respondents ranged from 19 to 68 years. The respondents were grouped into three categories- young aged (up to 30 years), middle aged (31 to 50 years) and old aged (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 5.

Table 5: Distribution of respondents according to their age

Category	Respondent (Number)	Percent	Average	Standard deviation
Young age (up to 30 years)	11	18.33	44.30	12.78
Middle age (31 to 50 years)	29	48.34		
Old age (above 50 years)	20	33.33		
Total	60	100		

Data presented in Table 5 showed that the majorities (29) of the respondents (48.34%) were in the middle aged category, 20 respondents were in the old aged category which constitutes 33.33% of the total respondents and only 11 respondents were young aged category which constitutes only 18.33 % in the study area.

4.1.2 Education

The education level of the farmers ranged from 00-16 with standard deviation of 3.69 of schooling. In this study, 31 respondents of the selected study area have secondary level education which constitutes 51.67%, 10 respondents of the selected study area have primary level education which constitutes 16.66%, 16 respondents have higher education level which constitutes 26.67% and 3 respondents have no education which constitutes 5%, (Table 6).

Table 6: Categorization of respondent farmers according to their educational level

Category	Respondent (Number)	Percent	Standard deviation
Illiterate (0)	3	5.00	3.69
Primary level (class 1 to 5)	10	16.66	
Secondary level (class 6 to 10)	31	51.67	
Higher level (11 or above)	16	26.67	
Total	60	100	

4.1.3 Occupation

The occupation of the respondents of the study area varied in distinct forms. However, on the basis of their occupation they are classified as

agriculture, grocery, day labourer, fishermen, rickshaw pulling, livestock and poultry, services and others. From the study, data presented in Table 7 revealed that majority of the respondent farmers (46.67 %) belonged to 'agriculture' as their main occupation while 3.33%, 8.33%, 1.66%, 5.00%, 8.33%, 15.00% and 11.66% of them were occupied by grocery, fishermen, day labourer, rickshaw pulling, livestock and poultry, services and others.

Table 7: Distribution of the respondent farmers on the basis of their occupation

Categories of occupation	Respondents (Number)	Percentage	Standard deviation
Agriculture	28	46.67	2.55
Grocery	2	3.33	
Fishermen	5	8.33	
Day lobourer	1	1.66	
Rickshaw pulling	3	5.00	
Livestock and poultry	5	8.33	
Services	9	15.00	
Others	7	11.66	
Total	60	100.0	

4.1.4 Sex

Sex scores of the respondent farmers denoted by 1 for male and 2 for female with a standard deviation of 0.39 respectively. Farmers were classified into 2 categories on the basis of observed scores (Table 8).

Table 8: Distribution of respondents according to their sex

Category	Respondent (Number)	Percent	Standard deviation
Male	49	81.67	0.39
Female	11	18.33	
Total	60	100	

Table 8 revealed that the major portions of the respondents under the study (81.67%) were male and minor portions (18.33%) were female in comparison with male.

4.1.5 Family member

Member of sampled farm households were categorized into 3 groups (Table 9). The categories and distribution of the respondents with their number, percent and standard deviation are furnished below.

Table 9: Family member of respondent farmers

Family member (Number)	**Respondent (Number)**	**Percent**	**Standard deviation**
Small (2-4)	31	51.67	1.98
Medium (5-6)	12	20.00	
Large (above 7)	17	28.33	
Total	60	100	

Data presented in Table 9 showed that majority of the farmers (51.67%) belonged to small size family, 20% of the respondents had medium size family and rest 28.33% of them belonged to large family.

4.1.6 Farm size

The farm size of the respondent farmers varied from 0.13 to 2.73 hectares with the standard deviation of 0.76. Four farm categories of the farmers on the basis of their farm holdings. The distribution of the farmers with number, percentage, mean and standard deviation was shown in Table 10.

Table 10: Distribution of respondent farmers according to their farm size

Category	Respondent (Number)	Percent	Standard deviation
Marginal (up to 0.50 ha)	21	35.00	0.76
Small (0.51 to 1.00 ha)	17	28.34	
Medium (1.01 to 2.00 ha)	14	23.33	
Large (above 2.00 ha)	8	13.33	
Total	60	100	

Data presented in Table 10 revealed that the highest proportion 35.00 % of the farmers were marginal while 28.34%, 23.33% and 13.33% of small, medium and large 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.

4.1.7 Homestead size

The homestead size of the respondents ranged from 0.06 to 0.30 hectare with a standard deviation of 0.06. Among the respondent farmers 36.67 % were medium, 18.33% were landless and marginal, 31.67% were small and 13.33% were large. Homesteads sizes are given below (Table 11).

Table 11: Categorization of respondent farmers according to their homestead size

Category	Respondent (Number)	Percent	Standard deviation
Landless and marginal (up to 0.08 ha)	11	18.33	0.06
Small (0.09 to 0.14 ha)	19	31.67	
Medium (0.15 to 0.20 ha)	22	36.67	
Large (above 0.20 ha)	8	13.33	
Total	60	100	

4.1.8 Annual income

Annual income of the farm families ranged from Tk. 31 thousand to Tk. 204 thousand having standard deviation of 40.67. The respondents are classified into 3 categories on the basis of 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 12 showed that majority (40.00%) of the respondents had low and medium income category whereas 20% of the respondents had high income category.

Table 12: Distribution of respondent farmers according to their annual income

Category	Respondent (Number)	Percent	Standard deviation
Low income (up to 60000 Tk.)	24	40.00	40.67
Medium income (60001-120000 Tk.)	24	40.00	
High income (above 120000 Tk.)	12	20.00	
Total	60	100	

4.1.9 Organization participation

Organizational participation scores of the respondent farmers varied from 4 to 15 with a standard deviation of 3.05. On the basis of the observed scores respondent farmers were classified into 3 categories (Table 13).

Table 13: Distribution of respondent farmers according to their organizational participation scores

Category	Respondent (Number)	Percent	Standard deviation
Low (up to 8)	37	61.67	3.05
Medium (9 to 11)	14	23.33	
High (above 12)	9	15.00	
Total	60	100	

Data presented in Table 13 revealed that major portion of the respondent farmers (61.67%) had low organizational participation whereas a good number

of them (23.33%) had medium organizational participation and rest (15.00%) had high organizational participation.

4.1.10 Problem confrontation

Problem confrontation scores of the respondents varied from 10-35 with standard deviation of 7.34. It was indicated that 36.67% of the respondent farmers have the highest problem confrontation ability, 35% of the respondents have lowest problem confrontation ability and rest 28.33% of the respondents have medium problem confrontation ability on homesteads agroforestry management, respectively (Table 14).

Table 14: Categorization of respondent farmers according to their problem confrontation on homesteads agroforestry

Category	Respondent (Number)	Percent	Standard deviation
Low (up to 15)	21	35.00	7.34
Medium (16-22)	17	28.33	
High (above 22)	22	36.67	
Total	60	100	

4.1.11 Livelihood status of respondents

This section presents the livelihood status possessed by respondent farmers in the study area. Livelihood status scores of the respondents varied from 0-21 with the standard deviation of 4.22. According to the perception of respondent farmers, the livelihood status score (LSS) varied from 0 to 21. Based on the obtained score farmer are classified into 3 categories such as ‘low livelihood status’ (0-7), ‘medium livelihood status’ (8-14) and ‘high livelihood status’ (15-21). The majority of the respondents were distributed under medium livelihood status classes (56.67%), while 33.33% belonged to high livelihood status and rest 10% belonged to low livelihood status classes.

