DIVERSITY OF MULTIPURPOSE TREE SPECIES IN HOMESTEAD AND CROP LAND AND ITS ECONOMIC IMPORTANCE ON THE LIVELIHOOD OF THE FARMERS OF MUKTAGACHA UPAZILA IN MYMENSINGH DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled **"DIVERSITY OF MULTIPURPOSE TREE SPECIES IN HOMESTEAD AND CROP LAND AND ITS ECONOMIC IMPORTANCE ON THE LIVELIHOOD OF THE FARMERS OF MUKTAGACHA UPAZILA IN MYMENSINGH DISTRICT"** submitted to the Department of Agroforestry and Environmental Science, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE (M.S.)** in **AGROFORESTRY AND ENVIRONMENTAL SCIENCE**, embodies the result of a piece of bonafide research work carried out by **FATEMA DALIA**, Registration No. 14-06059 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 been duly acknowledged.

June, 2021
Dhaka, Bangladesh

Prof. Dr. Md. Forhad Hossain
supervisor

Dedicated to

My

Beloved Parents

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DIVERSITY OF MULTIPURPOSE TREE SPECIES IN HOMESTEAD AND CROP LAND AND ITS ECONOMIC IMPORTANCE ON THE LIVELIHOOD OF THE FARMERS OF MUKTAGACHA UPAZILA IN MYMENSINGH DISTRICT

ABSTRACT

The purpose of this study was to assess diversity of multipurpose tree species in homestead and crop land and its economic importance on the livelihood of the farmers of Muktagacha upazila in Mymensingh district. The study area covered four villages of two unions at Muktagacha upazila in Mymensingh district, Bangladesh. Assessment was done by approach of purposive random sampling. Information concentrated from an accumulation of 67 households ranging from marginal, small, medium and large categories. A total of 3142 trees representing 24 families were identified. Fuel wood (25.96%), fruit (23.08%) and timber (23.08%) species were the important plant use categories. Determination of the relative abundance of the divergent species revealed that *Mangifera indica* constitutes 14.61% of homestead agroforestry followed by *Artocarpus heterophyllus*, which occupies 13.21%. Shannon Wiener index (H) was used to evaluate the tree diversity and evaluation showed that tree species diversity of the area was 0.057 and species evenness index (E) was 0.035. According to the plants categorization, Shannon Wiener index (H) varied from 0.028 to 0.265. Tree species diversity in homestead was significant and positively influenced by farm size, homestead size, crop land size, annual income and livelihood condition. Similarly, tree species diversity in crop land was significant and negatively influenced by farm size, homestead size, annual income and livelihood condition while crop land size was significant and positively correlated with crop land tree species diversity. Results of this study can contribute to modify agroforestry programs for implementing future tree planting activities for different target populations in various economic and environmental circumstances.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
Kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
ml	=	MiliLitre
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celceous
%	=	Percentage
NaOH	=	Sodium hydroxide
GM	=	Geometric mean
mg	=	Miligram
P	=	Phosphorus
K	=	Potassium
Ca	=	Calcium
L	=	Litre
Mg	=	Microgram
USA	=	United States of America
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Bangladesh is one of the most densely populated countries of the world. Having about 142.3 million people in its 1,47,570 km^2 of area (BBS, 2010). The country has a total area of 14.4 million hectares of which land covers 13.62 million hectares and river 0.78 million hectares. There are 7.62 million hectare of cultivable land and about 2.5 million hectares of forests in Bangladesh (BBS, 2010). About 70% of the population live in the rural areas in 25.35 million households spread over 87316 villages (BBS, 2010).There are only 808254 ha of homestead land (about 10.63 percent of total cultivable land) having 0.03 ha per household.

Agroforestry systems provide various goods and services including enhancement of carbon storage and organic matter, conservation of above and below ground biodiversity, improvement of soil fertility and structure and enhancement of water infiltration (Sanchez *et al*., 1997; Garrity *et al*., 2010; Tanga *et al*., 2014). Farmers in the Central Rift Valley give high priority to utilities from tangible goods such as firewood, timber and fruits, but they also value multiple ecosystem services provided by the trees (Iiyama *et al*., 2016).

Homestead represents a land use system involving purposeful management of multipurpose trees and shrubs in intimate association with seasonal vegetables (Fernandes and Nair, 1990). The homesteads of Bangladesh are a source of livelihood for many farmers and serve as safety net during the time of hardship and natural disaster. Farmers want to use his farm area for maximum production. But, there is no program to improve the overall productivity of homestead forests, nor to produce yield-increasing technology.

Multipurpose Tree Species (MPTs) refers to presence of different types of tree species which has multi-uses. The diversity of Multipurpose Tree Species in home garden have a wide socioeconomic and agro-ecological roles including production of food and a wide range of products such as firewood, fodders, spices, medicinal plants and avoidance of climate related hazards commonly associated with monoculture production systems. Multipurpose Tree Species in homestead forests supply 70% of timber and 90% of fuel wood and bamboo (Singh, 2000).

Trade-offs linked to the competition between trees and crops for light, nutrients and water should be managed through proper species–site matching, silviculture and tree management. Local knowledge surveys conducted in the area indicate that farmers can balance the reduction in crop yields with the various products and services that they get from the trees (Ataa-Asantewaa, 2013).

Generally, improving the tree cover in these farming systems through both natural regeneration and planting is crucially needed to reverse the continued degradation of the ecosystem, increase resilience and improve local people's livelihood. Diversifying the composition of farm tree species also enhances the stability and productivity of agro-ecosystems (Kindt and Coe, 2005) and combines the objectives of attaining gains in food security and in conservation of biodiversity (Atta-Krah *et al*., 2004; Garrity, 2004).

Forest is important natural resources of a country requiring 25% forestland of the total area of a country for its socio-economic upliftment and maintenance of environmental equilibrium. But Bangladesh has only 9% forestland of the total area as officially recorded where trees cover only 5.5% of the total area which is decreasing day by day. Agroforestry practices help overcome this deteriorating environment of the traditional agriculture. MPTs in homegardens of Bangladesh are a source of livelihood for many farmers. It increases income of the farmers and serve as safety net during the time of hardship and natural disaster. Farm production can be increased by incorporating intercropping, mixed cropping; and relay cropping system under agroforestry system. So the study was conducted with the following objectives:

1. To explore the diversity of multipurpose tree species (MPTs) existed in the homesteads area and in crop land
2. To find out the contribution of different MPTs diversity on the livelihood of the farmers and their economy in the study area.

CHAPTER II

REVIEW OF LITERATURE

This chapter deals with a brief review of the past studies and opinions of researchers having relation to this investigation which were gathered from text books, journals, dissertations, reports and other form of publications. This study is mainly concerned with diversity of multipurpose tree species in homestead and crop land and its economic importance on the livelihood of the the farmers of a particular region of Bangladesh.

2.1 Concepts of agroforestry and homestead agroforestry

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

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

Khalid and Bora (2000) stated that agroforestry does not merely mean planting trees in the fields or other places rather provide an effective land management system that can ensure more production in a balanced ecological environment. It helps to overcome shortcoming of traditional agriculture that are often characterized by low output at the cost of relatively high investment resulting in a deterioration of environment.

2.2 Importance of homestead agroforestry

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

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

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

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

2.3 Socio-economic effect of agroforestry

Salam *et al.* (2000) reported the positive effect of landholding size on farm level tree growing in Bangladesh and same was reported by Dwivedi *et al.* (2009) in India. They argued that when land becomes scarce, the overriding need to produce food takes precedence over the long-term value of trees thereby implying a decreasing likelihood of growing trees with decreasing size of landholding.

Sood *et al.* (2005) evaluated tree species preferences of the farmers in Manipur so that in future optimum choice of trees can be made for effective application of agroforestry programmes in the State. *Parkia roxburghii* and *Pinus spp*. were found to be the most grown tree species in the valleys and hills respectively.

Snelder and Lasco (2008) studied that smallholders of Asian countries including India have increasingly been involved in on-farm tree growing due to development of agroforestry systems. With the expansion of small-scale cultivation in numerous areas of the world, the awareness is increasing and land of smallholders are of increasing importance both in sustainable food production and protecting environmental services, such as biodiversity conservation, safeguarding of watershed and carbon sequestration.

Rahaman *et al.* (2008) reported from a case study to address the general constrain of lack of adoption in Litchi chinensis based agroforestry in North Bangladesh; that agroforestry and non-agroforestry farmers do not differ greatly in terms of educational level. They studied that lack of general education did not explain the low adoption rates of agroforestry.

Dwivedi *et al*. (2009) studied relationship between land holding of the farmers and age of farmers with tree preferences and the farmers' preferences for multi purpose trees (MPTS) in agroforestry. The decision of MPTS in descending order of preference for the respondent of age group 21–40 years (young) were Shisham, Teak, Neem and Subabul; for respondents of 41–60 year age group (middle age) were more or less similar to young respondents; and for older respondent of 61–80 years of age were Shisham, Teak, Siris and Butea. The overall preference of MPTS in relation to age was found as Shisham, Sagon, Neem and Sirisis in descending order of preference. Similarly, marginal farmers preferred Shisham, Teak, Subabul and Eucalyptus; small farmers preferred Shisha, Neem, Eucalyptus and Teak; and for larger farmers preferred Shisham, Teak, Eucalyptus and Neem trees in descending order of preference. The overall preference for MPTS trees in descending order of preference reported were Shisham, Teak, Eucalyptus and Neem.

Sharma (2009) studied horticulture based agroforestry systems in degraded lands in India. He reported that shrubs like Jharber *(Ziziphus nummularia)* and caronda *(Carissa carandas)* were more appropriate for farming in the natural/sown pasture of anjan grass *(Cenchrus ciliaris)* in Bundelkhand region where soil is sandy loam, shallow and underlain by murram layer. Various features of hortipastoral system like, growth, tree spacing, nutritive value of tree leaf fodder and productivity of the system, rooting system and effect of climate change were considered by various workers. He suggested that the main activity to establish fruit bearing trees in agroforestry system is to recognize appropriate species. Th primary basis of species selection is to follow the fruit trees being grown by farmers.

Zeleke (2009) considered status of traditional agroforestry in Burkitu Peasant Association, Oromia, in Ethiopia and studied that farmers choose on their preference of niches of agroforestry based on the types of components involved and other factors like agroforestry practice consisting of fruit bearing crops and vegetables were highly preferred to be practiced. He also studied that when the farm size is large it would encourage agroforestry practices, or that farmers would not see the need to undertake agroforestry. On the other hand, engagement in agroforestry on small farms would be seen as loss of land to trees that could potentially be used for food and cash crop production.

Mahapatra (2010) conducted study on planning economic land use models for dry land farm forestry in India and bring out that an economic estimation of dry land farming was undertaken to demonstrate the impact of trees on the yearly net profits of smallholding farms of eastern India.

Mustaq *et al*. (2012) while conducting study on selection of species for fuelwood used by the households in Samba district of Jammu and Kashmir in India revealed that State forests were the major source of fuelwood followed by their own farm. The species selection changes from village to village due to difference in personal choice and locality factors. *Acacia nilotica* and *Dalbergia sissoo* were the highly favored species in the study area due to their easiness of regeneration, better fuelwood quality and low smoke production. It was suggested that stress should be given for plantation of these species in agroforestry systems to achieve the need of the rural people for fuelwood and reduce the pressure from the prevailing state forests.

Adedayo and Oluronke (2014) studied that there was a significant association between the educational qualification and age of respondents as well as land ownership and the adoption of agroforestry practices in the area of study. However, there was no significant association between respondents size of farm and the adoption of agroforestry practices in the area of study.

Baig and Ehrenreich (2014) found that there was nothing new about the models of uniting land uses with forestry as grazing forests and interplanting trees with crops were both primordial practices and farmers had been growing and sustaining trees on their farmlands for centuries for a number of purposes. But their method was not conferring to the modern recommended scientific practices.

Chavan *et al.* (2015) gives the main features of the national agroforestry policy in India to successful ground-level schemes and the challenges to focus on agroforestry not only as a effective land-use system, but also to use its potential in the economic development of the country.

Mahato *et al*. (2019) revealed that in Ichak block of Hazaribagh district of Jharkhand most of the houses (98.12%) were headed by males of age between 40-

60 years. Different types of agroforestry practices were done by respondents on their farm. 80 percent of the respondents practiced agroforestry on 0.5 to 1.0 acre farm land. The major existing agroforestry practices in the area were found to be Homestead (84.38%), Trees on Field Bunds (8.12%), and Silvipasture (7.50%). 25.00 % household had maximum monthly income ranged between Rs. 9001-11000 followed by 16.87 % of more than Rs. 11000 and Rs.1001- 3000.

