DIVERSITY OF MULTIPURPOSE TREE SPECIES IN THE HOMESTEADS AND IT'S IMPACT ON THE LIVELIHOOD OF THE FARMERS OF GOPALPUR UPAZILA IN TANGAIL DISTRICT

A THESIS

BY

MD. AHSANUL HAQUE

DEPARTMENT OF AGROFORESTRY AND ENVIRONMENTAL SCIENCE

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

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BY

MD. AHSANUL HAQUE
REGISTRATION NO. : 09-03339

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APPROVED BY:

.....	.....
Dr. Nazmun Naher	**Dr. Md. Forhad Hossain**
Professor	**Professor**
Supervisor	**Co-Supervisor**

.....
Dr. Ferzana Islam
Chairman
Examination Committee

DEPARTMENT OF
AGROFORESTRY AND ENVIRONMENTAL SCIENCE
Sher-e-Bangla Agricultural University (SAU)
Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

*This is to certify that the thesis entitled '**DIVERSITY OF MULTIPURPOSE TREE SPECIES IN THE HOMESTEADS AND IT'S IMPACT ON THE LIVELIHOOD OF THE FARMERS OF GOPALPUR UPAZILA IN TANGAIL DISTRICT** 'submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science (MS)** in **Agroforestry and Environmental Science**, embodies the result of a piece of bonafide research work carried out by **Md. Ahsanul Haque**, Registration number: **09-03339,** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated: JUNE 2015
Place: Dhaka, Bangladesh

Dr. Nazmun Naher
Professor
Supervisor

DEDICATED

TO

MY BELOVED PARENTS

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ABSTRACT

Plant diversity in home gardens has a wide socio-economic and agro-ecological roles including production of food and a wide range of other products. The recent study was conducted in twelve villages of four unions under Gopalpur upazila in Tangail district to explore the Multipurpose Tree Species (MPTs) diversity and it's contribution on the livelihood of the farmers. Out of 3334 farmers, a sample of 12% farm families was selected based on stratified random sampling procedure. Thus, 400 farmers and finally 80 farmers were selected by using Yamane formula. Five percent (0.05) level of probability was used as the basis for rejection of any null hypothesis throughout the study. Data were collected through personal interview by the researcher himself during 15 September to 25 December, 2014 using the interview schedule. Farmer's opinion regarding multipurpose tree species in the homesteads and its impact on socio-economic development was the dependent variables of the study. Ten characteristics were age, education, occupation, family member, farm size, homestead area, annual income, socio-economic aspects, knowledge on MPTs in homestead agroforestry and problem confrontation constituted the independent variables of this study. Species diversity of MPTs in the homesteads agroforestry was measured by Shannon-wiener index (H). In case of all species, the highest index (H) value found in Jhaoail union (H=3.017) and the lowest index (H) value found in Dhopakandi union (H=2.967). Akashmoni (12.53 %), Jackfruit (18.28 %), Neem (1.45%), Bamboo (3.72%), Mander (2.03%) were found as dominant trees for timber, fruit, medicinal, fodder and fuel wood species, respectively in Gopalpur upazila. MPTs had direct impact on income of the farmers. Small farmers had average income 13.21 thousand taka, Medium farmers had average income 29.33 thousand taka and large farmers had average income 45.79 thousand taka from MPTs in homesteads agroforestry in Gopalpur upazila.