Table 15: Categorization of respondent farmers according to their livelihood status on homesteads agroforestry

Category	Respondent (Number)	Percent	Standard deviation
Low (up to 7)	21	35.00	4.22
Medium (8-14)	32	53.33	
High (15-21)	7	11.67	
Total	60	100	

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 16. The situation of the livelihood indicators is reflected by mean scores, which ranged from the highest 2.80 to the lowest 2.53. This indicated a difference of 0.27, suggesting a relatively low discrepancy between the mean scores of the seven livelihood indicators.

Table 16: Perceptions of farmer considering seven livelihood status indicators compared by mean values

Livelihood indicators	Existing situation of livelihood indicators (%)				Mean
	Do not know	Low	Medium	High	
Housing condition	5	41.7	38.3	15	2.63
Health situation	5	33.3	53.3	8.4	2.65
Water facilities	5	33.3	45	16.7	2.73
Sanitation	3.3	36.7	36.7	23.3	2.80
Food availability	5	45	41.7	8.3	2.53
Organizational participation	5	33.3	53.3	8.4	2.65
Freedom in cash expenditure	0	48.3	36.7	15	2.67

The livelihood indicator "sanitation" received the highest mean score of 2.80 and was considered as "high" by 23.3% of the surveyed respondents.

The lowest mean score (2.53) was recorded for the indicator "food availability" and this was identified as "low" by 45% of the farmer and "medium" by 41.7%. The overall mean of seven livelihood indicators was 2.66 which is higher than medium. Mean values of the four following livelihood indicators were found to be higher than medium: freedom in cash expenditure (2.67), water facilities (2.73), health situation (2.65), organizational participation (2.65) and housing condition (2.63). Two indicators such as water facilities and freedom in cash expenditure had higher mean value than medium (2.73 and 2.67, respectively) and none of the indicator possessed its highest value 3.

This result explore that all of the seven livelihood status indicators are need to be developed in order to obtain developed livelihood situations for the surveyed respondents. 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 32 plant species 23 families were recorded from the set of 60 homesteads surveyed. 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 32 plant species major seven species found in dominancy than others and the highest percent of occurrence was found *Mangifera indica* (21.17%) followed by *Artocarpus heterophyllus* (16.41%), *Cocos nucifera* (8.93%), *Swietenia macrophylla* (8.23%), *Musa spp.* (5.45%), *Azadirachta indica* (4.00%) and *Litchi chinensis* (4.00%) respectively. Among the tree species Mango and Jackfruit were dominant and found up to 99% respondent

houses. The diversity of fruit species in the study area was rich compared to the all other species. Similar type of fruit species diversity was observed by Belali (2011) in Narayangonj and he observed total 28 fruit species in Narayangonj area. Similar type of species diversity was found by Sadat (2007) in Gaibandha and he observed total 21 timber species in his study area.

4.2.2 Species diversity index, richness and evenness

In total, 32 different plant species were found from 23 families in the selected households and total 1871 trees were measured. It was found that mango tree ranks top of the list which was 396 nos. of the total plant population followed by Jackfruit (n= 307), Coconut (n= 167), Mahagony (n= 154), Banana (n= 102), Neem (n= 75) and Litchi (n= 75) respectively. Tree diversity described by the Shannon-Wiener diversity index (H) results 2.723. The Diversity Index (SDI), the Dominance Index (ID), the Species Richness Index (R) and the Species Evenness Index (E) have also been measured and presented in Table 17. A full list of florists is attached. The data obtained from the Species Diversity Index (2.723) showed a higher value than the Dominance Index (0.185), which represents less dominance of the tree species with more diversity. The estimated value of the Species Richness Index and the Species Evenness Index was 9.47 and 1.81, respectively, reflecting the greater wealth of tree species (corroborated with previous findings) and the more uniform distribution of the total number of individuals among all possible tree species.

Table 17: Diversity related characters

Characters	**Result**
No. of Species= S	32
No. of individuals= N	1871
Shannon-Wiener diversity index, H= $\sum Pi \times \text{Ln}(Pi)$	2.723
Diversity index, SDI= S/N	0.0171
Index of Dominance, ID= $\sum(Pi \times Pi)$	0.185
Species Richness Index, R= (S-1)/ Log N	9.47
Species Evenness Index, E= H/Log S	1.81

4.2.3 Uses of multipurpose tree species of homestead Agroforestry

Different tree species were observed in the homestead area with diversified uses. Total 60 tree species were recorded from the study area of which 17 timber species, 19 fruit species, 8 medicinal species, 5 fodder species and 11 fuel wood trees. In case of percent, there are 28.30% timber trees, 31.70% fruit trees, 13.30% medicinal trees, 8.30% fodder trees and 18.30% fuel wood trees in study area (Figure 3).

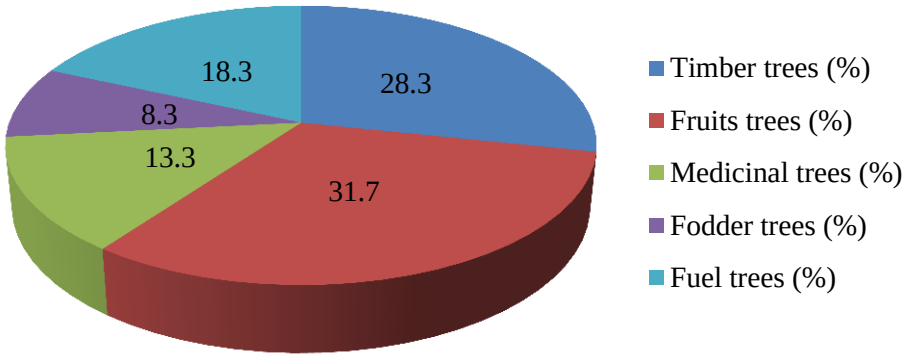

Figure 3: Uses of multipurpose tree species by the surveyed respondents of homestead agroforestry

4.2.4 Distribution of respondents according to their income from MPTs

In homestead agroforestry, Multipurpose Tree Species (MPTs) have direct impact on income of the farmers. Farmers are classified into three categories on the basis of MPTs number and standard deviation was 19.42. Small farmers with MPTs number (15–30) have average low income 23.91 thousand taka. Medium farmers with MPTs number (31–50) have average medium income 41.18 thousand taka. And large farmers with MPTs number more than 51 have average the highest income 81.57 thousand taka (Table 18).

Table 18: Categorization of respondents according to their income from MPTs

Category	Respondent (Number)	Percent	Average income (Thousand Tk.)	Standard Deviation
Small (15-30)	24	40.00	23.91	26.24
Medium (31-50)	22	36.67	41.18	
Large (above 51)	14	23.33	81.57	

4.2.5 Distribution of respondents according to their socio-economic aspects

Scores of farmer's opinion regarding changes in socio-economic aspects due to homestead agroforestry ranged from 0 to 54. Zero indicated no opinion and 54 indicated high opinion. 41.67% respondents think that MPTs in homestead agroforestry have low impact in improving socio-economic aspects. Another 41.67% respondents think that MPTs in homestead agroforestry have medium impact in improving socio-economic aspects and rest 16.66% respondents think that MPTs in homestead agroforestry have high impact in improving socio-economic aspects (Table 19).

Table 19: Distribution of the farmers according to their socio-economic aspects

Category	Respondent (Number)	Percent	Average	Standard deviation
Low (up to 19)	25	41.67	22.76	7.64
Medium (20 to 32)	25	41.67		
Large (above 32)	10	16.66		
Total	60	100		

4.3 Relationship between tree species diversity and the selected characteristics of the respondent farmers in the homestead Agroforestry

This section deals with relationship between tree species diversity and the selected characteristics of the respondent 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, organizational participation, problem confrontation and livelihood status of the respondent farmers in the homesteads. Regression analysis and Pearson's Product Moment Co-efficient of Correlation (r) were used to explore the relationships of the variables with description of the meaning of "r" (Cohen and Holiday, 1982).