2.4 Agroforestry systems and practices

Agroforestry systems range from subsistence livestock silvo-pastoral systems to home gardens, on-farm timber production, tree crops of all types integrated with other crops and biomass plantations within a wide diversity of biophysical conditions and socio-ecological characteristics. The term has come to include the role of trees in landscape level interactions, such as nutrient flows from forest to farm, or community reliance on fuel, timber, or biomass available within the agricultural landscape (Zomer *et al.*, 2009). After a meta analysis covering more than 500 publications on agroforestry from 1992-2002, Montambault and Alvalpati (2005) reported that regarding system the focus has shifted from forest-like to silvopastoral systems.

Man has been practicing agroforestry since he learnt the art of cultivating agriculture crop and domestication of livestock and has never stopped using trees (Tewari, 1995). Agroforestry has been practiced for millennia by agrarian-based societies throughout the world (Garrity, 2006). The World Bank estimates that 1.2 billion people practice some form of agroforestry on their farms and in their communities (World Bank, 2004). Agroforestry system has been practiced for a long time throughout the world. With the establishment of WAFC (World Agroforestry Centre) the ancient practice of agroforestry was institutionalized. The WAFC with the help of global inventory contributes immensely in collecting, evaluating and disseminating information on new approaches of agroforestry system.

According to Rafiq *et al*. (2000) traditional agroforestry is the result of farmers innovation and experimentation over centuries. Traditional agroforestry has been practiced for millennia by agrarian-based societies throughout the world (Garrity, 2006). The World Bank estimates that 1.2 billion people practice some form of agroforestry on their farms and in their communities (World Bank, 2004). Ideally, agroforestry integrates a wide range of traditional practices that have been validated and adapted to local conditions over generations. Sustainable management and protection of the natural resource base by native and peasant communities is often an integral part of their livelihood strategy (Prins, 2000). These practices are part of the cultural heritage and identity.. From the early taungya systems to scattered trees on farm lands, agrisilviculture, silvipasture, agrihorticulture, hortipasture, energy farms, farm boundary planting, aquaforestry, home garden, slash and burn agriculture etc. are various forms of Agroforestry systems practiced throughout India (Nair, 1993).

Cropland Agroforestry (CAF) is a traditional land use system in Bangladesh where tree species like date palm (*Phoenix sylvestris*), palmyra palm (*Borassus flabellifer*), babla (*Acacia nilotica*), mango (*Mangifera indica*), khoer (*A. catechu*), mahogany (*Swietenia mahogany*), jackfruit (*Artocarpus heterophyllus*), eucalyptus and sissoo (*Dalbergia sissoo*) grow naturally or planted on agricultural lands and are purposely retained and maintained by the farmers for different household utilities, products and also for cash income (Abedin *et al*., 1987; Hasan *et al*., 1987; Abedin and Quddus, 1991; FAO, 2004). Due to biophysical and social variations various patterns of cropland agroforestry systems are practiced in different agro-ecological regions of Bangladesh (Shams, 2013). Under this system, trees are planted on the borders or within the field, systemically or at irregular intervals, usually with crops such as rice, wheat, pulse, jute, oilseed, sugarcane, vegetables and others, and farmers also grow shade tolerant crops such as turmeric, ginger and aroid when trees have high canopy coverage (e.g. jackfruit, mahagony) (Miah *et al*., 2002). CAF system provides enough food, timber, fodder, fruit, fuel wood, construction materials, raw materials and other products for forest-based small-scale enterprises and other cottage industries (Abedin *et al*., 1987; Hasan *et al*., 1987; Rahman, 2011). The best product having commercial value from cropland trees might be poles and pulpwood as these trees are mostly short-rotation species (Ghosh *et al*., 2011). Trees in crop fields work as insurance in case of sudden crop failure or to support crops against environmental hazards and also to provide extra income from trees. Moreover, if there is a failure in one crop, the other crops would supplement the deficit. So, CAF is largely evolved with sustainability concerns - resiliency, diversity, and avoiding negative side effects in mind (Brooks *et al*., 1995).

The promising tradition of tree inclusion in to the farmlands through retention of remnant or naturally regenerated indigenous tree species and undertaking plantation activities have been reported in Ethiopia. From a study on status of traditional agroforestry in Burkitu Peasant Association, Oromia, in Ethiopia, Zeleke, (2009) reported promising tradition of keeping trees on farmers' land. Homestead, farm boundary, trees on farm land, grazing land and live fence were the common niches where tree retention has been practiced. Among the aforementioned niches, homestead was the most preferred niche by the majority of the respondents followed by farm boundary and farm land. Similarly, home stead was the most preferred niche for tree plantation. Kindu, (2001) noted the types of traditional agroforestry practices in Yeku watershed northeastern Ethiopia as trees and shrubs in silvipastoral lands, trees on farmlands, trees along rivers, and trees in homesteads. Growing Acacia albida as a permanent tree crop, on farmlands with cereals, vegetables and coffee underneath or in between, is an indigenous agroforestry system in the Harrarghe highlands of Eastern Ethiopia (Poschen, 1986). Homegardens in central, eastern, western and southern Ethiopia are characterized as backyards, front-yards, side-yards and enclosing yards (Zemede and Ayele, 1995). Farmers in Wondo-Genet, which is located within the Ethiopian Rift Valley, have been planting trees near and around homestead, along external and internal boundaries to a lesser scale as woodlot. Fruit trees, coffee, and *Cordia africana* in most cases are planted in the home garden together with Ensete ventricosum (Abebe, 2000).

Agroforestry has a long tradition in the Indian subcontinent (India, Pakistan, Bangladesh, Nepal, Bhutan and Sri Lanka). Farmers in the subcontinent basically practice a mixed-farming system. The socio-religious fabric of the people of the subcontinent is interwoven to a very great extent with raising, caring for and respecting trees. Trees are integrated extensively in the crop- and livestock-production systems of the region according to the agroclimatic and other local conditions. Deliberate growing of trees in homesteads, on field bunds, their sporadic distribution in agricultural fields, and the systematic retention of shade trees in tea and coffee plantations are other common examples of prevalent agroforestry practices. Similarly, it is a common practice to utilize the open interspaces in the newly planted orchards and forests for cultivating crops for 2-3 years and to interplant shade tolerant crops such as turmeric and ginger later (Singh, 1987). A brief review of traditional agroforestry systems of Southeast Asia and the Indian subcontinent is available with (Snelder and Lasco, 2008) and Singh, (1987), respectively.

In Bangladesh there is a long tradition of tree growing in homesteads and homegardens like elsewhere in Southeast Asia (e.g., Ahmed and Ali, 2003). Likewise tree growing in the form of traditional forestry has been practiced in the form of village forests, tea and rubber gardens and shifting cultivation systems in hill forest (Islam, 2013). Whereas in present times homegardens cover only about 2.3 percent of the land (Jensen, 1995), village forests play a more important role supplying 80 to 82 percent of the forest products in villages (Forestry Master Plan, 1992). It is estimated that these forests cover about 270,000 ha (Forestry Master Plan, 1992) containing, amongst others, bamboo, palms, and trees (for fruit, fuelwood, construction, shade, and other multiple purposes).

In mid-hills of Nepal, shifting cultivation is practiced by ethnic people for generations (Regmi *et al.*, 2005). Locally this form of farming is called Khoriya farming (Aryal and Kerkhoff, 2008; Dhakal, 2000). Under Khoriya farming generally steep to gentle steep land is cultivated using slash -and-burn techniques (Brady, 1996). Patches of forest land are first cleared off and subsequent burning of dried vegetation is done before sowing maize or leguminous crops. After one or two cycles of crops the land is abandoned for few years. In the mean time, farmers go for other patches of land to clear the vegetation for cultivation purpose. According to Aryal *et al.* (2009), Kerkhoff and Sharma (2006), and Regmi *et al*. (2005), Khoriya farmers are mostly food unsecure, marginalized and often they have to rely on wild and uncultivated plants for subsistence.

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

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

2.5 Species composition of homestead agroforestry

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

Alison (1994) mentioned that species density (number of species per hectare) was declining with increasing garden size. Soemarwato *et. al.,* (1991) and Michon *et. al.* (1983) stated that homegardens are intensively cultivated and have the highest diversity of species.

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

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

2.6 Socio-economic conditions of households and their relationships with agroforestry practices

Socio-economic considerations are increasingly becoming important in technology diffusion and adoption processes. This is more so for agricultural, forestry, agroforestry and related innovations, which are meant for the diverse environments and circumstances of rural people (Rocheleau and Raintree, 1986). Raintree (1991) pointed out that the degree of socio-economic stratification, which exists within a locality, is important in determining the adoption of a new technology particularly if it is highly attached to factors, which govern access to resources. The stratification of a community can be on the basis of wealth, landholding size, gender, age, ethnicity, religion, education etc.

2.6.1 Households' age and agroforestry practices

Varied relationship between age of the farmers and innovation adoptions has been reported by Rogers (1995). Rogers and Svenning (1969) commented that younger farmers accept change and adopt innovations more readily compared to older farmers.

Aturamu and Daramola (2003) reported negative response of age of farmer towards the adoption of agroforestry based technologies while studying the impact of socio-economic factors to adopt or maintain agroforestry. McGinty *et al*. (2006) observed that age of farmers significantly contribute to farmer's intentions to adopt or maintain agroforestry. The younger farmers were found to be more likely to adopt or maintain agroforestry than older farmers. They argued that younger farmers may be more risk taking even though older farmers may have more experience.

Rogers (2003) reviewed the relationship between age and adoption and noted inconsistent relationship of age and adoption. About half of the many diffusion studies on adoption show no relationship, a few found that early adopters are younger and some indicate they are older. Diffusion in this context refers to the stage in which the technology spreads to general use and application while adoption refers to the stage in where a technology is selected for use by an individual or an organization.

Arbuckle (2005) in his study of non-operator landowner and agroforestry found age variable as not significant, while Dorr (2006) found age to be significant and negative for alley cropping, windbreaks, and forest farming, and not significant and negative for riparian buffers and silvopasture.

Fregene (2007) observed negative impact of age of respondents on adoption of the two traditionally considered conservation agroforestry practices in U.S., windbreak and riparian buffers. Older farmers were found to be less interested in implementing new practices including adoption of agroforestry. It was argued that older the respondents, the odds of their interest in adopting agroforestry decreases with a change of probability less than one. This means seeing agroforestry in terms of tree, investment were less likely to be adopted by older landowners because of the time frame involved in production.

2.6.2 Households' level of education and agroforestry practices

Level of education has been shown to be important in many studies. The higher the level of education, the more likely interested in adopting new practices.

Farmers with lower education levels are considered to be low adopters and risk averse. Rogers and Svenning (1969) asserted that the education level decreases from innovators to late adopters, and persons with a higher level of education are supposedly more capable of understanding the innovation.

Korsching *et al*. (1983) showed that education relates directly to innovation. The higher the level of education the more likely landowners are to be interested in adopting new practices like agroforestry. Older farmers are viewed as less flexible, more risk averse, and less willing to engage in innovative farm technology (Thacher *et al*., 1997). The farm experience and education (both formal education and informal training) of the farmer are important characteristics that influence decisions made in farm tree growing (Adesina and Chianu, 2002). Aturamu and Daramola (2003) reported that adoption of agroforestry increased with the rise in level of farmer education.

Flower *et al.* (2005), in their study of habitus and interest in agroforestry practices in Missouri, found that educational level was positively related with the adoption of agroforestry practices.

Sood *et al*. (2005) reported that education of head of household and the family have significant influence on tree growing. Based on the result, it was suggested that long term planning is required to increase education level of the society to encourage on-farm tree growing.

Dorr (2006) found impact of education level significant in silvopasture and not significant in windbreaks, alley cropping, riparian buffers and forest farming.

Muneer (2008) reported that farmers adoption of agroforestry farming system in Northern Kordofan state in Sudan was significantly affected by the farmer's level of formal education. He argued that as educated farmers usually have access to more information sources, can comprehend and benefit more from extension messages and are usually more aware about environmental problems (Haggblade *et al*., 2004)

2.6.3 Households farm size and agroforestry practices

The trade-off between agricultural production and tree growth is an important factor in the farmers allocation of family land and labour. Land size could be a crucial factor in this trade-off as it limits the number of trees that land-poor farmers can tolerate to grow close to their food crops in view of the possible competition and shade effects of trees. Studies on farm size and the use of practices show either a significant and positive relation (Korsching *et al*, 1983; and Ervin and Ervin, 1982) or non-significant effects (Mattews *et al*., 1993). Most studies indicate the larger the farm size the greater the use of conservation practices. Byerlee *et al*. (1981) reported that increase in the size of the land holdings was associated with a strong increase in the optimal number of fruit trees on farm. In a study on adopters and their relationship to innovativeness Korsching *et al*. (1983) found that users of agroforestry practices have larger farms with greater income and own more land. They argued that larger households having farms are able to absorb most of the production costs in establishing agroforestry due to economies of scale, but at the same time they might see the trees as an obstacle for farm equipment to operate effectively which may prevent them from adopting.