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

CHARTER I

INTRODUCTION

Bangladesh is one of the most densely populated countries in the world with a population of 152.5 million and with an annual growth rate of 1.37 (BBS, 2011). There are 32.07 million homesteads in Bangladesh and over 74% of the population lives in the rural areas (BBS, 2005). Approximately 7% area (0.53 million ha) of the total 8.4 million ha of cultivable land in Bangladesh is occupied by homesteads which is extremely productive (BBS, 2005). According to Bangladesh Bureau of Statistics (BBS) and Forest Department (FD), a total number of 2.52 million hectare areas that is nearly 17.4% of the land mass is forest including homestead plantation. However, the actual tree coverage area of Bangladesh is estimated only at 9.10% of the country. Most of the forests are distributed in the southeastern and southwestern region of the country. Out of 64 districts of Bangladesh, 35 districts have no natural forest (Bhuiyan, 1994). The situation of northern part of Bangladesh is even not up to desirable level. Forest productivity in Bangladesh is also extremely low (0.5-2.5m3/ha/yr) for both plantation and natural forests (ADB, 1993). Forests provide sources of incomes and subsistence benefits, create employment opportunities, and constitute reservoirs of economic values which may help ameliorate household incomes – particularly in rural areas. The FAO estimates that forest industries contribute more than US$ 450 billion to national incomes, contributing nearly 1% of the global GDP in 2008 and providing formal employment to 0.4% of the global labor force (FAO 2012). Agroforestry, the integration of tree, crop and vegetable on the same area of land is a promising production system for maximizing yield (Nair, 1990). Among different agroforestry system homestead agroforestry is one of the oldest, potential and promising agroforestry system in Bangladesh. Homestead represents a land use system involving purposeful management of multipurpose trees and shrubs in intimate association with seasonal vegetables (Fernandes and Nair, 1990). From the conservation point of view, homesteads are the *in situ* conservation

sites of wide range of plant biodiversity (Mannan, 2000). Diversity of 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). Multipurpose tree species grown in the homesteads are a source of fruit, fuel wood, fodder, and building materials. In the context of the prevailing shortage of fuel wood and excessive deforestation in Bangladesh, homestead agroforestry system needs to be strengthened (Leuschner and Khaleque, 1987). The diversity of MPTs in the homegarden associated with other organisms contribute to the formation and maintenance of soil structure, retention of moisture, promotes the recycling of nutrients; and also reduces ecosystem vulnerability to climate change. Multipurpose trees bring subsoil nutrients to the surface; provide shade, and slow erosion. Many trees provide fodder, living fencepost, fruit shade, wood and other edible parts. 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:

i) To explore Multipurpose Tree Species (MPTs) diversity existed in the homesteads area; and
ii) To find out contribution of different MPTs on the livelihood of the farmers in the study area.

CHAPTER II

REVIEW OF LITERATURE

This chapter presents 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 multipurpose tree species of the homestead agroforestry under different level of the farmers of a particular region of Bangladesh.

2.1 Concepts of agroforestry and homestead agroforestry

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.

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

Nair (1993) stated that today there is a consensus of opinion that agroforestry is practiced for a variety of objectives. It represents as an interface between agriculture and forestry and encompasses maxed land-use practices. This practices have been developed primarily in response to be special needs and conditions of tropical developing countries that have not been satisfactorily addressed by advances increase environmental agriculture or forest.

Saka *et.al.* (1990) stated that in agroforestry systems there are both ecological and economical interactions between the different components. Agroforestry can provide a sound ecological basis for increase crop and animal productivity,

more dependable economic returns and greater diversity in social benefits on sustained basis.

Abedin and Quddus (1990) stated that regarding tree raising, homestead were more relative stand points because farmer never sells their homestead before crop land. They also stated that lack of quality planting material and training knowledge of improved management techniques were the major limitations for improving homestead productivity.

Nivez (1987) defined homestead as a small scale production system supplying plant and animal consumption and utilitarian items either not obtainable, affordable or readily available through retail markets, field cultivation, hunting, gathering, fishing and wage earning for better livelihood.

According to FAO (1986) homegardens are one of the most elaborate systems of indigenous agroforestry, found most often in tropical and sub-tropical areas where subsistence land use systems predominate.

Fernandes and Nair (1986) stated that homegarden represent a land use system involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and invariable livestock within the compounds of individual house, the whole crop-tree-animal unit being intensively managed by family labour.

Hocking (1986) reported that 15 million household of Bangladesh occupy about 0.3 million hectare under traditional agroforestry practice in homestead.

Lundgren and Raintree (1982) stated that agroforestry is a collective name for land use systems and technologies where woody perennials are deliberately grown on the same land management units as agricultural crops and/or animals in some form of spatial arrangement or temporal sequence.