Table 20: The meaning of correlation co-efficient (r)

r value	Meaning
± 0.00-0.19	Very low correlation
± 0.20-0.39	Low correlation
± 0.40-0.69	Medium correlation
± 0.70-0.89	High correlation
± 0.90-1.00	Very high correlation

The relationships between the respondent's selected socio-economic attributes and the diversity of homestead tree species have been shown in Table 21.

Table 21: Computed co-efficient of correlation (r) between Dependent variable and Independent variables (N = 60)

Dependent variable	Independent variables	Correlation co-efficient 'r'
Tree species diversity	Age	0.347**
	Education	0.369**
	Occupation	0.273*
	Sex	-0.069^{NS}
	Family size	0.255*
	Farm size	0.638**
	Homestead size	0.824**
	Annual income	0.970**
	Organizational participation	0.303*
	Problem confrontation	-0.275*
	Livelihood status	0.948**

******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 respondent farmers and tree species diversity

The age of the respondent farmers and tree species diversity was examined against the null hypothesis as "there is no relationship between the age of the respondent farmers and tree species diversity". The relationship between age of the respondent farmers and tree species diversity was measured and shown in figure 4. It is shown a linear equation as: $Y = 9.94x + 25.38$ ($R^2 = 0.120$), where R^2 value was positive, $r = 0.347$ and $p < 0.01$. So it revealed that the relationship between age of the farmers and tree species diversity was significant and at the same time there was a low relationship between age of the farmers and tree species diversity. Agarwal (2001) also observed same relation

in northern Bangladesh.

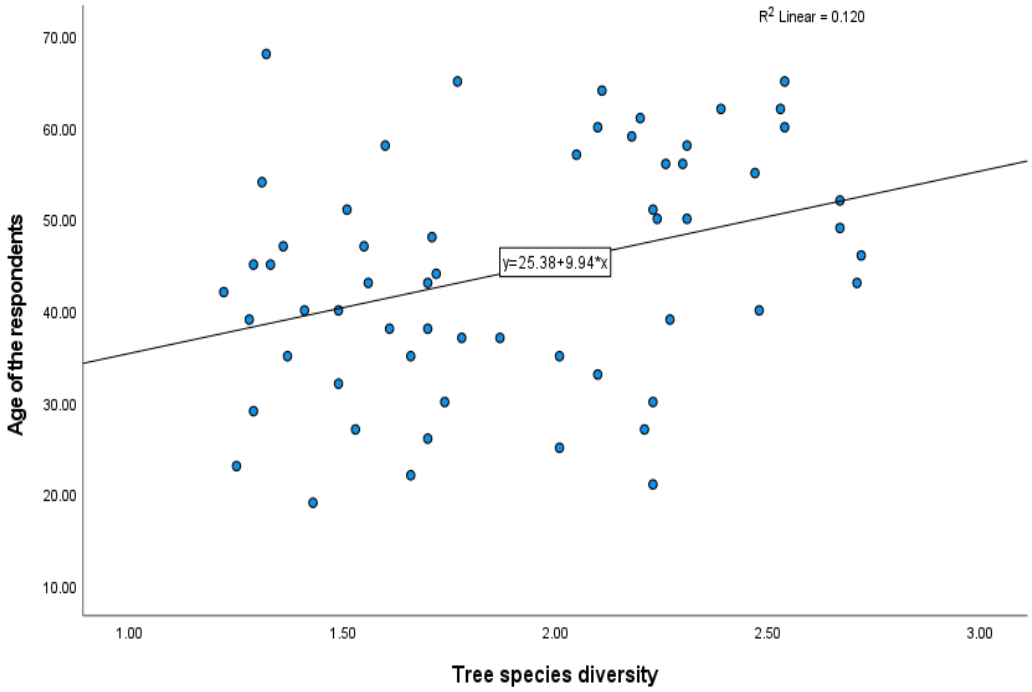

Figure 4: Relation between age of the respondent farmers and tree species diversity

4.3.2 Relation between education of the farmers and tree species diversity

The education of the respondent farmers and tree species diversity was examined by testing the following null hypothesis: "there is no relationship between the education level of the respondent farmers and tree species diversity". Figure 5 indicated a linear equation as: $Y = 3.06x + 2.70$ ($R^2 = 0.137$), where R^2 value was positive, $r = 0.369$ and $p < 0.01$. So it indicated that there was significant and low positive correlation between tree species diversity and level of education of the respondent farmers. Sudmeye *et al.* (2004) also observed the same result in Rangpur district.

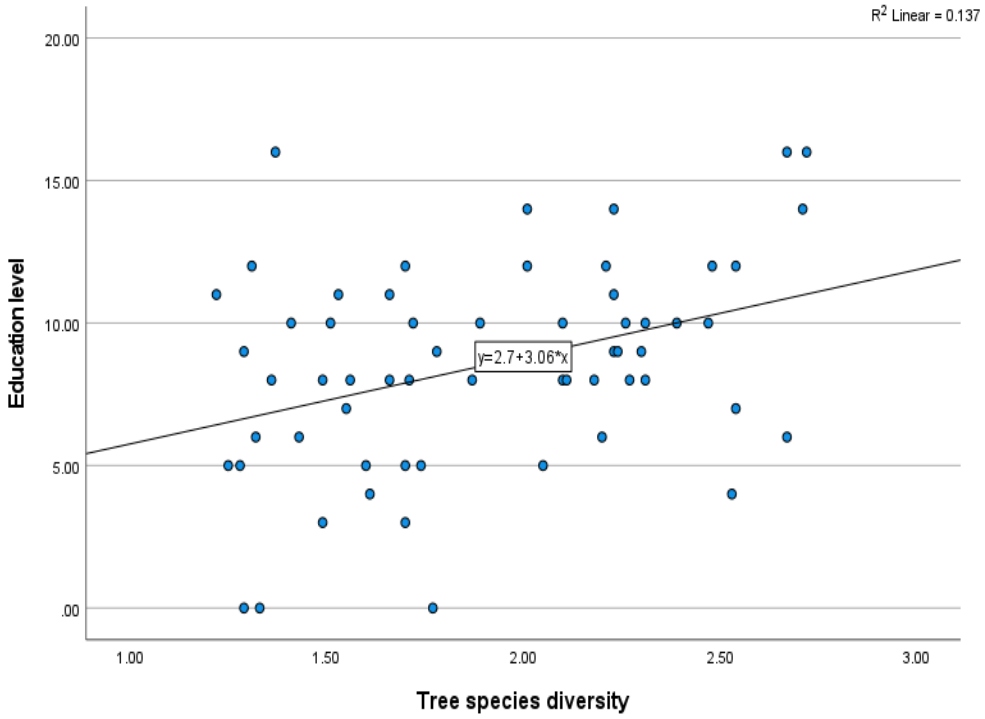

Figure 5: Relation between education of the farmers and tree species diversity

4.3.3 Relation between occupation of the farmers and tree species diversity

The relation between occupation of the respondent farmers and tree species diversity was examined by testing the null hypothesis: "there is no relationship between occupation of the respondent farmers and tree species diversity". Figure 6 indicated a linear equation as: $Y = 1.56x + 0.42$ ($R^2 = 0.075$), where R^2 value was positive, $r = 0.273$ and $p < 0.05$. So it indicated that there was significant and low positive correlation between the occupation of the farmers and tree species diversity. It means that a person having higher tree species diversity in his/her homestead was likely to higher level of occupation.