The positive effect of landholding size on farm level tree growing has been reported by Salam *et al*. (2000) in Bangladesh and Dwivedi *et al*. (2009) in India. They argued that when land becomes scarce, the overriding need to produce food takes precedence over the long-term value of trees thereby implying a decreasing likelihood of growing trees with decreasing size of landholding.

Arbuckle *et al*. (2005) studied on adoption of agroforestry among landowners in Missouri (in USA) and found that those who participate in farming activities and have a larger percentage of land under crops were considerably less likely to be interested in agroforestry practices. They also found that landowners who have closer ties to farming and strong financial motivations are less interested in agroforestry, while those that place a high importance on environmental and recreational aspects of their land are more interested in agroforestry as a potential land use application.

Studies on farm size and the use of practices have been found to show either a significant effect or a strong positive relationship (Fregene, 2007). According to Zeleke (2009), it could be expected that when the farm size is large it would encourage agroforestry practices, or that farmers would not see the need to undertake agroforestry. On the other hand, engagement in agroforestry on small farms would be seen as loss of land to trees that could potentially be used for food and cash crop production.

2.6.4 Households family size and agroforestry practices

Tree growing is a land use activity and therefore farm size and agricultural holdings are expected to have positive influence on growing trees on farms (Sood and Mitchell, 2009). As compared to agriculture, tree growing is less labour intensive (Arnold 1997; Malla, 2000).

Byerlee *et al.* (1981) observed that excess family labor obtain income from offfarm activities rather than being a limiting constraint to on-farm activities. Jones and Price, (1985) in their study found that shortage of family labour (for crop cultivation) had no influence of on tree planting. In many countries of the world, particular species of trees or simply individual trees with special shapes have distinctive religious or spiritual connotations. This can often influence tree cultivation practices (Carter, 1995).

Singhal and Kumar (1997) reported a significant association between family size and tree planting in Garhwal Himalayas.

Sood (2006) reported that shortage of family labour for agricultural work could result in households opting for less labor intensive land use like tree growing.

2.6.5 Households income and agroforestry practices

Since tree planting is not as labor intensive as other agricultural production activities, farmers whose main source of income is non-agricultural are more likely to plant trees on farms (Salam *et al*., 2000). Generally, resource endowments are likely to be positively correlated with probability of farm tree planting.

Salam *et al*. (2000) analyzed why farmers plant trees in Bangladesh with emphasis on homestead agroforestry. They found that in tree planting efforts economic factors play a larger role than do ecological factors.

While studying the impact of socio-economic factors to adopt or maintain agroforestry, McGinty *et al.* (2006) observed that average annual income of farmers significantly contribute to farmer's intentions to adopt or maintain agroforestry. The lower income farmers were found to be more likely to adopt or maintain agroforestry than higher income farmers.

Sood (2006) examined adoption of traditional agroforestry in relation to economic and farming conditions of households and found increased agroforestry adoption among households with higher off-farm, agricultural, and total incomes. Fregene (2007) also found on-farm monetary benefit to be positively and significantly associated with agroforestry adoption. It was observed that respondents that have achieved on-farm monetary benefits of agroforestry were five times more likely to adopt agroforestry.

2.7 Households preference for future tree planting

Zubair and Garforth (2005) reported that the farmer's willingness to grow trees on their farmlands is a function of their attitudes mainly towards the advantages of growing trees. The farmers perceive tree planting as a source of income, providing wood for fuel and furniture, controlling erosion and pollution, and providing shade for humans and animals. They further stated that now the farmers have long recognized the value of planting trees on their fields for sheltering crops, generating wood for self-consumption and commercial sale.

While studying farm level traditional agroforestry systems in Manipur, Sood *et al*. (2005) evaluated tree species preferences of the farmers so that proper choice of trees can be made in future for successful implementation of agroforestry programmes in the State. *Parkia roxburghii* and *Pinus spp.* were found to be the most preferred forestry tree species in the valleys and hills respectively.

Nouman *et al*. (2006) investigated to find out the reasons for adoption of agroforestry by farmers in Faisalabad district of Pakistan and reported that *Dalbergia sissoo* was the most preferred tree species and was followed by *Acacia nilotica, Populus deltoids, Eucalyptus camaldulensis* and *Melia azaderach*. They concluded that the farmers were planting trees on their farmlands mainly to obtain fodder for their livestock and fuel wood to meet their combustion needs. The high preferences of farmers for *Dalbergia sissoo* and *Acacia nilotica* are because these species give better economic returns and have best quality of timber, fuel wood and fodder. They further reported that fruit trees were not encouraged by farmers to grow on farmlands due to its management problems. It was understood that farmers gave their opinions about different tree species regarding their liking and disliking.

Madiwalar *et al*. (2007) conducted a study in three districts (viz, Bidar, Gulbarga and Raichur) in Karnataka State in India and reported that the farmers preferred fuel wood yielding sps., fruit yielding sps., fodder yielding sps., timber yielding sps., Short duration sps., etc. The highest preference was for fruit yielding tree species and was followed by timber yielding tree species.

In addition to forestry plantations, smallholders of Asian countries including India have increasingly been involved in on-farm tree growing through the establishment of agroforestry systems. More recently, with the expansion of small-scale cultivation in many regions of the world, the awareness is mounting that lands controlled by smallholders are of increasing importance in both sustainable food production and safeguarding environmental services, such as biodiversity conservation, watershed protection and carbon sequestration. They more and more determine the environmental, economical and ecological value of the landscape (Snelder and Lasco, 2008).

Sharma (2009) reviewed fruit tree based agroforestry systems (AFS) for degraded lands in India. He noted that bushes like jharber *(Ziziphus nummularia)* and caronda (*Carissa carandas*) were more suitable for cultivation in the natural/sown pasture of anjan *(Cenchrus ciliaris)* in Bundelkhand region where soil is sandy loam, shallow and underlain by murram layer. He further summarized the criteria for MPTS selection in the following five steps: (i) Suitability to local edaphic and agroclimatic conditions, (ii) Potential for tree management practices, (iii) Purpose of tree plantation, (iv) Adaptability to the agrarian system, and (v) Socio-economic considerations. Additionally, various aspects of hortipastoral system like, tree spacing, growth and productivity of the system, rooting system, nutritive value of tree leaf fodder and impact of climate change were undertaken by various workers.

It was suggested that the first and foremost activity to establish fruit trees in agroforestry system is to identify suitable species. The main basis of species selection is to follow the fruit trees being grown by farmers.

Zeleke (2009) studied status of traditional agroforestry in Burkitu Peasant Association, Oromia, in Ethiopia and reported that farmers decide on their preference of niches of agroforestry based on the types of components involved and other dictating factors. For example, agroforestry practice composed of fruit crops and other vegetables was most preferred to be practiced in homesteads. Nair (1993) also indicated that tropical home gardens consist of an assemblage of plants, which may include trees, shrubs, vines, and herbaceous plants, growing in or adjacent to a homestead or home compound these gardens are planted and maintained by members of the household and their products are intended primarily for house hold consumption and provide shade to people and animals.

CHAPTER III

MATERIALS AND METHODS

The methodology used in conducting any research is critically important and deserves careful consideration. It enables the researcher to collect valid and reliable information in terms of hypothesis or research instrument and to analyze the information properly to arrive at valid results.

3.1 Geographical location of the study area

The study was conducted in four villages namely Norkona, Soyedpara, Rudropur and Mankun under Muktagacha upazila in Mymensingh district. The study area is located in the north part of Bangladesh. Mymensingh is a district in Mymensingh Division, Bangladesh, and is bordered on the north by Meghalaya, a state of India and the Garo Hills, on the south by Gazipur District, on the east by the districts of Netrokona and Kishoreganj, and on the west by the districts of Sherpur, Jamalpur and Tangail. The district consists of 12 upazilas and Muktagacha upazilas was the study area. The locations of the study area was showed in the Figure 1.

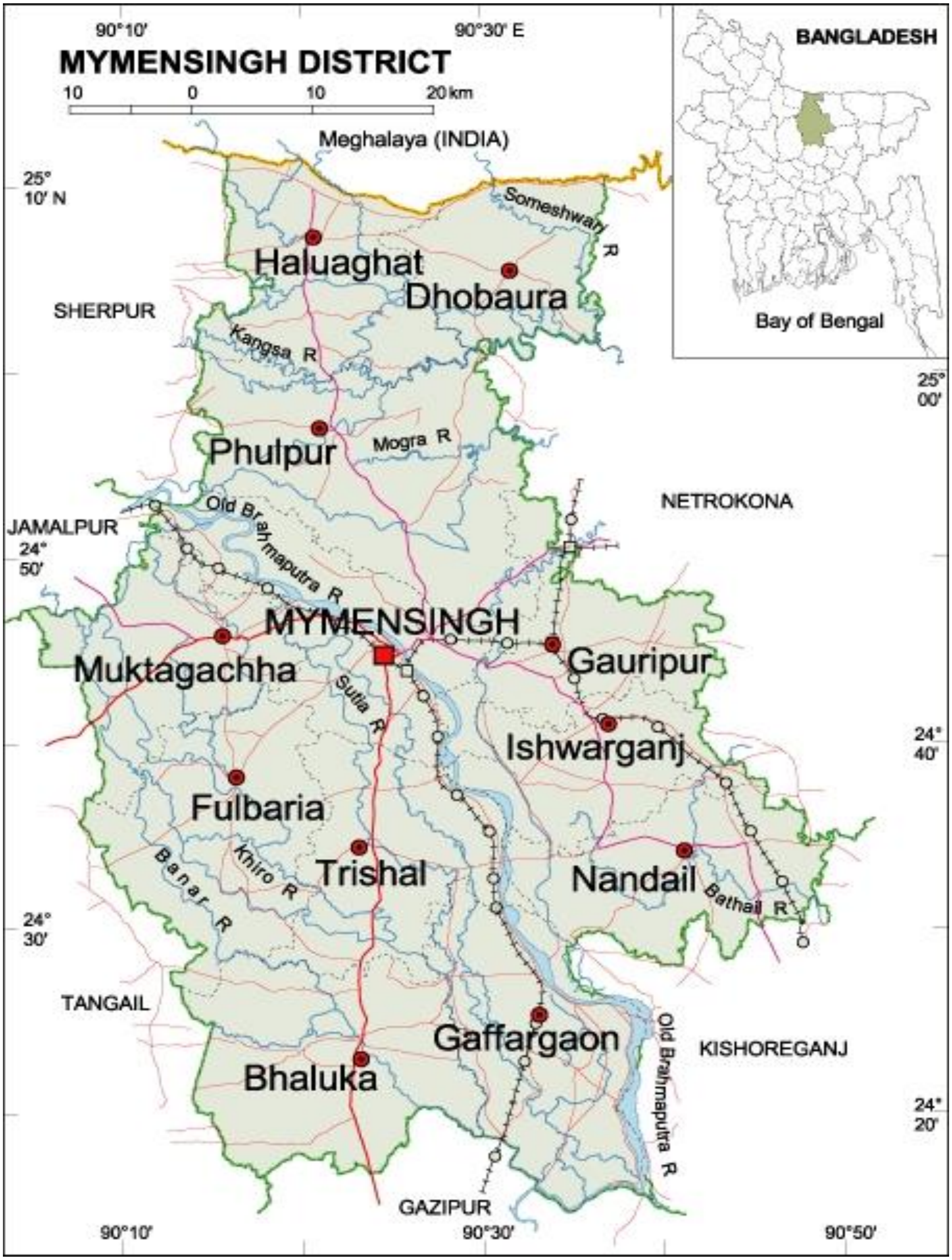

Figure 1. Location of the study area

3.2 Site selection and sampling procedure

This study was conducted in Mymensingh district that was purposively selected. Mymensingh district is consisting of 12 upazilas. Out of 12 upazilas, Muktagacha was selected randomly. Muktagacha Upazila has 10 unions (Lowest unit of local government). Among 10 unions of Muktagacha upazila, two unions named Mankun and Borogram were randomly selected. Again, two villages from each union named Norkona and Soyedpara from Borogram union and Rudropur and Mankun from Mankun union were randomly selected. There are total 1027 of different farm families in these selected villages. Out of 1027 farm families, a sample of 15%, i.e., 154 household were selected by stratified random sampling method (Table 1). Then finally 67 representative farm families were selected for questionnaire survey and tree diversity assessment was done from each homestead and crop land. Final selection of homestead and cropland has been done by using (Yamane, 1967) formula:

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

Where, n = Sampling size

N = Population

e = Error of precision

Table 1. Distribution of population and sample size in four selected villages under two unions of Muktagacha upazila in Mymensingh district

Union	Village	No. of total households	No. of households primary selected	No. of households finally selected for data collection
Borogram	Norkona	264	40	18
	Soyedpara	309	46	21
Mankun	Rudrapur	247	37	15
	Mankun	207	31	13
Total		1027	154	67

3.3 Household characteristics data

In 67 households, initially a questionnaire survey was conducted. Field data collection was made by physical measurement directly from the study sites. Demographic data of household (age, education, family size) were recorded with the help of family members. Socioeconomic household data such as homestead size (dwelling + homegarden), and agricultural land holding, annual income from homestead, income from agricultural land were also recorded. Homestead and agricultural land holdings size were recorded in decimal which further subsequently converted into hectare. For comparison the homesteads were categorized into four size group namely marginal or landless (<0.08 ha), small (0.09-0.14 ha), medium (0.15-0.20 ha) and large (> 0.2 ha).