2.2 Importance of homestead agroforestry

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.

Leuschner and Khaleque (1987) opined that the homestead agroforestry system is very important in the economy of Bangladesh. In fact, agroforestry is a term that invariable brings up the homesteads to the forefront. Particularly in a country like Bangladesh, the very act of concentrating on the homesteads areas would cover more than three-fourth of all matters concerned with agroforestry at large.

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

Byron (1984) estimated that 30,400 hectare of homestead in Bangladesh provided 70 % of fuel wood and 90 % bamboo per year.

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

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

2.3 Area and land use of homestead agroforestry

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

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

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

Chowdhury (1988) conducted a study at Paban district and estimated that the number of plants per unit of homestead gradually decreased in the marginal farms. He observed that 77 % marginal, 25 % small and 42 % larger farmers

felt trees cash in crisis period. Further, he found that 89 % farmer did not get any formal advice on planting and managing trees.

2.4 Species composition of homestead agroforestry

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

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

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

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

Abedin and Quddus (1990) recorded 28 different tree species in the homestead of the Barind Treat in Rajshahi district. *Mangifera indica* and *Phoenix sylvestris* were the most dominant species, whereas *Artocarpus heterophyllus*

was only of minor occurrence. They also mentioned that the average tree density was higher in Potuakhali and rangpur (1.5 and 1.4 trees $10m^{-2}$, respectively) than in rajshahi (0.7) where the annual rainfull is the lowest in Bangladesh.

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

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

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

Kowero and Temu (1985) found in a study in West Java homegardens in the citarum watershed an excess of 500 species in 350 gardens with Shannon diversity indices of greater than 2.7.

2.5 Structure of the homestead agroforestry

Millat-e-Mustafa (1997) stated that the homegardens displayed a broadly consistent vertical structure throughout the country and many important species

are typical in all the regions. The homegardens have a multistoried canopy configuration.

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

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

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

2.6 Homestead fuel use

According to Dewees (1989) fuel wood consumption is quite dynamically related to its economic cost and supply. Energy consumption to development countries must be evaluated by balancing energy consumption with other variables and costs which influences demand, such as income, price and substitution effects.

According to Hassain and Shailo (1987) scarcity of fuel wood is very common in Bangladesh. The present annual demand of fuel wood in the country stands in 2.04 million m^3 and the timber at 0.92 million m^3, resulting in a deficit of 1.42 million m^3 of fuel wood and 0.16 million m^3 of timber. Of the above

supply it is estimated that 88.5 % of wood and 48.9 % fuel wood come from homestead forest.

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

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

2.7 Income from homestead production

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

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

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

HAF practicing women in decisions marking on crucial socio-economic matters in the households.

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

Rebeka (1994) studied the economic aspects of homestead enterprises in some selected areas of Jessore district. The study estimated that total cost of production of vegetables produce in homestead area was Tk. 1,226.44 while gross and net return per household were Tk. 1,753.83 and Tk. 527.39, respectively. Per household total cost of production of fruits and other perennials was Tk. 947.32 while gross and net return per household was Tk. 10,555.65 and Tk. 9,608.33, respectively. Per household total cost of livestock and poultry enterprise was Tk. 10,860.13 while gross and net returns per household were Tk. 15,012.42 and Tk. 4,152.42, respectively. Maximum net return was earned from fruits and other perennials production.

2.8 Management of homestead agroforestry

Sultana (2003) stated that every member of the family has some contribution in homesteads, the major labor input was seed preservation, land preparation, transplanting. Watering and harvesting were done by women. Men usually help in fertilizer and pesticide application.

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

In a study conducted in four physiographic regions of Bangladesh. Millat-e-mustafa (1997) observed that women and older members of the family were

involved in sowing, maintenance of vegetable garden, harvesting and other less laborious jobs.

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

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

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

Aireen (1992) conducted a study on women's involvement in activities farming in some selected areas of Gazipur district. The study revealed that homestead farming was generally carried out by women. On an average, women spent 30 % of daytime in household activities and another 30 % on homestead agricultural operations such as, land preparation, planting, seedling, weeding, irrigation and post harvest activities.