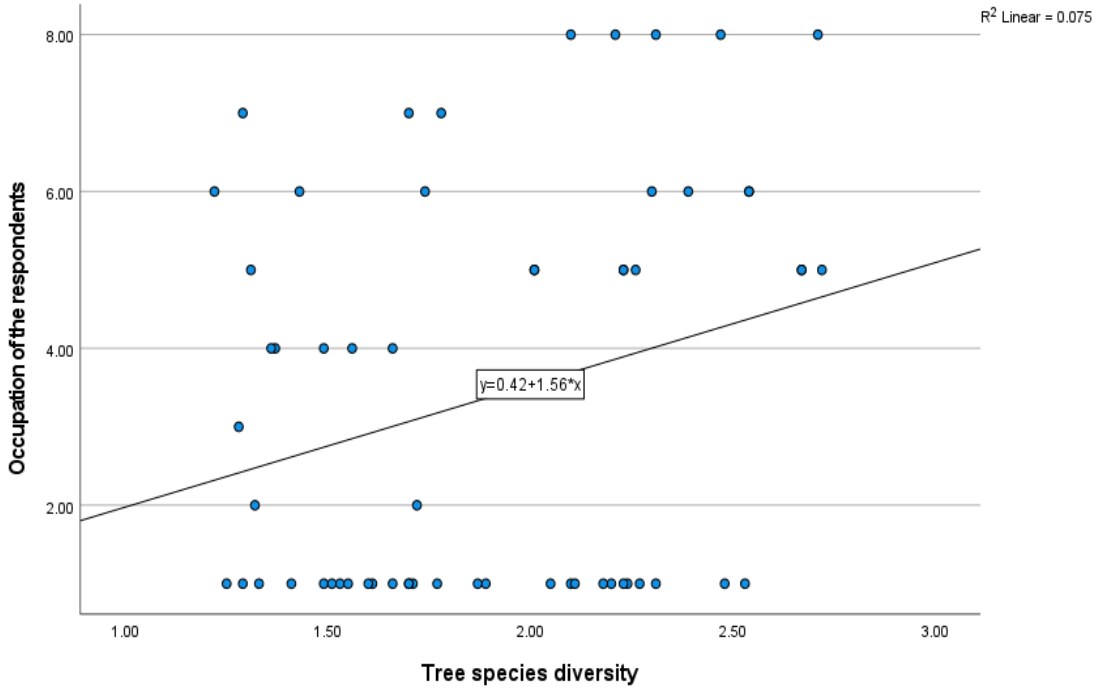

Figure 6: Relation between occupation of the farmers and tree species diversity

4.3.4 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 the respondent farmers and tree species diversity". The relationship between sex of the respondent farmers and tree species diversity was measured and shown in figure 7. It is shown a linear equation as: $Y = -0.06x+1.30$ ($R^2 = 0.005$), where R^2 value was positive, $r = -0.069$ and $p > 0.05$. So it indicated that the relationship between sex of the respondent 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.

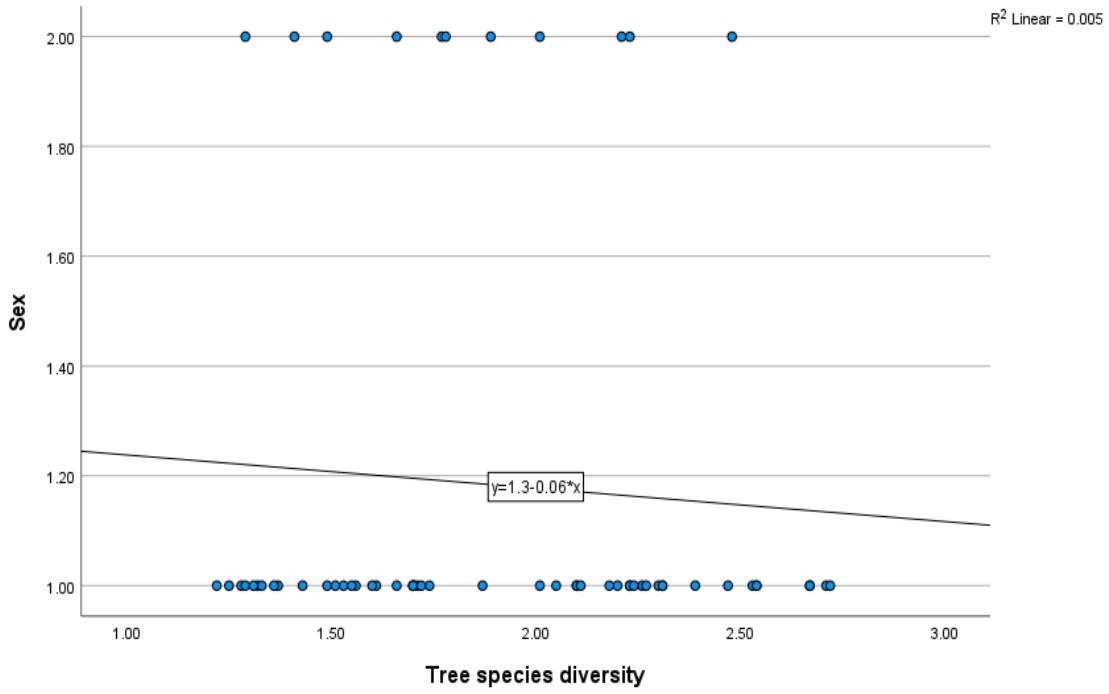

Figure 7: Relation between sex of the farmers and tree species diversity

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

The family size of the respondent farmers and the tree species diversity was examined by testing the following null hypothesis: "there is no relationship between the family size of the respondent farmers and tree species diversity". Figure 8 indicated a linear equation as: $Y = 1.13x + 3.21$ ($R^2 = 0.065$), where R^2 value was positive, $r = 0.255$ and $p < 0.05$. So it indicated that the relationship between the family size of the respondent farmers and tree species diversity was significant and at the same time there was a low relationship between the family size of the respondent farmers and tree species diversity. Halim and Hossain (1994) also explored the same result in Tangail district.