3.4 Variables of the study and development of the research instruments

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

3.4.1 Measurement of independent variables

The following independent variables were included in the study:

i) Age
ii) Education
iii) Family size
iv) Farm size
v) Homestead size
vi) Crop land size

vii) Annual income and
viii) Livelihood status of the farmers

3.4.1.1 Age

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

3.4.1.2 Level of education

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

3.4.1.3 Family size

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

3.4.1.4 Farm size

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

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

3.4.1.5 Homestead size

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

3.4.1.6 Cultivable land size

Cultivable land size was measured by the land that was used for crop production and crop management through all the year round. It also includes the aspects that are used to produce human benefits by their intensive utilization. It was express in hectare.

3.4.1.7 Livelihood status

This section presents the livelihood status possessed by farmers in the study area. The assessment of the perception of farmer on seven livelihood indicators, were used to determine the existing livelihood status. The data obtained from 67 farmers by administering a simple scale 0 - 3 for the score of seven livelihood indicators, whereby 0 stands for ‘no livelihood status’, 1 for ‘lower situation’, 2 for ‘middle situation’ and 3 for ‘higher situation’. A rank order of seven indicators was listed based on the total scores according to ascending order from least important to most important, whereby rank 1 denotes ‘least important’ and rank 7 denotes ‘most important’ (Table 2).

Table 2. Livelihood indicators and livelihood status score from both quantitative and qualitative data

Livelihood indicators	Qualitative rank	Evaluation scale (0 - 3)	Obtained score
Water facilities	1	0 – 3	
Sanitation	2	0 – 3	
Freedom in cash	3	0 – 3	
Participation in social	4	0 – 3	
Food availability	5	0 – 3	
Health situation	6	0 – 3	
Housing condition	7	0 – 3	
Total			

Based on the obtained score farmer are classified into three categories such as ‘low livelihood status’ (0 - 7), ‘medium livelihood status’ (8 - 14) and ‘high livelihood status’ (15 - 21).

3.4.2 Measurement of dependent variable

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

3.5 Tree species identification

Tree species were identified with their botanical names in the field and cross-checked by using different identification literature. The mentioned literature was also used to determine scientific names for a few species not identified in the field, but only recorded with their local names. Tree species diversity was assessed within the fixed boundaries of the sample homegardens acquiring common names that subsequently translated into botanical names. An index was setup based on the number of species and their frequency in homegardens. For this study, mainly Shannon-Wiener diversity index (H) was used due to its suitability for evaluating diversity of tree species. The Shannon–Wiener diversity characterizes the proportion of species abundance in the population being at maximum when all species are equally abundant and the lowest when the sample contained one species. The proportion of species (i) relative to total number of species (Pi) was calculated and then multiplied by the natural logarithm of the same proportion (ln Pi). The resulting product is summed across species, and multiplied by -1.

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

Where, Σ= Summation.

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

H = Shannon index

n = No. of species

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

Where, D = Diversity Index,

S = Total number of species,

N = Total number of individuals

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

Where, ID = Index of Dominance

Pi = 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

S = Total no. of species

3.6 Collection of data

Data for the study were collected through personal interview by the researcher himself during 20 October to 20 January, 2020 using the interview schedule. To get actual and valid information from them, all possible efforts were made to explain the purpose of the study to respondents in order. The interview was conducted with the respondents in their house. Proper rapport was establishment so that they did not feel hesitation to furnish proper response to the questions and statements in the schedule. The questions were explained and clarified whenever any respondent felt difficulty in answering the question. Ten farmers were kept in the reserve list during final collection.

3.7 Compilation of data

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

3.8 Hypothesis

A null hypothesis states that there is no relationship between the concerned variable. If a null hypothesis is rejected on the basis of statistical test, it is concluded that there is a relationship between the concerned variables. However, following null hypotheses was formulated for the present study:

- There was no relationship between the selected characteristics of the respondents and their tree species diversity in homestead.
- There was no relationship between the selected characteristics of the respondents and their tree species diversity in crop land.

The selected characteristics were age, education, family size, farm size, homestead size, crop land size, annual income and livelihood status and the dependent variable was tree species diversity in homestead and cropland agroforestry.

3.9 Analysis of data

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

CHAPTER IV

RESULTS AND DISCUSSION

The present work entitled "Diversity of multipurpose tree species in homestead and crop land and its economic importance on the livelihood of the farmers of Muktagacha upazila in Mymensingh district" was carried out during 20 October to 20 January, 2020. The results obtained from the investigations undertaken, probable reasons for getting such results together with corresponding Tables and Figures are presented in this chapter.

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

Eight characteristics of independent variables of the study have investigated and the descriptions of each of the individual characteristics are presented in Table 3

Table 3. Description of farmers characteristics treated as independent variables of the study (N= 67).

Characteristics	Measuring unit	Observed range	Mean	Standard deviation
Age	Years	21-66	42.63	12.74
Education	Level of class	0-16	8.49	3.47
Family size	Numbers	2-9	4.79	2.09
Farm size	Hectare	0.1-3.26	1.61	0.808
Homestead size	Hectare	0.01-0.33	0.175	0.082
Crop land size	Hectare	0.06-3.04	1.349	0.737
Annual income	Thousand	18-302	89.21	73.31
Livelihood status	Scale scores	5-20	11.66	3.835

4.1.1 Age

The age of the respondents ranged from 21 to 66 years. The respondents were grouped into three categories- young (up to 30 years), middle (31 to 50 years) and old (above 50 years) on the basis of their age. Number and percent distribution of farmers according to their age group were given in Table 4. Data presented in Table 4 revealed that the majority of the respondent (49.25%) were in the middle aged category, 26.87% of the respondents were in the young aged and only 23.88% were old aged category in the study area.

Table 4. Distribution of respondents according to their age

Category	Respondent (Number)	Percent	Average	Standard deviation
Young age (up to 30 years)	18	26.87	42.36	11.94
Middle age (35 to 50 years)	33	49.25		
Old age (above 50 years)	16	23.88		
Total	67	100.00		

4.1.2 Education

The education level of the respondents ranged from 0-16 with an average of 8.49 and standard deviation of 3.47 of schooling. In this study 55.22% of the farmers had secondary level education which was highest in the study area, whereas under secondary level education was 29.85% (Table 5).

Table 5. Categorization of respondents according to their education

Category	Respondent (Number)	Percent	Average	Standard deviation
Illiterate (0)	3	4.48	6.52	0.398
Primary level (class 1 to 5)	7	10.45		
Secondary level (class 6 to 10)	37	55.22		
Above secondary level (11 or above)	20	29.85		
Total	67	100.00		

Similarly, illiterate respondents were minimum (4.48%) whereas 10.45% respondents were under primary level education (Table 5).

4.1.3 Family size

Household members of study area were ranged from 2 to 9 with mean and standard deviation of 4.79 and 2.09, respectively and were categorized into three groups (Table 6). The categories and distribution of the respondents with their number, percent, mean and standard deviation are furnished below. Data presented in Table 6. showed that the majority of the farmers (49.25%) belonged to small size family, 22.39% of the respondents had large size family and 28.36% of them belonged to medium family.

Table 6. Family sizes of sampled farmers

Category	Respondent (Number)	Percent	Average	Standard deviation
Small (1-4)	33	49.25	5.12	1.904
Medium (5-6)	19	28.36		
Large (above 7)	15	22.39		
Total	67	100.00		

4.1.4 Farm size

Respondents of the study area were categorized into four groups according to their farm size (Table 7). The farm size of the respondents varied from 0.10 to 3.26 hectare with the mean of 1.61 and standard deviation of 0.808. Data presented in Table 7 showed that the highest proportion (46.27%) of the respondents were medium while 26.87%, 16.42% and 10.45% of large, small and marginal farm categories, respectively. The farmers having marginal farm size were the lowest percentage in the study area.

Table 7. Distribution of the farmers on the basis of their farm size

Category	Respondent (Number)	Percent	Average	Standard deviation
Marginal (up to 0.50 ha)	7	10.45	1.62	0.578
Small (0.51 to 1.00 ha)	11	16.42		
Medium (1.00 to 2.00 ha)	31	46.27		
Large (above 2.00 ha)	18	26.87		
Total	67	100.00		

4.1.5 Homestead size

The homestead size of the farmer ranged from 0.01 - 0.33 hectare with an average of 0.175 hectare and standard deviation of 0.082 (Table 8). Among the respondents, the highest portion (37.31%) was in medium category; followed by 26.87% respondents were in large category. The minimum respondents, 13.43% were landless and 22.39% were considered as small farmer according to homestead size.

Table 8. Categorization of respondents according to their homestead size

Category	Respondent (Number)	Percent	Average	Standard deviation
Landless/marginal (up to 0.08 ha)	9	13.43	0.16	0.057
Small (0.09 to 0.14 ha)	15	22.39		
Medium (0.15 to 0.20 ha)	25	37.31		
Large (above 0.21 ha)	18	26.87		
Total	67	100.00		

4.1.6 Crop land size

Respondents of the study area were categorized into four groups by their crop land size (Table 9). The crop land size of the respondents of the study area varied from 0.06 to 3.04 hectare with the mean value of 1.349 and standard deviation of 0.737.

Data presented in Table 9 showed that the highest proportion (29.85%) of the respondents were medium while 26.87%, 25.37% and 17.91% were in large, small and marginal crop land size categories, respectively. The marginal farmer was the lowest in number by crop land size under the study area.

Table 9. Categorization of respondents according to their crop land size

Category	Respondent (Number)	Percent	Average	Standard deviation
Marginal (up to 0.50 ha)	12	17.91	1.45	0.523
Small (0.51 to 1.00 ha)	17	25.37		
Medium (1.00 to 2.00 ha)	20	29.85		
Large (above 2.00 ha)	18	26.87		
Total	67	100.00		

4.1.7 Annual income

Annual income of the farm families ranged from Tk. 18 thousand to Tk. 302 thousand with an average 73.12 thousand having standard deviation of 73.31. The respondents are classified three categories based on their income e.g.; low income (up to Tk. 60 thousand) category, medium income (Tk. 60-120 thousand) and high income (above Tk. 120 thousands) categories. Data presented in Table 10 and indicated that majority (46.27%) of the respondents had low income category whereas 34.33% of the respondents had medium income category and the minimum 19.40% of the respondents in high income category.

Table 10. Distribution of respondents according to their annual income

Category	Respondent (Number)	Percent	Average	Standard deviation
Low income (up to 60000)	31	46.27	73.12	51.44
Medium income (60001-120000)	23	34.33		
High income (above 120000)	13	19.40		
Total	67	100.00		

4.1.8 Livelihood status of farmer

This section presents the livelihood status possessed by farmers in the study area. The livelihood status of farmer obtained by calculation of seven livelihood indicators. Here, farmers are classified into three categories. Table 11 showed that the majority of the farmers were distributed under low to medium livelihood status (74.63%), while 25.37% belonged to high livelihood status.

Table 11. Distribution of respondents based on their livelihood status score

Category	Respondent (Number)	Percent	Average	Standard deviation
Low livelihood status (0-7)	8	11.94	11.56	3.633
Medium livelihood status (8-14)	42	62.69		
High livelihood status (15-21)	17	25.37		
Total	67	100.00		

4.2 Tree species diversity

Selected study area were composed with multiple tree species. Abundance of tree species in total at homestead and crop land and their uses are presented in Table 12. A total of 41 plant species of 24 families were recorded from the set of 67 homesteads surveyed. Name of species, their abundance in homesteads, percentage of abundance, plant type, and uses were arranged in the alphabetical order of species family name (Table 12, 13 and 14). Tree species in the homesteads are used mainly for fruit, fuel, and timber purposes. Non wood products and services such as vegetables, oil, medicines, resins etc. are provided by different tree species. In homestead and crop land together, among 41 plant species major seven species were found in dominant category than others and the highest percent occurrence was found for *Mangifera indica* (14.61%) followed by *Artocarpus heterophyllus* (13.21%), *Musa spp.* (10.12%), *Cocos nucifera* (8.37%), *Borassus flabellifer* (6.56%), *Phoenix sylvestris* (6.02%) and *Swietenia macrophylla* (4.77%) (Table 12).

Table 12. List of total tree species (homestead + crop land) and uses in Muktagacha upazila in Mymensingh district

Sl. No.	Common Name	Scientific name	Family	Abundance (Total no. of individuals)	Percentage of abundance	Plant type	Uses
1	Kathal/Jackfruit	*Artocarpus heterophyllus*	Moraceae	415	13.21	Tr	1, 2, 3, 5
2	Coconut/Narkel	*Cocos nucifera*	Arecaceae	263	8.37	Tr	1, 2, 7
3	Jalpai	*Elaeocarpus tectorius*	Elaeocarpaceae	9	0.29	Tr	1, 2, 3
4	Chalta	*Dilenia indica*	Dilleniaceae	4	0.13	Tr	1, 3
5	Mango	*Mangifera indica*	Anacardiaceae	459	14.61	Tr	1, 2, 3, 5
6	Shil Koroi/Raintree	*Albizia saman*	Mimosaceae	27	0.86	Tr	2, 3
7	Koroi	*Albizzia procera*	Mimosaceae	63	2.01	Tr	2, 3
8	Betelnut	*Areca catechu*	Arecaceae	24	0.76	Tr	1, 2, 4, 7
9	Mahogany	*Swietenia macrophylla*	Meliaceae	150	4.77	Tr	2, 3
10	Tamarind/Tetul	*Tamariandus indica*	Caesalpiniaceae	14	0.45	Tr	1, 3
11	Khejur/Date Palm	*Phoenix sylvestris*	Arecaceae	189	6.02	Tr	1, 2, 3, 6
12	Tal/Palmyra Palm	*Borassus flabellifer*	Arecaceae	206	6.56	Tr	1, 2, 3, 7
13	Sissu	*Dalbergia sisso*	Fabaceae	7	0.22	Tr	2, 3, 6
14	Amra/Hog pulm	*Spondias spp.*	Anacardiaceae	21	0.67	ST	1, 5, 6
15	Shimul/Cotton	*Bombax ceiba*	Malvaceae	9	0.29	Tr	2, 3, 6
16	Garjan	*Dipterocarpus turbinatus*	Dipterocarpaceae	8	0.25	Tr	2,3
17	Jarul	*Lagerstroemia speciosa*	Lythraceae	77	2.45	Tr	2, 3
18	Papaya	*Carica papaya*	Caricaceae	67	2.13	Sh	1
19	Neem	*Azadirachta indica*	Meliaceae	90	2.86	Tr	2, 3, 6
20	Arhar	*Cajanus cajan*	Fabaceae	7	0.22	H	1, 5
21	Mandar	*Erythrina variegate*	Fabaceae	12	0.38	Tr	2, 3, 4, 5
22	Jamrul	*Syzygium sumarengense*	Myrtaceae	23	0.73	Tr	1,3

23	Litchi	*Litchi chinensis*	Sapindaceae	54	1.72	Tr	1, 2, 3, 5
24	Teak/Segun	*Tectona grandis*	Verbenaceae	43	1.37	Tr	2, 3
25	Bel/Wood Apple	*Aegle marmelos*	Rutaceae	9	0.29	Tr	1, 3
26	Sajna	*Moringa oleifera*	Moringaceae	23	0.73	ST	1, 5, 6
27	Bamboo	*Bambusa sp.*	Gramineae	61	1.94	H	3,4
28	Kul	*Zizyphus mauritiana*	Rhamnaceae	78	2.48	ST	1, 5
29	Amrul	*Oxalis corniculate*	Oxalidaceae	23	0.73	H	6
30	Banyan/Bat	*Ficus benghalensis*	Moraceae	18	0.57	Tr	2, 3, 5, 6
31	Amloki	*Phyllanthus emblica*	Phyllanthaceae	8	0.25	Tr	1,6
32	Kamranga	*Averrhoa carambola*	Oxalidaceae	9	0.29	Tr	1, 3
33	Lebu/Lemon	*Citrus limon*	Rutaceae	63	2.01	Sh	1, 6
34	Payera/Guava	*Psidium guajava*	Myrtaceae	76	2.42	ST	1, 2
35	Jam/Black Berry	*Syzygium cumini*	Myrtaceae	9	0.29	Tr	1, 2, 3
36	Akashmoni	*Acacia auriculiformis*	Fabaceae	81	2.58	Tr	2,3
37	Kola/Banana	*Musa spp.*	Musaceae	318	10.12	Sh	1, 4, 5
38	Kadam	*Neolamarckia cadamba*	Rubiaceae	17	0.54	Tr	2,3,4
39	Jambura/Pummelo	*Citrus grandis*	Rutaceae	54	1.72	Tr	1, 3
40	Mingiri	*Cassia siamea*	Caesalpiniaceae	18	0.57	Tr	2,3
41	Ipil-ipil	*Leucaena leucocephala*	Fabaceae	36	1.15	Tr	3,4,5
Total				3142	100.00		

Plant type: Tr: tree, H: herb, Sh: shrub and ST = herb+shrub

Uses: 1: food/fruit, 2: timber, 3: fuel wood, 4: fence, 5: fodder, 6: medicine and 7: others

Table 13. List of tree species in homestead and their uses found in Muktagacha upazila in Mymensingh district

Sl. No.	Common Name	Scientific name	Family	Abundance (Total no. of individuals)	Percentage of abundance	Plant type	Uses
1	Kathal/Jackfruit	*Artocarpus heterophyllus*	Moraceae	308	9.80	Tr	1, 2, 3, 5
2	Coconut/Narkel	*Cocos nucifera*	Arecaceae	205	6.52	Tr	1, 2, 7
3	Jalpai	*Elaeocarpus tectorius*	Elaeocarpaceae	9	0.29	Tr	1, 2, 3
4	Chalta	*Dilenia indica*	Dilleniaceae	4	0.13	Tr	1, 3
5	Mango	*Mangifera indica*	Anacardiaceae	341	10.85	Tr	1, 2, 3, 5
6	Shil Koroi/Raintree	*Albizia saman*	Mimosaceae	27	0.86	Tr	2, 3
7	Koroi	*Albizzia procera*	Mimosaceae	63	2.01	Tr	2, 3
8	Betelnut	*Areca catechu*	Arecaceae	24	0.76	Tr	1, 2, 4, 7
9	Mahogany	*Swietenia macrophylla*	Meliaceae	118	3.76	Tr	2, 3
10	Tamarind/Tetul	*Tamariandus indica*	Caesalpiniaceae	14	0.45	Tr	1, 3
11	Khejur/Date Palm	*Phoenix sylvestris*	Arecaceae	127	4.04	Tr	1, 2, 3, 6
12	Tal/Palmyra Palm	*Borassus flabellifer*	Arecaceae	133	4.23	Tr	1, 2, 3, 7
13	Sissu	*Dalbergia sisso*	Fabaceae	7	0.22	Tr	2, 3, 6
14	Amra/Hog pulm	*Spondias spp.*	Anacardiaceae	21	0.67	ST	1, 5, 6
15	Shimul/Cotton	*Bombax ceiba*	Malvaceae	9	0.29	Tr	2, 3, 6
16	Garjan	*Dipterocarpus turbinatus*	Dipterocarpaceae	8	0.25	Tr	2,3
17	Jarul	*Lagerstroemia speciosa*	Lythraceae	77	2.45	Tr	2, 3
18	Papaya	*Carica papaya*	Caricaceae	67	2.13	Sh	1
19	Neem	*Azadirachta indica*	Meliaceae	78	2.48	Tr	2, 3, 6
20	Arhar	*Cajanus cajan*	Fabaceae	7	0.22	H	1, 5
21	Mandar	*Erythrina variegate*	Fabaceae	12	0.38	Tr	2, 3, 4, 5
22	Jamrul	*Syzygium sumarengense*	Myrtaceae	23	0.73	Tr	1,3

23	Litchi	*Litchi chinensis*	Sapindaceae	40	1.27	Tr	1, 2, 3, 5
24	Teak/Segun	*Tectona grandis*	Verbenaceae	26	0.83	Tr	2, 3
25	Bel/Wood Apple	*Aegle marmelos*	Rutaceae	9	0.29	Tr	1, 3
26	Sajna	*Moringa oleifera*	Moringaceae	23	0.73	ST	1, 5, 6
27	Bamboo	*Bambusa sp.*	Gramineae	61	1.94	H	3,4
28	Kul	*Zizyphus mauritiana*	Rhamnaceae	56	1.78	ST	1, 5
29	Amrul	*Oxalis corniculate*	Oxalidaceae	23	0.73	H	6
30	Banyan/Bat	*Ficus benghalensis*	Moraceae	18	0.57	Tr	2, 3, 5, 6
31	Amloki	*Phyllanthus emblica*	Phyllanthaceae	8	0.25	Tr	1,6
32	Kamranga	*Averrhoa carambola*	Oxalidaceae	9	0.29	Tr	1, 3
33	Lebu/Lemon	*Citrus limon*	Rutaceae	56	1.78	Sh	1, 6
34	Payera/Guava	*Psidium guajava*	Myrtaceae	58	1.85	ST	1, 2
35	Jam/Black Berry	*Syzygium cumini*	Myrtaceae	9	0.29	Tr	1, 2, 3
36	Akashmoni	*Acacia auriculiformis*	Fabaceae	57	1.81	Tr	2,3
37	Kola/Banana	*Musa spp.*	Musaceae	215	6.84	Sh	1, 4, 5
38	Kadam	*Neolamarckia cadamba*	Rubiaceae	17	0.54	Tr	2,3,4
39	Jambura/Pummelo	*Citrus grandis*	Rutaceae	54	1.72	Tr	1, 3
40	Mingiri	*Cassia siamea*	Caesalpiniaceae	18	0.57	Tr	2,3
41	Ipil-ipil	*Leucaena leucocephala*	Fabaceae	21	0.67	Tr	3,4,5
Total				2460	78.29		

Plant type: Tr: tree, H: herb, Sh: shrub and ST = herb+shrub

Uses: 1: food/fruit, 2: timber, 3: fuel wood, 4: fence, 5: fodder, 6: medicine and 7: others

Table 14. List of tree species in crop land with uses observed in Muktagacha upazila in Mymensingh district

Sl. No.	Common Name	Scientific name	Family	Abundance (Total no. of individuals)	Percentage of abundance	Plant type	Uses
1	Kathal/Jackfruit	*Artocarpus heterophyllus*	Moraceae	107	3.41	Tr	1, 2, 3, 5
2	Coconut/Narkel	*Cocos nucifera*	Arecaceae	58	1.85	Tr	1, 2, 7
3	Mango	*Mangifera indica*	Anacardiaceae	118	3.76	Tr	1, 2, 3, 5
4	Mahogany	*Swietenia macrophylla*	Meliaceae	32	1.02	Tr	2, 3
5	Khejur/Date Palm	*Phoenix sylvestris*	Arecaceae	62	1.97	Tr	1, 2, 3, 6
6	Tal/Palmyra Palm	*Borassus flabellifer*	Arecaceae	73	2.32	Tr	1, 2, 3, 7
7	Neem	*Azadirachta indica*	Meliaceae	12	0.38	Tr	2, 3, 6
8	Litchi	*Litchi chinensis*	Sapindaceae	14	0.45	Tr	1, 2, 3, 5
9	Teak/Segun	*Tectona grandis*	Verbenaceae	17	0.54	Tr	2, 3
10	Kul	*Zizyphus mauritiana*	Rhamnaceae	22	0.70	ST	1, 5
11	Lebu/Lemon	*Citrus limon*	Rutaceae	7	0.22	Sh	1, 6
12	Payera/Guava	*Psidium guajava*	Myrtaceae	18	0.57	ST	1, 2
13	Akashmoni	*Acacia auriculiformis*	Fabaceae	24	0.76	Tr	2,3
14	Kola/Banana	*Musa spp.*	Musaceae	103	3.28	Sh	1, 4, 5
15	Ipil-ipil	*Leucaena leucocephala*	Fabaceae	15	0.48	Tr	3,4,5
Total				682	21.71		

Plant type: Tr: tree, H: herb, Sh: shrub and ST=herb+shrub

Uses: 1: food/fruit, 2: timber, 3: fuel wood, 4: fence, 5: fodder, 6: medicine and 7: others

In case of the presence of tree species in homestead, similar trend was also found and among 41 species, four species *viz*. *Mangifera indica* (10.85%), *Artocarpus heterophyllus* (9.80%), *Musa spp.* (6.84%) and *Cocos nucifera* (6.52) had dominance over other species (Table 13). Regarding the abundance of tree species in crop land, 15 species were found where *Mangifera indica* (3.76%), *Artocarpus heterophyllus* (3.41%) and *Musa spp.* (3.28%) were in highest percentage (Table 14).