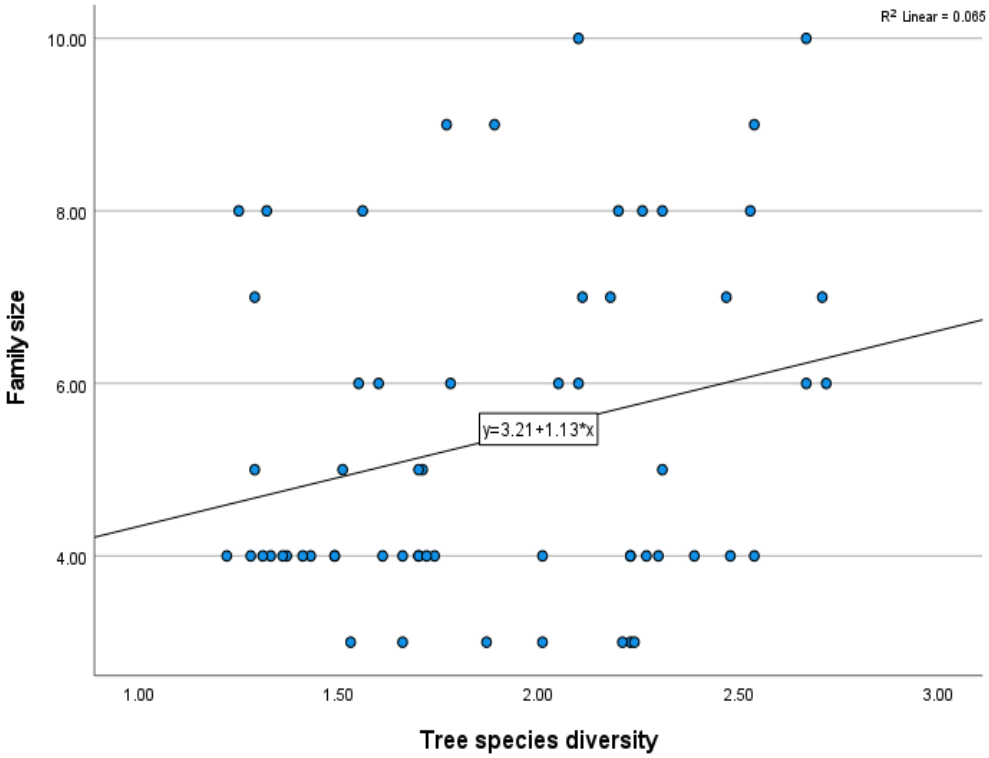

Figure 8: Relation between family size of the farmers and tree species diversity

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

The farm size of the respondent farmers and tree species diversity was examined by testing the following null hypothesis: "there is no relationship between the farm size of the respondent farmers and tree species diversity". Figure 9 indicated a linear equation as: $Y = 1.08x + 1.05$ ($R^2 = 0.407$), where R^2 value was positive, $r = 0.638$ and $p<0.01$. So it indicated that there was significant and medium positive correlation between tree species diversity and farm size of the respondents.

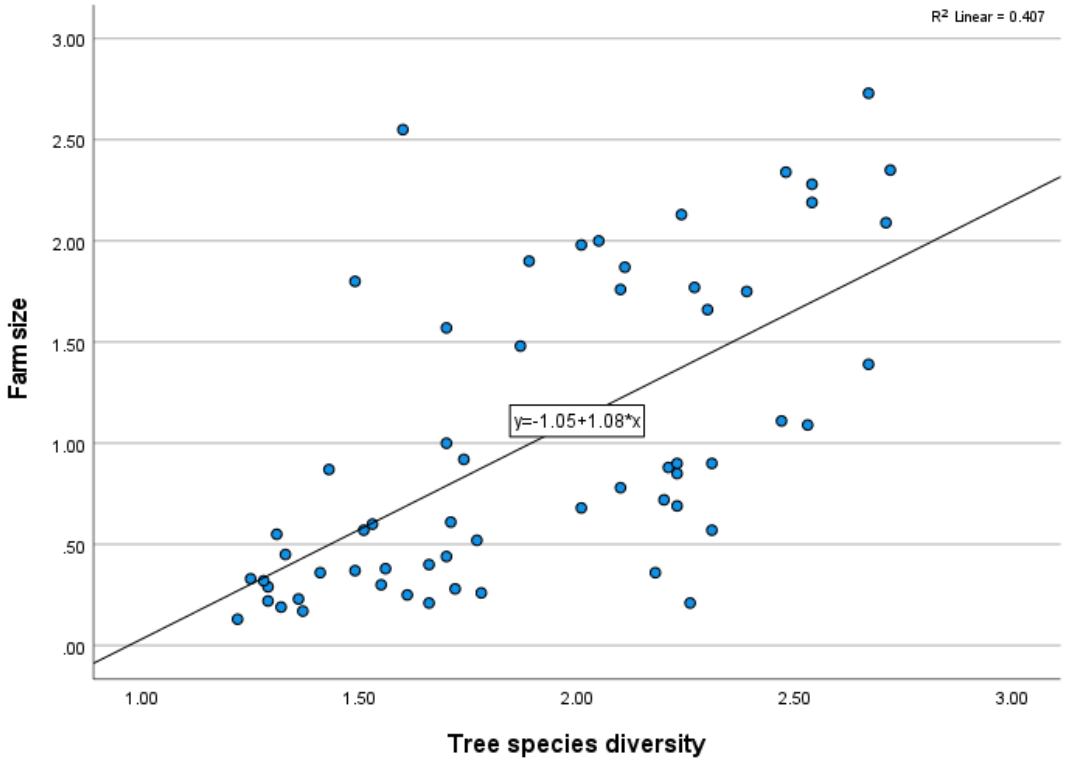

Figure 9: Relation between farm size of the farmers and tree species diversity

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

The homestead size of the respondent 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 10 indicated a linear equation as: $Y = 0.1x + 0.05$ ($R^2 = 0.680$), where R^2 value was positive, $r = 0.824$ and $p < 0.01$. So it indicated that there was significant and very high positive correlation between tree species diversity and homestead size of the respondents.

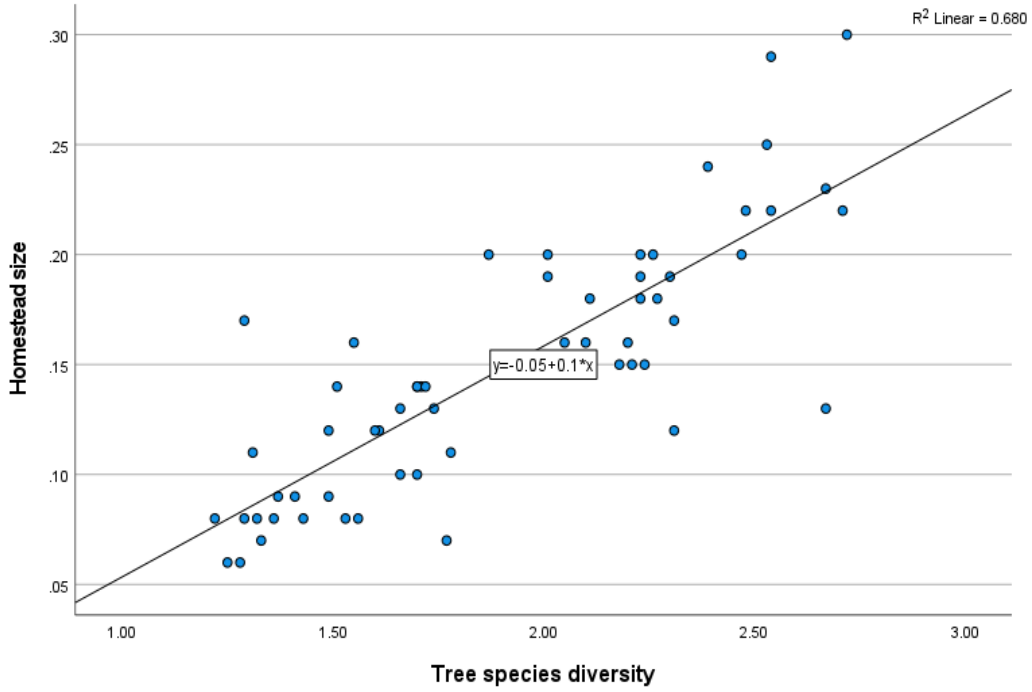

Figure 10: Relation between homestead size of the farmers and tree species diversity

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

The relation between annual income of the respondent farmers and tree species diversity was examined by testing the null hypothesis: "there is no relationship between annual income of the respondent farmers and their attitude towards tree species diversity". Figure 11 indicated a linear equation as: Y = 88.47x-83.92 (R^2 = 0.940), where R^2 value was also positive, r = 0.970 and $p<0.01$. The relationship between the two concerned variables also showed very high 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 very highly correlated with each other in. Halim and Hossain(1994) also found the same result in Tangail district.