4.2.1 Species diversity, richness and evenness

In total, 39 different plant species were found belonging 24 families in the surveyed households and total 3142 trees were measured. It was found that Mango tree ranks top of the list which was 459 nos. of the total plant population followed by jackfruit (n= 415), kola/banana (n= 318), coconut (n= 263), tal/*palmyra palm* (n= 206) and khejur/date palm (n= 189) respectively. Tree diversity described by the Shannon Wiener diversity index (H) results 0.057. Diversity Index (SDI), Index of dominance (ID), Species Richness Index (R) and Species Evenness Index (E) were also calculated and shown on Table 15. The complete floristic list is appended. Data obtained from Species Diversity Index (0.056) show higher value than Index of Dominance (0.00017) which represents less dominancy of the tree species with more diversity. The calculated value of Species Richness Index and Species Evenness Index was 11.44 and 0.035 respectively representing more richness of tree species (corroborated with the previous findings) and more evenly the total number of individuals is distributed among all possible tree species.

Table 15. Various diversity related parameters

Parameters	Result
No. of Species= S	41
No. of individuals= N	3142
Shannon Winner index of diversity, H= - $\Sigma Pi * Ln(Pi)$	0.057
Diversity Index, SDI= S/N	0.013
Index of Dominance, ID= $\Sigma(Pi*Pi)$	0.00017
Species Richness Index, R= (S-1)/Log N	11.44
Species Evenness Index, E= H/Log S	0.035

4.2.2 Categorization of tree species

In homestead agroforestry, tree species have direct impact on income of farmers. Farmers are classified into four categories on the basis of tree species number with Shannon Weiner Index (H), mean and standard deviation. Categorization was done by small tree species number (1–10) under category I, medium tree species number (11– 50) under category II, large tree species number (51–100) under category III and vary large tree species number (>100) under category were shown on Table 16.

Table 16. Categorization of tree species according to their number

Category	Total number of individual species	Percent	Total number of plant species	Shannon Weiner Index, H	Mean	Standard deviation
Small tree species number (1-10)	10.00	24.39	77	0.265	2.21	1.94
Medium tree species number (11-50)	14.00	34.15	677	0.080		
Large tree species number (51-100)	10.00	24.39	1084	0.043		
Vary large tree species number (>100)	7.00	17.07	1304	0.028		
Total	41.00	100.00	3142			

4.2.3 Socioeconomic uses of trees species

Different tree species were observed in the homestead area and cropland area. Based on table 12, socioeconomic uses of trees species were recorded by accumulation. From the accumulation, 27 fuel wood tree species (25.96%), 24 fruit/food (23.08%), 24 timber species (23.08%), 11 fodder species (10.58%), 9 medicinal species (8.65%), 6 fence species (5.77%) and 3 others species (2.88%) were found (Table 17 and Figure 2) in study area.

Table 17. Categorization of tree species according to their socioeconomic uses

Category by uses	**Species Value**
Food/Fruit	24
Timber	24
Fuel Wood	27
Fence	6
Fodder	11
Medicine	9
Others	3
Total	**104**

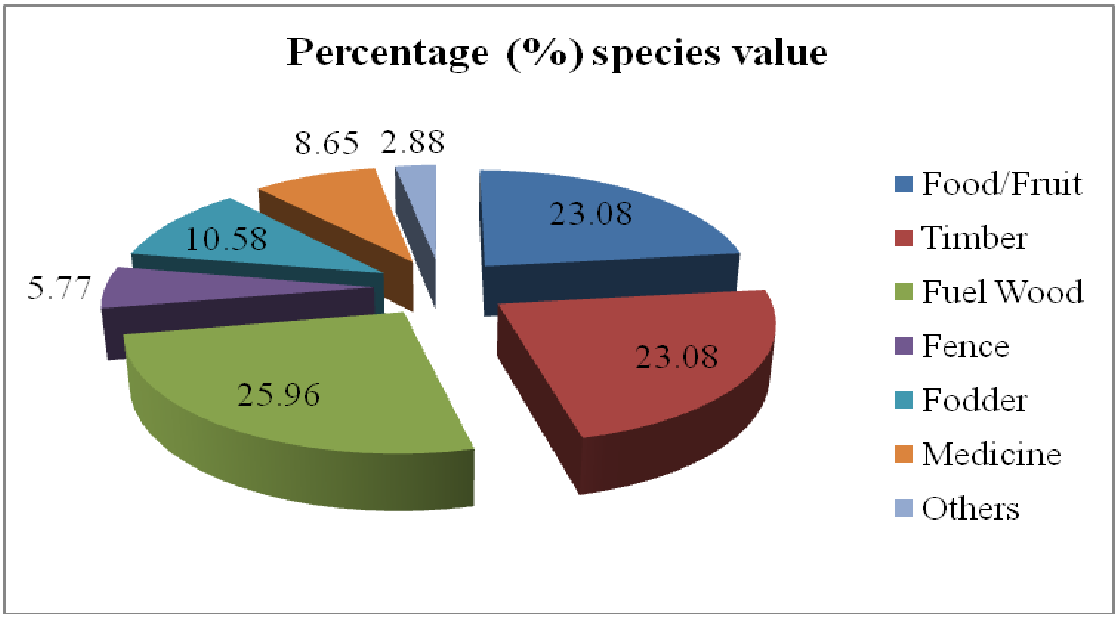

Figure 2. Categorization of tree species percentage according to their socioeconomic uses

4.3 Relationship between tree species diversity in homestead and crop land and the socioeconomic characteristics of the farmers

4.3.1 Relationship between tree species diversity in homestead and the socioeconomic characteristics of the farmers

Co-efficient of correlation was computed in order to explore the relationship between selected characteristics of the respondents and tree species diversity in their homestead. As mentioned earlier, 8 (eight) characteristics of respondents were included in independent variables of the study. The characteristics were: age, education, family size, farm size, homestead size, crop land size, annual income and livelihood status. The dependent variable was tree species diversity in homestead. To explore the relationships, Pearson's Product Moment Correlation Co-efficient (r) was used to test the null hypothesis concerning the relation between any two variables. Five percent (0.05) level of probability was used as the basis of rejection of a null hypothesis. The relationship between selected characteristics of the respondents and tree species diversity in homestead was presented in Table 18.

Table 18. Computed co-efficient of correlation (r) between dependent variable (Tree species diversity in homestead) and independent variables (age, education, family size, farm size, homestead size, crop land size, annual income and livelihood status) (N = 67)

Dependent variable	Independent variables	Correlation co-efficient 'r'	Tabulated value	
			5% level	1% level
Tree species diversity in homestead agroforestry	Age	0.137^{NS}	0.232	0.303
	Education	0.055^{NS}		
	Family size	-0.102^{NS}		
	Farm size	0.848(**)		
	Homestead size	0.843(**)		
	Crop land size	0.807(**)		
	Annual income	0.631(**)		
	Livelihood status	0.815(**)		

**Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level and NS = Non-significant

4.3.1.1 Relation between age of the farmers and tree species diversity in homestead

The relationship between age of respondents and tree species diversity in homestead was examined. The co-efficient of correlation between the concerned variables were found to be 0.137 as shown in Table 18. This led to following observation regarding the relationship between two variables under consideration.

- The relationship showed a positive trend.
- Low relationship was found between the concerned variables.
- The computed value of ‘r’ (0.137) was found lower than tabulated value of ‘r’ (0.232) at 5% level of significance.
- The relationship (r = 0.137) between two variables was not significant.
- So, null hypothesis is accepted.

The findings indicate that the age of the house head had positive non-significant relationship with tree species diversity in homestead.

4.3.1.2 Relation between educational level of the farmers and tree species diversity in homestead

The relationship between educational level of the respondents and tree species diversity in homestead was examined. The co-efficient of correlation between the concerned variables were found to be 0.055 as shown in Table 18. This led to the following observation regarding the relationship between the two variables under consideration.

- The relationship showed a positive trend.
- Low relationship was found between the concerned variables.
- The computed value of ‘r’ (0.055) was found lower than tabulated value of ‘r’ (0.232) at 5% level of significance.
- The relationship (r = 0.055) between two variables was not significant.
- So, null hypothesis is accepted.

The growers who had higher education had a tendency to grow various kinds of fruits in their homestead. This might be due to their knowledge about the nutritious value of different fruits and their importance to human health and environment. Flower *et al*. (2005) also found similar result with the present study and reported that educational level was positively related with the adoption of agroforestry practices which was supported by Muneer (2008).

4.3.1.3 Relation between family size of the farmers and tree species diversity in homestead

The relationship between family size and tree species diversity in homestead was examined. Computed value of the co-efficient of correlation between the family size and tree species diversity in homestead was found to be -0.102 as shown in Table 18. Following observations were recorded regarding the relationship between the two variables on the basis of co-efficient of correlation.

- The relationship showed a very low tendency in the negative direction between the concerned variables.
- Low relationship was found to exist between the two variables.
- The computed value of ‘r’ (0.102) was found lower than tabulated value of ‘r’ (0.232) at 5% level of significance.
- The relationship (r = -0.102) between two variables was not significant.
- So, null hypothesis is accepted.

The findings imply that the family size of the farmers had no significant relationship with fruit diversity in their homestead.

4.3.1.4 Relation between farm size of the farmers and tree species diversity in homestead

The relationship between farm size and tree species diversity in homestead was observed. Computed value of the coefficient of correlation between farm size of the farmers and tree species diversity in homestead was found to be 0.848** as shown in Table 18. Following observations were made regarding the relationship between the two variables.

- The relationship showed a high tendency in the positive direction between the concerned variables.
- Very strong relationship was found to exist between the two variables.
- The computed value of ‘r’ (0.804) was found higher than tabulated value of ‘r’ (0.303) at 1% level of significance.
- The relationship (r = 0.848**) between two variables was highly significant.
- So, null hypothesis is rejected.

It indicated that there was a strong significant and positive correlation between tree species diversity and farm size of the respondents. This result also indicated that farm size is directly correlated with tree species diversity which indicates that if farm size is increased, tree species diversity is also being increased in homestead. Similar result was also by Zeleke (2009) who studied that when the farm size is large it would encourage agroforestry practices. The positive effect of landholding size on farm level tree growing has been reported by Salam *et al*. (2000) in Bangladesh and Dwivedi *et al*. (2009) in India.

4.3.1.5 Relation between homestead size of the farmers and tree species diversity in homestead

The relationship between homestead size and tree species diversity in homestead was observed. Computed value of the coefficient of correlation between homestead size of the farmers and tree species diversity in homestead was found to be 0.843** as shown in Table 18. Following observations were recorded regarding the relationship between the two variables on the basis of the co-efficient of correlation.

- The relationship showed a high tendency in the positive direction between the concerned variables.

- Very strong relationship was found to exist between the two variables.
- The computed value of 'r' (0.843) was found higher than tabulated value of 'r' (0.303) at 1% level of significance.
- The relationship (r = 0.843**) between two variables was highly significant.
- So, null hypothesis is rejected.

The researcher concluded that the homestead size of the farmers had highly significant relationship with tree species diversity in homestead. The findings also indicate that tree species diversity in homestead increases with the increasing of homestead size.

4.3.1.6 Relation between crop land size of the farmers and tree species diversity in homestead

The relationship between crop land size and tree species diversity in homestead was investicated. Computed value of the coefficient of correlation between crop land size of the farmers and tree species diversity in homestead was found to be 0.807** as shown in Table 18. Following inferences were drawn regarding relationship between the two variables.

- The relationship showed a high tendency in the positive direction between the concerned variables.
- Very strong relationship was found to exist between the two variables.
- The computed value of 'r' (0.807) was found higher than tabulated value of 'r' (0.303) at 1% level of significance.
- The relationship (r = 0.807**) between two variables was highly significant.
- So, null hypothesis is rejected.

It indicated that there was a highly significant and positive correlation between tree species diversity and crop land size of the respondents. This relation also indicated that higher crop land size showed positive response on higher tree species diversity in homestead.

4.3.1.7 Relation between annual income of the farmers and tree species diversity in homestead

The relationship between annual income and tree species diversity in homestead was examined. Computed value of the coefficient of correlation between annual income of the farmers and tree species diversity in homestead was found to be 0.631** as shown in Table 18. Following inferences were drawn regarding the relationship between the two variables.

- The relationship showed a high tendency in the positive direction between the concerned variables.
- Very strong relationship was found to exist between the two variables.
- The computed value of 'r' (0.631) was found higher than tabulated value of 'r' (0.303) at 1% level of significance.
- The relationship (r = 0.631**) between two variables was highly significant.
- So, null hypothesis is rejected.

It indicated that there was a highly significant and positive correlation between tree species diversity and annual income of the respondents. This relation also indicated that higher annual income showed higher tree species diversity in homestead. Sood (2006) reported that traditional agroforestry in relation to economic and farming conditions of households increased agroforestry practices among households with higher off-farm, agricultural, and total incomes. McGinty *et al*. (2006) observed that average annual income of farmers significantly contribute to farmers' intentions to adopt or maintain agroforestry. Fregene (2007) also found on-farm monetary benefit to be positively and significantly associated with agroforestry practices.