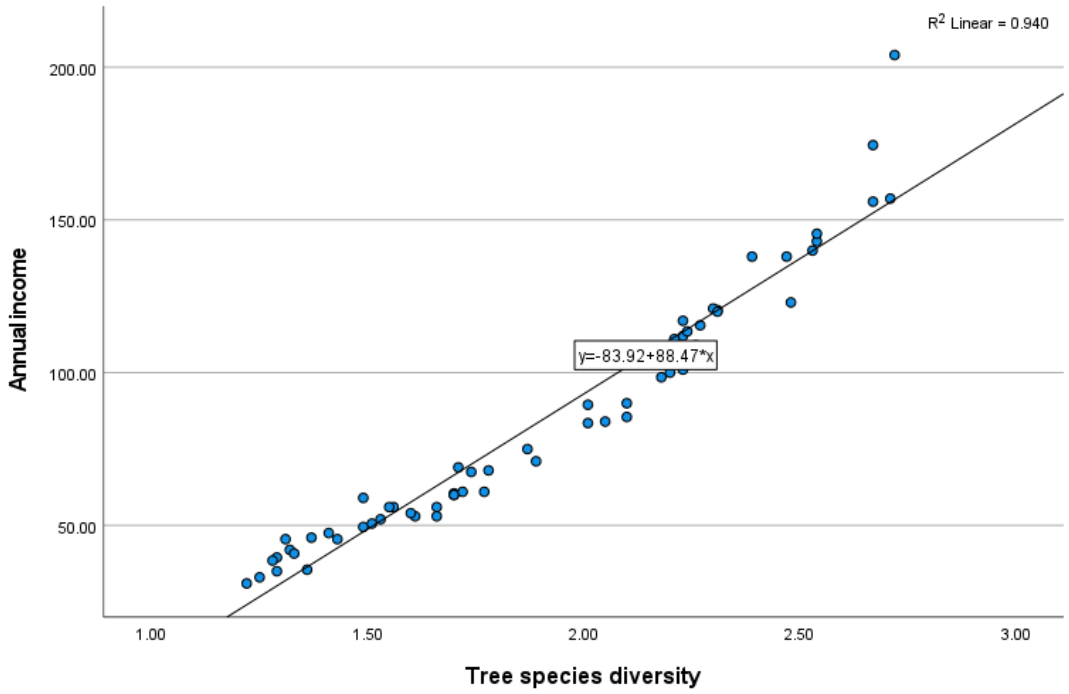

Figure 11: Relation between annual income of the farmers and tree species diversity

4.3.9 Relation between organizational participation of the farmers and tree species diversity

The relation between organizational participation of the farmers and tree species diversity was examined by testing the null hypothesis: "there is no relationship between organizational participation of the respondent farmers and tree species diversity". Figure 12 indicated a linear equation as: $Y = 2.07x + 4.46$ ($R^2 = 0.092$), where R^2 value was positive, $r = 0.303$ and $p < 0.05$. So it indicated that there was a significant and low correlation between the two concerned variables.

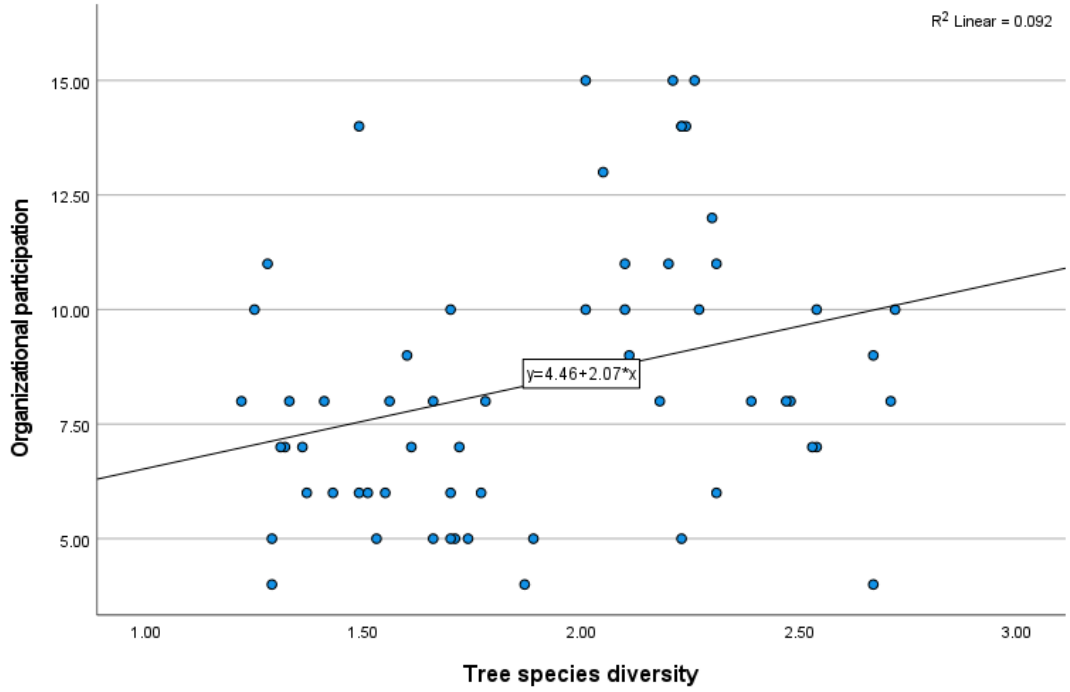

Figure 12: Relation between organizational participation of the farmers and tree species diversity

4.3.10 Relation between problem confrontation of the farmers and tree species diversity

The relation between problem confrontation of the farmers and tree species diversity was examined by testing the null hypothesis: "there is no relationship between problem confrontation of the respondent farmers and tree species diversity". Figure 13 indicated a linear equation as: $Y = -4.53x + 29.19$ ($R^2 = 0.076$), where R^2 value was positive, $r = -0.275$ and $p < 0.05$. So it indicated that there was a significant and negative low correlation between the two concerned variables.

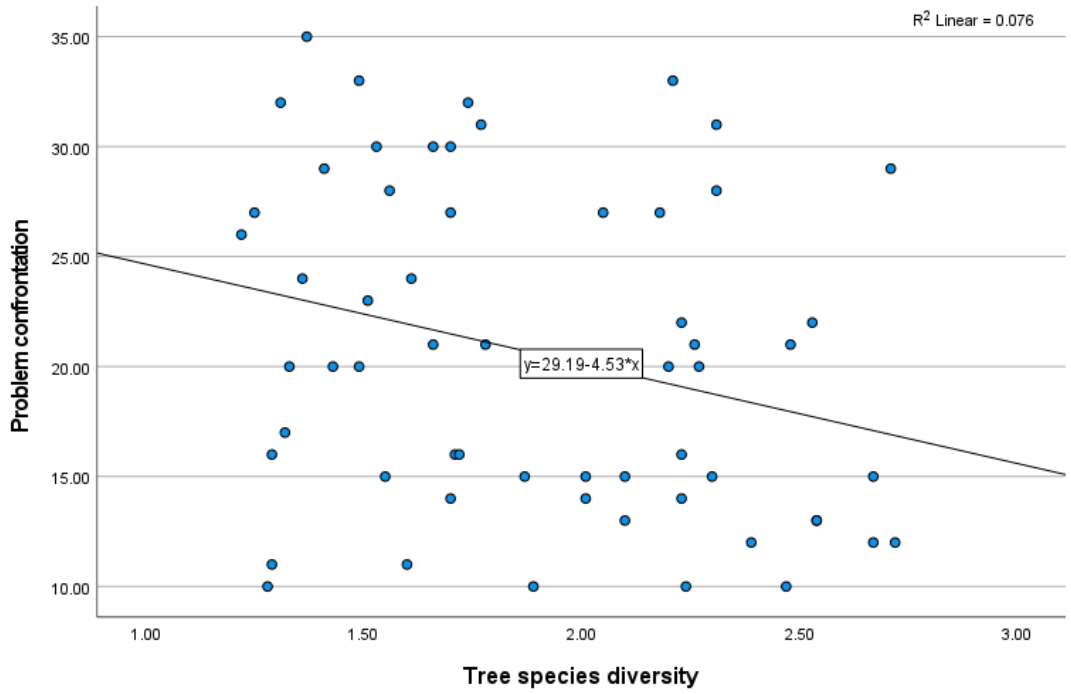

Figure 13: Relation between problem confrontation of the farmers and tree species diversity