4.3.1.8 Relation between annual income of the farmers and tree species diversity in homestead

The relationship between livelihood status and tree species diversity in homestead was examined. Computed value of the coefficient of correlation between livelihood status of the farmers and tree species diversity in homestead was found to be 0.815** as shown in Table 18. Following inferences were drawn regarding the relationship between the two variables.

- The relationship showed a high tendency in the positive direction between the concerned variables.
- Very strong relationship was found to exist between the two variables.
- The computed value of ‘r’ (0.815) was found higher than tabulated value of ‘r’ (0.303) at 1% level of significance.
- The relationship (r = 0.815**) between two variables was highly significant.
- So, null hypothesis is rejected.

It indicated that there was a highly significant and positive correlation between tree species diversity in homestead and livelihood status of the respondents. This relation also indicated that higher livelihood status showed higher tree species diversity. It also means that a person having higher tree species diversity in his/her homestead was likely to higher livelihood condition. Zubair and Garforth (2005) reported that the farmers have long recognized the value of planting trees on their fields for sheltering crops, generating wood for self-consumption and commercial sale. Sustainable management and protection of the natural resource base by native and peasant communities is often an integral part of their livelihood strategy (Prins, 2000).

4.3.2 Relationship between tree species diversity in crop land and the socioeconomic characteristics of the farmers

Co-efficient of correlation was subtracted to explore the relationship between selected characteristics (age, education, family size, farm size, homestead size, crop land size, annual income and livelihood status) of the respondents and tree species diversity in their crop land. Pearson’s Product Moment Correlation Co-efficient (r) was used to test to explore the relationships regarding the null hypothesis. Five percent (0.05) and one percent (0.01) level of probability was used as the basis of rejection of a null hypothesis. The relationship between selected characteristics of the respondents and tree species diversity in crop land was presented in Table 19.

Table 19. Computed co-efficient of correlation (r) between tree species diversity in crop land (dependent variable) and independent variables (age, education, family size, farm size, homestead size, crop land size, annual income and livelihood status) (N = 67)

Dependent variable	Independent variables	Correlation co-efficient 'r'	Tabulated value	
			5% level	1% level
Tree species diversity in cropland agroforestry	Age	0.057[NS]	0.232	0.303
	Education	0.035[NS]		
	Family size	-0.151[NS]		
	Farm size	-0.556(**)		
	Homestead size	-0.850(**)		
	Crop land size	0.255(*)		
	Annual income	-0.701(**)		
	Livelihood status	-0.450(**)		

**Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level and NS = Non-significant

4.3.2.1 Relation between age of the farmers and tree species diversity in crop land

The relationship between age of respondents and tree species diversity in crop land was examined. The co-efficient of correlation between the concerned variables were found to be 0.057 as shown in Table 19. This led to following observation regarding the relationship between two variables under consideration.

- The relationship showed a positive trend.
- Low relationship was found between the concerned variables.
- The computed value of 'r' (0.057) was found lower than tabulated value of 'r' (0.232) at 5% level of significance.

- The relationship (r = 0.057) between two variables was not significant.
- So, null hypothesis is accepted.

The findings indicated that average age of the respondents had positive non-significant relationship with tree species diversity in crop land. Arbuckle (2005) also found non-significant relation between age and agroforestry practices by the respondents which supported the present study.

4.3.2.2 Relation between educational level of the farmers and tree species diversity in crop land

The relationship between educational level of the respondents and tree species diversity in crop land was examined. The co-efficient of correlation between the concerned variables were found to be 0.035 as shown in Table 19. This led to the following observation regarding the relationship between the two variables under consideration.

- The relationship showed a positive trend.
- Low relationship was found between the concerned variables.
- The computed value of ‘r’ (0.035) was found lower than tabulated value of ‘r’ (0.232) at 5% level of significance.
- The relationship (r = 0.035) between two variables was not significant.
- So, null hypothesis is accepted.

The growers who had higher education who may explore to grow different fruit trees in their crop land to get extra facility in association with crop yield. This might be due to their knowledge about their demand of different fruits and their importance. Dorr (2006) also found non-significant relation between education of respondents and their crop land agroforestry practices.

4.3.2.3 Relation between family size of the farmers and tree species diversity in crop land

The relationship between family size and tree species diversity in crop land was examined. Computed value of the co-efficient of correlation between the family size and tree species diversity in crop land was found to be -0.151 as shown in Table 19. Following observations were recorded regarding the relationship between the two variables on the basis of co-efficient of correlation.

- The relationship showed a very low tendency in the negative direction between the concerned variables.
- Low relationship was found to exist between the two variables.
- The computed value of 'r' (0.151) was found lower than tabulated value of 'r' (0.232) at 5% level of significance.
- The relationship (r = -0.151) between two variables was not significant.
- So, null hypothesis is accepted.

From the findings the researcher concluded that the family size of the farmers had non-significant negative relationship with tree diversity in their crop land which indicated that tree species diversity decreased with the increase of family size.

4.3.2.4 Relation between farm size of the farmers and tree species diversity in crop land

The relationship between farm size and tree species diversity in crop land was observed. Computed value of the coefficient of correlation between farm size of the farmers and tree species diversity in crop land was found to be -0.556** as shown in Table 19. Following inferences were drawn regarding the relationship between the two variables.

- The relationship showed a high tendency in the negative direction between the concerned variables.
- Very strong negative relationship was found to exist between the two variables.
- The computed value of 'r' (0.556) was found higher than tabulated value of 'r' (0.303) at 1% level of significance.

- The relationship (r = -0.556**) between two variables was highly significant.
- So, null hypothesis is rejected.

So, it indicated that there was a strong significant and negative correlation between tree species diversity in crop land and farm size of the respondents. This result also indicated that farm size had strong negative correlation with tree species diversity in crop land which indicates that if farm size is increased, tree species diversity is decreased crop land agroforestry.

4.3.2.5 Relation between homestead size of the farmers and tree species diversity in crop land

The relationship between homestead size and tree species diversity in crop land was observed. Computed value of the coefficient of correlation between homestead size of the farmers and tree species diversity in crop land was found to be -0.850** as shown in Table 19. Following observations were recorded regarding the relationship between the two variables on the basis of the co-efficient of correlation.

- The relationship showed a high tendency in the negative direction between the concerned variables.
- Very strong relationship was found to exist between the two variables.
- The computed value of ‘r’ (0.850**) was found higher than tabulated value of ‘r’ (0.303) at 1% level of significance.
- The relationship (r = -0.850**) between two variables was highly significant.
- So, null hypothesis is rejected.

The researcher concluded that the homestead size of the farmers had highly significant and negative relationship with tree species diversity in crop land. The findings also indicate that tree species diversity in crop land decreases with the increasing of homestead size. Korsching *et al*. (1983) also observed similar result which supported the present study.

4.3.2.6 Relation between crop land size of the farmers and tree species diversity in crop land

The relationship between crop land size and tree species diversity in crop land was observed. Computed value of the coefficient of correlation between crop land size of the farmers and tree species diversity in crop land was found to be 0.255* as shown in Table 19. Following observations were made regarding the relationship between the two variables.

- The relationship showed a high tendency in the positive direction between the concerned variables.
- Strong relationship was found to exist between the two variables.
- The computed value of ‘r’ (0.255*) was found higher than tabulated value of ‘r’ (0.232) at 5% level of significance.
- The relationship (r = 0.255*) between two variables was significant.
- So, null hypothesis is rejected.

It indicated that there was a significant and positive correlation between tree species diversity and crop land size of the respondents. This relation also indicated that higher crop land size showed positive response on higher tree species diversity.

4.3.2.7 Relation between annual income of the farmers and tree species diversity in crop land

The relationship between annual income and tree species diversity in crop land was examined. Computed value of the coefficient of correlation between annual income of the farmers and tree species diversity in crop land was found to be -0.701** as shown in Table 19. The following observations were made regarding the relationship between the two variables.

- The relationship showed a high tendency in the negative direction between the concerned variables.
- Very strong negative relationship was found to exist between the two variables.
- The computed value of 'r' (0.701) was found higher than tabulated value of 'r' (0.303) at 1% level of significance.
- The relationship (r = -0.701**) between two variables was highly significant.
- So, null hypothesis is rejected.

It indicated that there was a highly significant and negative correlation between tree species diversity in crop land and annual income of the respondents. This relation also indicated that higher annual income showed lower tree species diversity in crop land.

4.3.2.8 Relation between annual income of the farmers and tree species diversity in crop land

The relationship between livelihood status of the respondents and tree species diversity in crop land was examined. Computed value of the coefficient of correlation between livelihood status of the farmers and tree species diversity in crop land was found to be -0.450** as shown in Table 19. Following observations were made regarding the relationship between the two variables.

- The relationship showed a high tendency in the negative direction between the concerned variables.
- Very strong negative relationship was found to exist between the two variables.
- The computed value of 'r' (-0.450**) was found higher than tabulated value of 'r' (0.303) at 1% level of significance.
- The relationship (r = -0.450**) between two variables was highly significant.

- So, null hypothesis is rejected.

It indicated that there was a highly significant and negative correlation between tree species diversity in crop land and livelihood status of the respondents. This relation also indicated that higher livelihood status showed lower tree species diversity in crop land.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

SUMMARY

The field survey was conducted at randomly selected four villages under two union of Muktagachha upazila in Mymensingh district, from 20 October to 20 January, 2020. Two villages in each union *viz*. Norkona and Soyedpara from Borogram union and Rudropur and Mankun from Mankun union were selected randomly. A total of 67 homestead with crop land were identified as representative of the study area. From each village, 20-30 farmers were randomly selected for face-to-face interviewing and data collection. In this study, structured and semi-structured interview schedules as well as several tools of the participatory rural appraisal were used to obtain necessary information. The collected data from respondents were analyzed using the Statistical Package for Social Science (SPSS, version 21.0) program and Microsoft Excel 2010. Both descriptive and analytical methods were employed in order to analyze the data. Eight characteristics were considered as independent variables to test the dependent variable – tree species diversity in homestead and crop land. The selected independent variables were measured through computing scores based on either scale or appropriate methodology which are followed by previous researchers. Correlation analysis was employed to find out the significant impact of tree species diversity on socioeconomic condition of farmers.

Different tree species were observed in the homestead area as diversified condition. From the accumulation of recorded species, fuel wood (25.96%), fruit/food (23.08%), timber (23.08%), fodder (10.58%), medicinal (8.65%), fence (5.77%) and others species (2.88%) were found (Table 17). Data obtained from Species Diversity Index (0.057) show higher value than Index of Dominance (0.00017) which represents less dominancy of the tree species with more diversity. The calculated value of Species Richness Index and Species Evenness Index was 11.44 and 0.035 respectively which represent the more richness of tree species and more evenly the total number of individuals is distributed among all possible tree species (Table 15).

Different types of relationship were shown between independent variables and tree diversity in homestead and crop land. The study also revealed that Farmer’s age and education has non-significant positive relationship with the tree species diversity in their homestead and crop land.

Family size with tree species diversity in their homestead had non-significant negative relationship while farm size, homestead size, crop land size, annual income and livelihood status were highly and positively correlated with tree species diversity in homestead.

Again, family size with tree species diversity in their crop land had non-significant negative relationship while farm size, homestead size, annual income and livelihood status were highly and negatively correlated with tree species diversity but crop land size was significant and positively correlated with tree species diversity in crop land.

CONCLUSION

Results of the present study showed that studied farmlands had considerable species richness and diversity. A total of 3142 trees, representing 41 genera and 24 families were recorded in the 67 farm plots of study sites. Tree species diversity in homestead was positively significant by farm size, homestead size, crop land size, annual income and livelihood status. Again, tree species diversity in crop land was negatively significant by farm size, homestead size, annual income and livelihood status but positively correlated with crop land size. Different tree species were observed in the homestead area as diversified condition. Fuel wood was mostly diversified compared to fruit/food, timber, fodder, medicinal plants, fence and others species. Species Diversity Index showed higher value than Index of Dominance which represents less dominancy of the tree species with more diversity. As population increases there is a need to intensify the land use in order to support the larger population. The impact of diversity of trees on farmer's livelihood and socioeconomic condition is beyond of question as trees are the integral part of nature as well as human society. Most of the trees, in homestead and crop land are not planted in a planned way. There is enough scope to improve productivity in the homestead and cropland by replacing the existing tree species with the improved and/or exotic ones, planting trees in planned ways and improving management practices with modern agroforestry technologies for maximization of income through increasing diversity of trees in homestead and crop land. Farmers depend on the naturally growing plant on the homestead and crop land. To increase tree plantation in the homesteads and crop land and their appropriate management, including intercropping practices should be the strategy for enhancing tree species diversity of the study area in order to meet basic needs of its people and maintain environmental balance.

RECOMMENDATIONS

In spite of the immense scope and prospects of the homestead and crop land, no systemic program has so far been under-taken to improve their species diversity. In order to improve prevailing socioeconomic condition of the studied farmer, comprehensive initiatives are needed to be taken by the government organizations (GOs), non-government organizations (NGOs), development agencies, as well as rural society. By considering the overall aspect of this present study the following points can be recommended:

i. This type of research findings will be helpful to facilitate similar research in other district/area in Bangladesh. In this regard if all district/area carried out under similar research then it will represent the overall socioeconomic condition as well as pattern of tree species diversity in Bangladesh.
ii. To meet growing demand for tree products, many fruits and forest species can grow voluntarily without any management from the seed sources of mother trees.
iii. Increasing awareness, facilitating need-based training and improving and encouraging of homestead plantings become a vital activity as such activities already common and practiced by most of farmers.
iv. Utilizing labor, family income earners and cultivable land, generally, designing appropriate management strategies and approaches should be required for domestication and integration of improved trees by diversifying and intensifying a wide range of priority species for meeting needs of farmers and environmental services. It can assist policy makers and planners in finding solutions for engaging farmer in tree plantation program for improving socioeconomic condition and reducing poverty.

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APPENDICES

APPENDIX I: Questionnaire on interview schedule used in this study to assess farmer's information

English version of an interview schedule
Department of Agroforestry and Environmental Science
Sher-e-Bangla Agricultural University
Dhaka-1207

Interview schedule for data collection of the research

DIVERSITY OF MULTIPURPOSE TREE SPECIES IN HOMESTEAD AND CROP LAND AND ITS ECONOMIC IMPORTANCE ON THE LIVELIHOOD OF THE FARMERS OF MUKTAGACHA UPAZILA IN MYMENSINGH 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 up to …………… 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.	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)		
7.	Homestead		
Total			

7. Crop land size

Sl. No.	Description	Area	
		Local unit	Hectare
1.	Own crop land under own cultivation		
2.	Crop land taken from others on borga		
3.	Crop land given to others on borga		
4.	Crop land taken from others on lease		
5.	Others (specify)		
Total			

8. 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	
Total		

9. Livelihood

Scoring of livelihood status

Livelihood indicators	Marks	Evaluation scale (0 - 3)	Score (0-3)
Water facilities	1	0 - 3	
Sanitation	2	0 - 3	
Freedom in cash	3	0 - 3	
Participation in social	4	0 - 3	
Food availability	5	0 - 3	
Health situation	6	0 - 3	
Housing condition	7	0 - 3	
Total			

10. Tree species in homestead and crop land: Please list of tree species in your homestead

Sl. No.	Name of tree specie	No.	Uses
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.	Others		
Total			

Thank you giving me your valuable time

Appendix II. Tabulation of collected data through survey using prepared questionnaire

Sl. No.	Age	Education	Family size	Farm size	Homestead size	Crop land size	Annual income	Livelihood status	Species diversity in Homestead	Species diversity in Crop land
1	61.00	12.00	3.00	0.70	0.09	0.48	40.00	9.00	3.15	13.67
2	27.00	4.00	5.00	2.30	0.25	2.10	64.00	15.00	0.62	5.86
3	48.00	13.00	3.00	0.21	0.03	0.07	18.00	5.00	5.13	20.50
4	37.00	12.00	7.00	1.50	0.20	1.40	57.00	11.00	2.28	13.67
5	21.00	5.00	2.00	0.64	0.08	0.48	36.00	7.00	2.05	20.50
6	39.00	9.00	6.00	2.60	0.30	2.20	142.00	16.00	0.23	0.75
7	25.00	16.00	2.00	3.00	0.24	2.60	168.00	18.00	0.21	0.71
8	52.00	7.00	4.00	0.72	0.09	0.50	42.00	8.00	5.13	13.67
9	24.00	6.00	8.00	1.30	0.11	0.94	32.00	9.00	2.41	13.67
10	28.00	13.00	4.00	1.40	0.17	0.88	36.00	10.00	2.73	8.20
11	45.00	12.00	5.00	0.84	0.10	0.80	30.00	10.00	2.28	10.25
12	48.00	8.00	5.00	1.63	0.20	1.50	76.00	13.00	0.76	4.56
13	59.00	9.00	4.00	2.40	0.33	2.12	204.00	15.00	0.24	0.85
14	26.00	4.00	8.00	1.50	0.20	1.45	80.00	14.00	0.64	3.73
15	46.00	10.00	5.00	0.27	0.04	0.22	21.00	6.00	5.86	20.50
16	55.00	11.00	3.00	1.20	0.20	0.80	45.00	9.00	2.93	13.67
17	27.00	7.00	9.00	0.90	0.12	0.83	32.00	8.00	3.42	13.67
18	53.00	11.00	3.00	3.26	0.22	3.04	302.00	20.00	0.20	0.66
19	21.00	8.00	5.00	1.70	0.18	1.62	80.00	13.00	1.52	10.25
20	64.00	0.00	6.00	0.88	0.11	0.80	35.00	9.00	3.42	10.25
21	24.00	10.00	6.00	2.40	0.30	2.10	200.00	16.00	0.29	1.14
22	37.00	12.00	8.00	2.70	0.30	2.30	188.00	16.00	0.25	1.24
23	39.00	7.00	3.00	0.60	0.08	0.45	38.00	8.00	5.86	20.50
24	26.00	6.00	5.00	2.00	0.18	1.80	98.00	13.00	1.95	10.25
25	66.00	0.00	5.00	1.80	0.20	1.75	78.00	12.00	1.52	8.20
26	44.00	7.00	3.00	0.45	0.08	0.36	23.00	7.00	5.86	20.50
27	28.00	14.00	7.00	1.40	0.20	1.12	92.00	12.00	0.89	6.83
28	48.00	8.00	6.00	1.70	0.19	1.50	82.00	11.00	0.98	8.20
29	29.00	10.00	2.00	0.75	0.10	0.72	48.00	8.00	2.93	8.20
30	40.00	12.00	7.00	1.80	0.20	1.50	76.00	9.00	1.08	6.83
31	62.00	9.00	4.00	3.00	0.33	2.60	300.00	17.00	0.30	1.28
32	30.00	6.00	5.00	2.80	0.28	2.50	266.00	18.00	0.38	1.58
33	42.00	16.00	3.00	1.33	0.18	0.90	52.00	10.00	2.56	13.67
34	44.00	10.00	8.00	0.10	0.01	0.06	19.00	5.00	6.83	20.50
35	47.00	9.00	3.00	1.52	0.15	1.30	50.00	11.00	1.64	10.25
36	28.00	13.00	5.00	1.60	0.19	1.40	66.00	13.00	0.75	5.13

37	45.00	3.00	9.00	2.48	0.30	2.10	118.00	12.00	0.66	3.15
38	48.00	7.00	6.00	1.00	0.11	0.84	33.00	11.00	3.73	10.25
39	44.00	12.00	5.00	1.80	0.18	1.60	76.00	14.00	1.95	6.83
40	26.00	8.00	2.00	0.86	0.12	0.68	57.00	10.00	3.15	8.20
41	36.00	3.00	9.00	3.20	0.30	2.80	296.00	18.00	0.64	3.73
42	43.00	6.00	5.00	2.00	0.15	1.50	115.00	12.00	0.93	5.86
43	65.00	8.00	3.00	1.12	0.14	0.80	124.00	9.00	2.93	13.67
44	47.00	12.00	7.00	0.42	0.05	0.32	24.00	6.00	6.83	20.50
45	42.00	7.00	3.00	2.00	0.20	1.70	100.00	13.00	1.58	10.25
46	24.00	7.00	6.00	1.20	0.12	0.75	25.00	8.00	5.86	20.50
47	40.00	12.00	8.00	1.60	0.18	1.00	28.00	8.00	1.24	5.86
48	59.00	6.00	5.00	2.50	0.28	2.20	120.00	16.00	0.68	4.56
49	42.00	0.00	5.00	2.80	0.33	2.40	164.00	19.00	0.61	2.93
50	48.00	9.00	8.00	3.00	0.24	2.60	280.00	19.00	0.50	3.73
51	61.00	12.00	4.00	1.40	0.14	1.00	30.00	8.00	3.42	13.67
52	66.00	8.00	4.00	0.50	0.03	0.42	28.00	6.00	5.86	20.50
53	23.00	7.00	2.00	1.80	0.18	1.20	107.00	12.00	0.66	5.13
54	44.00	7.00	3.00	1.30	0.13	1.00	26.00	10.00	2.93	20.50
55	62.00	11.00	3.00	2.40	0.27	2.10	118.00	17.00	0.68	3.42
56	37.00	6.00	8.00	1.70	0.20	1.30	142.00	11.00	1.03	5.86
57	39.00	5.00	3.00	0.70	0.10	1.40	42.00	9.00	5.13	20.50
58	49.00	8.00	3.00	1.60	0.20	1.30	60.00	10.00	2.05	10.25
59	48.00	8.00	3.00	2.50	0.22	2.10	109.00	17.00	0.58	3.15
60	55.00	12.00	4.00	1.70	0.15	1.40	80.00	14.00	0.59	4.56
61	37.00	9.00	9.00	1.75	0.18	1.30	87.00	13.00	0.66	5.86
62	57.00	9.00	4.00	0.32	0.02	0.28	30.00	6.00	6.83	20.50
63	50.00	4.00	3.00	1.75	0.20	1.20	92.00	12.00	0.65	3.73
64	27.00	10.00	2.00	1.30	0.09	0.96	23.00	9.00	2.28	10.25
65	49.00	6.00	2.00	2.40	0.27	2.10	102.00	15.00	0.62	2.93
66	53.00	11.00	3.00	2.40	0.25	2.10	92.00	16.00	0.73	3.73
67	50.00	10.00	3.00	1.52	0.15	0.75	33.00	10.00	2.56	13.67

Appendix III. Analytical output of collecting data using SPSS statistical program

Items	Age	Education	Family size	Farm size	Homestead size	Crop land size	Annual income	Livelihood status	Homestead tree species diversity	Crop land tree species diversity
Mean	42.627	8.4925	4.791	1.611	0.1748	1.3491	89.209	11.657	2.2064	9.4346
Std. Error of Mean	1.556	0.4239	0.2557	0.099	0.01001	0.09008	8.9561	0.4686	0.23757	2.0361
Std. Deviation	12.736	3.4701	2.093	0.809	0.08193	0.73733	73.309	3.8358	1.9446	6.4944
Variance	162.21	12.042	4.380	0.654	0.007	0.544	5374.14	14.714	3.781	4.2771
Range	45.00	16.00	7.00	3.16	0.32	2.98	284.00	15.00	6.63	19.84
Minimum	21.00	0.00	2.00	0.10	0.01	0.06	18.00	5.00	0.20	0.66
Maximum	66.00	16.00	9.00	3.26	0.33	3.04	302.00	20.00	6.83	20.50
Sum	2856.00	569.00	321.00	107.92	11.71	90.39	5977.00	781.00	147.83	632.04

Appendix IV. Correlation matrix regarding correlation between independent variables and tree species diversity in homestead

Variables	Age	Education	Family size	Farm size	Homestead size	Crop land size	Annual income	Livelihood status	Species Diversity in homestead
Age	1	-0.037	-0.185	-0.03	-0.021	-0.025	0.039	-0.036	0.137
Education		1	-0.146	-0.103	-0.131	-0.153	-0.101	-0.105	0.055
Family size			1	0.132	0.169	0.135	0.158	0.066	-0.102
Farm size				1	0.920(**)	0.971(**)	0.836(**)	0.938(**)	0.848(**)
Homestead size					1	0.897(**)	0.749(**)	0.865(**)	0.843(**)
Crop land size						1	0.842(**)	0.948(**)	0.807(**)
Annual income							1	0.824(**)	0.631(**)
Livelihood status								1	0.815(**)
Species diversity in homestead									1

Appendix V. Correlation matrix regarding correlation between independent variables and tree species diversity in crop land

Variables	Age	Education	Family size	Farm size	Homestead size	Crop land size	Annual income	Livelihood status	Species Diversity in crop land
Age	1	-0.037	-0.185	-0.03	-0.021	-0.025	0.039	-0.036	0.057
Education		1	-0.146	-0.103	-0.131	-0.153	-0.101	-0.105	0.035
Family size			1	0.132	0.169	0.135	0.158	0.066	-0.151
Farm size				1	0.920(**)	0.971(**)	0.836(**)	0.938(**)	-0.856(**)
Homestead size					1	0.897(**)	0.749(**)	0.865(**)	-0.850(**)
Crop land size						1	0.842(**)	0.948(**)	0.225(*)
Annual income							1	0.824(**)	-0.701(**)
Livelihood status								1	-0.450(**)
Species diversity in crop land									1