4.3.11 Relation between livelihood status 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 problem confrontation of the respondent farmers and tree species diversity". Figure 14 indicated a linear equation as: $Y = 8.98x - 4.71$ ($R^2 = 0.898$), where R^2 value was positive, $r = 0.948$ and $p < 0.05$. So it indicated that there was a significant and strongly positive correlation between the livelihood status of the respondent farmers and tree species diversity. It means that a person having higher tree species diversity in his/her homestead was likely to higher livelihood condition.

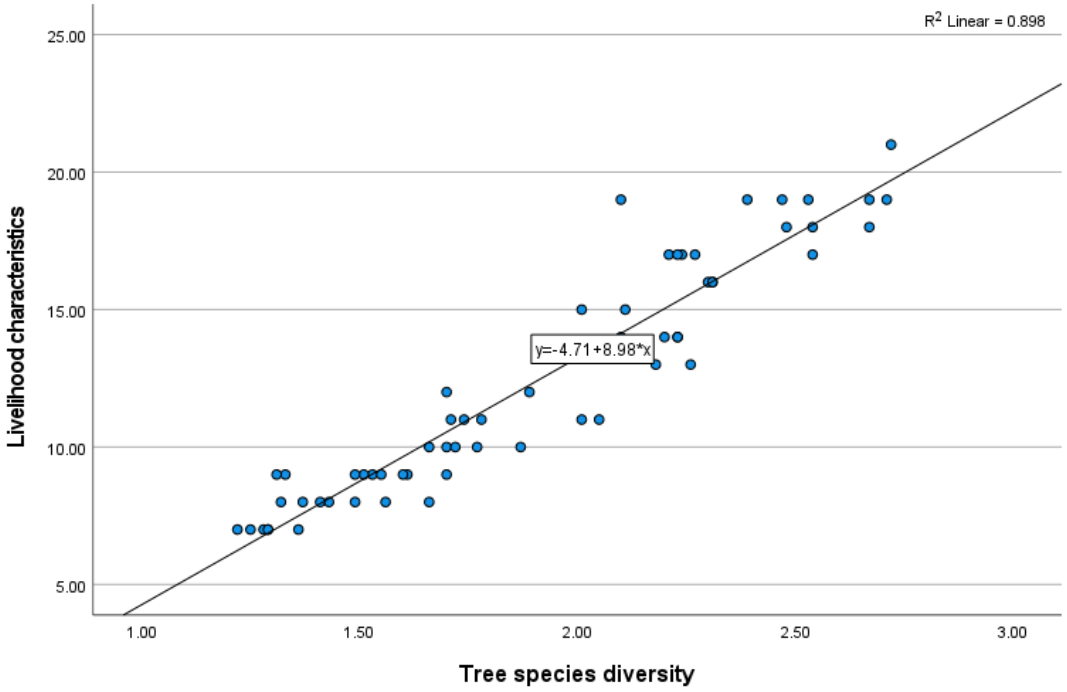

Figure 14: Relation between livelihood status of the farmers and tree species diversity

CHAPTER 5
SUMMARY AND CONCLUSION

SUMMARY

The study was carried out in eight villages under four unions of Kishoreganj and Saidpur upazilas in Nilphamari district. Study areas were selected purposively as the location. There are farm families in those villages. A total of 500 farmers of the 8 villages constituted the population of study. A sample of 12% farm families was selected based on stratified random sampling procedure. However, 60 farmers were selected from farmers by using Yamane formula. Therefore, these 60 farmers constitute the sample of this study. Direct and open form question and different scales were used to obtain information from the sampled farmers during 15 September to 15 December, 2019. Eleven characteristics were considered as independent variables to test the dependent variable – tree species diversity. The selected independent variables were *viz*; age, education, occupation, sex, family member, farm size, homestead area, annual income, organizational participation, problems confrontation and livelihood condition of farmers under the study. Tree species diversity in homestead agroforestry was the dependent variables of the study. The collected data from respondents were analyzed using the Statistical Package for Social Science (SPSS, version 26.0) program and Microsoft Excel 2010. Descriptive statistics like range, mean, standard deviation, frequency, percentage and range orders were used to describe both the independent and dependent variables. Both regression and correlation analysis were employed to find out the significant impact of tree species diversity on socio-economic condition of farmers. Pearson's Product Moment Correlation Co-efficient (r) was used for test of hypothesis. Five percent (5 %) level of significant was used as the basis for rejecting a null hypothesis.

Different tree species were observed in the homestead area as diversified condition. From the recorded analyzed data, among 60 tree species from the study area of which 31.70% fruit trees, 28.30% timber tress, 13.30% medicinal trees, 8.30% fodder trees and 18.30% fuel wood trees. Species diversity index for the Multipurpose Tree Species (MPTs) in the homesteads agroforestry was measured by Shannon-wiener index (H). The species diversity index (2.723) was obtained from the study. Data obtained from species diversity index (2.723) showed higher value than index of dominance (0.185) which remarks less dominancy of the tree species with more diversity. The calculated value of species richness index and species evenness index was 9.47 and 1.81 which remarks the more richness of tree species and more evenly the total number of individuals is distributed among all possible tree species. Different types of relationship were shown between independent variables and dependent variables (tree species 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 species diversity and livelihood status showed highest positive significant correlation. The relationship of tree species diversity among different parameters varied from one to another.

CONCLUSION

i. A total of 1871 trees, representing 32 genera and 23 families were recorded in the 60 farm plots of study sites.

ii. Tree species diversity was positively significant by livelihood condition and other parameters except sex of the respondents.

iii. Tree species diversity didn't show significant relationship between genders of the respondents.

iv. The effect of the diversity of tree species on the socio-economic situation of farmers is beyond question, as trees are an integral part of both nature and human society.

RECOMMENDATIONS

Comprehensive initiatives need to be taken by government organizations (GOs), non-governmental organizations (NGOs), development agencies, and rural society in order to improve the prevailing socio-economic situation of the farmers studied. The following points can be recommended by considering the overall aspect of this present study:

i. This type of research findings will be helpful to facilitate similar research in other districts / areas in Bangladesh. In this respect, if all districts/areas are carried out under similar research, the overall socio-economic condition and pattern of diversity of tree species in Bangladesh will be represented.

Generally, appropriate management strategies and approaches should be developed for the domestication and integration of improved trees by diversifying and intensifying a wide range of priority species to meet the needs of farmers and environmental services. It can help policy makers and planners find solutions to engage farmers in tree planting programs to improve socio-economic conditions and reduce poverty.

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APPENDICES

Appendix 1: Interview schedule used in this study to evaluate farmer's socioeconomic condition

English version of an interview schedule
Department of Agroforestry and Environmental Science
Sher-e-Bangla Agricultural University
Dhaka-1207
Interview schedule for data collection for the research on

"TREE SPECIES DIVERSITY IN THE HOMESTEADS AND ITS IMPACT ON SOCIOECONOMIC CONDITION OF THE FARMERS IN NILPHAMARI DISTRICT"

(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	Fallow		
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 homestead: Please list of tree species in your homestead

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

9. **Organizational Participation**

Sl. No.	Name of the Organization	No. of participation	Nature and duration of participation		
			Ordinary member (year)	Executive Committee member (year)	Executive committee officer (year
1.	BRAC				
2.	Grameen Bank				
3.	ASA				
4.	School committee				
5.	Others (If any)				

10. Problem confrontation by the farmers on diversity of multipurpose tree species plantation (Please mention the problems of diversity of multipurpose tree species plantation)

Sl. No.	Problems	Nature of problems			
		High	Medium	Low	Not at all
1	Lack of appropriate technology				
2	Lack of Credit facilities				
3	Lack of good quality seed/seedlings				
4	Lack of Advice in proper time				
5	High price of quality plants				
6	Insect Pest Infestation				
7	Damaged by animals				
8	Marketing problem of products				
9	Conflict with neighbors				
10	Difficulties in post-harvest of products				
11	Difficulty in ploughing and laddering				
12	Obstructs sunlight and air				
13	Shortage of water				
14	Shortage of animal manure				
15	Shortage of equipment				
16	Lack of storage facilities				
17	Lack of transportation facilities				

11. Income from multipurpose tree species

Sl. No.	Types of tree species	Income (Taka)
1	Timber trees	
2	Fruit trees	
3	Medicinal trees	
4	Fodder trees	
5	Fuel wood trees	
Total		

12. Farmer's attitude regarding in contribution of diversified tree species for the improvement of rural life on socio-economic condition

Sl. No.	Statement regarding changes in socio-economic aspects due to homestead agroforestry	Nature of problems			
		Strongly agree	Agree	Disagree	Strongly disagree
1	Increasing economic security during crisis period				
2	Increase in the supply of timber, house making materials for industry due to increases in number of plants in homestead				
3	Increasing the supply of animal feed from homestead agroforestry				
4	Increasing the quantities of vegetables, fruits, timber, medicinal, fuel from homestead agroforestry				
5	Increasing employment opportunity				
6	Sometimes lead to quarrel among the farmers due to the shadow of the trees in homestead agroforestry				

7	Increasing the income of farmers from the MPTs				
8	Increasing the availability of fuel materials				
9	Decreasing the family malnutrition				
10	Make opportunity to use the fallow land for plantation				
11	Increasing spices (ginger, turmeric etc.) cultivation under the shady plant in homestead				
12	Improving the livelihood status				
13	Improving the participation in social activities due to homestead agroforestry				
14	Reducing the soil erosion				
15	Medicinal plants helps to the homestead				
16	Fulfill the demand of vegetables from homestead				
17	Fulfill the demand of nutrition				
18	Fulfill the demand of agricultural crops from homestead agroforestry				

13. Please answer the following questions

Sl. No.	**Question**	**Yes**	**No**
1	Is a homestead agroforestry increasing the aesthetic value?		
2	Beneficial for environmental aspects		
3	Do you work in your home garden regularly?		
4	Is your home garden productive?		
5	Do you practice any mixed combinations agriculture?		

Thank you giving me your valuable time

Appendix 2: Interview schedule for data collection for the research on

"TREE SPECIES DIVERSITY IN THE HOMESTEADS AND ITS IMPACT ON SOCIOECONOMIC CONDITION OF THE FARMERS IN NILPHAMARI DISTRICT"

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 3: Descriptive statistics of independent variables

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Age of the respondents	60	19.00	68.00	44.3000	12.78147	163.366
Education level	60	.00	16.00	8.5167	3.68916	13.610
Occupation of the respondents	60	1.00	8.00	3.3833	2.54513	6.478
Sex	60	1.00	2.00	1.1833	.39020	.152
Family size	60	3.00	10.00	5.3667	1.98269	3.931
Farm size	60	.13	2.73	1.0092	.75659	.572
Homestead size	60	.06	.30	.1482	.05673	.003
Annual income	60	31.00	204.00	84.4233	40.67139	1654.162
Organizational participation	60	4.00	15.00	8.4000	3.04876	9.295
Problem confrontation	60	10.00	35.00	20.5667	7.34239	53.911
Livelihood characteristics	60	7.00	21.00	12.3667	4.22248	17.829
Valid N (listwise)	60					

Appendix 4: Tree diversity measurement (Shannon-Weiner Index Calculation Table)

Sl. No.	Species	Number	*Pi*	*LnPi*	*Pi*LnPi*	Percentage (%)
1.	*Mangifera indica*	396	0.2117	-1.5525	-0.3286	21.17
2.	*Areca catechu*	60	0.0321	-3.4388	-0.1104	3.21
3.	*Cocos nucifera*	167	0.0893	-2.4158	-0.2157	8.93
4.	*Phoenix sylvestris*	55	0.0294	-3.5268	-0.1037	2.94
5.	*Borassus flabellifer*	69	0.0369	-3.2995	-0.1218	3.69
6.	*Tamariandus indica*	10	0.0053	-5.2400	-0.0277	0.53
7.	*Carica papaya*	37	0.0197	-3.9271	-0.0774	1.97
8.	*Dilenia indica*	8	0.0042	-5.4727	-0.0229	0.42
9.	*Albizzia procera*	3	0.0016	-6.4377	-0.0103	0.16
10.	*Elaeocarpus tectorius*	26	0.0138	-4.2831	-0.0592	1.38
11.	*Dalbergia sisso*	16	0.0086	-4.7559	-0.0409	0.86
12.	*Cajanus cajan*	3	0.0016	-6.4377	-0.0103	0.16
13.	*Lagerstroemia speciosa*	12	0.0064	-5.0995	-0.0326	0.64
14.	*Swietenia macrophylla*	154	0.0823	-2.4974	-0.2055	8.23
15.	*Azadirachta indica*	75	0.0400	-3.2188	-0.1287	4.00
16.	*Bombax ceiba*	5	0.0026	-5.9522	-0.0155	0.26
17.	*Spondias spp.*	56	0.0299	-3.5099	-0.0820	2.99
18.	*Albizia saman*	6	0.0032	-5.7446	-0.0184	0.32
19.	*Artocarpus heterophyllus*	307	0.1641	-1.8073	-0.2966	16.41
20.	*Ficus benghalensis*	21	0.0112	-4.4918	-0.0503	1.12
21.	*Moringa oleifera*	19	0.0101	-4.5952	-0.0464	1.01
22.	*Musa spp.*	102	0.0545	-2.9095	-0.1586	5.45
23.	*Syzygium cumini*	24	0.0128	-4.3583	-0.0558	1.28
24.	*Psidium guajava*	50	0.0267	-3.6231	-0.0967	2.67

Sl. No	Species	Number	Pi	LnPi	Pi*LnPi	Percentage (%)
25.	*Averrhoa carambola*	24	0.0128	-4.3583	-0.0558	1.28
26.	*Zizyphus mauritiana*	40	0.0214	-3.8453	-0.0823	2.13
27.	*Neolamarckia cadamba*	21	0.0112	-4.4918	-0.0503	1.12
28.	*Aegle marmelos*	11	0.0059	-5.1328	-0.0303	0.59
29.	*Citrus grandis*	16	0.0085	-4.7676	-0.0405	0.85
30.	*Citrus limon*	13	0.0069	-4.9762	-0.0343	0.69
31.	*Litchi chinensis*	75	0.0400	-3.2188	-0.1287	4.00
32.	*Tectona grandis*	3	0.0016	-6.4377	-0.0103	0.16
Total		**1871**			**-2.723**	**100**