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

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

Hossain *et. al.* (1988b) made a survey of 500 farm families in five locations namely- Pabna, Jessore, Tangail, Barishal and Comilla. Participation of women in different activities of growing trees and vegetables in the homestead varied with the farm category. wife, regardless of farm class, was more involved in vegetable production while husband played a dominant role in tree growing activities. Other family members like children and mother-in-law had recessive role in most of these actively of homestead plantation. The prevailing production system of homestead trees and crops primarily depended on indigenous technology.

2.9 Diversity of MPTs in the homestead agroforestry

Multipurpose tree is a tree that clearly constitutes an essential component of an agroforestry system or other multipurpose land use systems. Regardless of the number of its potential or actual use, a multipurpose tree has to have the capacity to provide in its specific function(s) in the system a substantial and recognizable contribution to the sustainability of yields, to the increase of outputs and/or the reduction of input and to the ecological stability of this system. Only a tree that is kept and maintained or introduced into an agroforestry system especially for one or more of these purpose qualifies as a multipurpose tree (Okigbo, 2003).

Multipurpose trees are defined as all woody perennials that are purposefully grown to provide more than one significant contribution to the production and/or service functions of a land-use system. They are so classified according

to the attributes of the plant species as well as to the plant's functional role in the agroforestry technology under consideration (Burley and Carlowitz, 1984).

Multipurpose trees are trees that are deliberately grown and managed for more than one output. They may supply food in the form of fruit, nuts, or leaves that can be used as a vegetable; while at the same time supplying firewood, add nitrogen to the soil, or supply some other combination of multiple outputs.

Raintree (2011) listed the characteristics of an ideal multipurpose trees as follows; high nitrogen–fixing capacity, capacity of fast growing, ability to restore fertility, suppress weed in a shorter time than natural bush fallow ability to control soil erosion, ease of establishment and ease of eradication tolerance to drought etc.

Fast growing Nitrogen–fixing multipurpose trees are of particular interest to agroforesters because of the central role they play in agricultural production (Young, 1989).

A country's biological wealth can be measured in terms of its biological diversity. Biological diversity or bio-diversity is the total variety of the life forms (microbes, fungi, plants and animals) on earth. The term bio-diversity is indeed commonly used to describe to number, variety and variability of living organisms. It has become a widespread practice to define bio-diversity in term of genes, species and ecosystems. Perhaps become the living world is most widely considered in terms of species, bio-diversity is very commonly uses as a synonym of species diversity, in particular of species richness, which is number of species in a site on habitat (Global bio-diversity, 1992).

Bio-diversity has species multiple values such as consumptive use value, productive use value, non consumptive, option value and existence value.

Hossain and Bari (1996) stated that the homesteads in rural Bangladesh are clustered with nearly 25 species of fruit trees and 30 species of timber, fuelwood and industrial wood trees. There are the habitats for many herbs,

shrubs and creeper species. Thus, homestead is a complex ecosystem and it varies from location to location with minor ecological changes. It is therefore essential that homestead agroforestry systems of each locality be studied to find out the interactions of trees and crops and their relationship with social and economic parameters.

CHAPTER III

MATERIALS AND METHODS

The study was conducted to explore the diversity of multipurpose tree species in the homesteads and it's impact on the livelihood of the farmers of Gopalpur upazila in Tangail district. A chronological description of the methodology used for this study is presented below:

3.1 Geographical location of the study area

The study was conducted in twelve villages under four unions of Gopalpur upazila in Tangail district. The study area is located in the middle part of Bangladesh. The Tangail district is situated between 24°05' and 23°45' North latitude and between 89°45' and 90°15' East longitudes with an area of 1378.99 sq. km. Administratively this district is divided into 12 upazilas namely Bashail, Bhuapur, Delduar, Ghatail, Gopalpur, Modhupur, Mirzapur, Nagarpur, Shakhipur, Tangail sadar, Kalihati and Dhanbari. Location of the Tangail district is shown in the Figure 1and the study area is shown in the Figure 2.

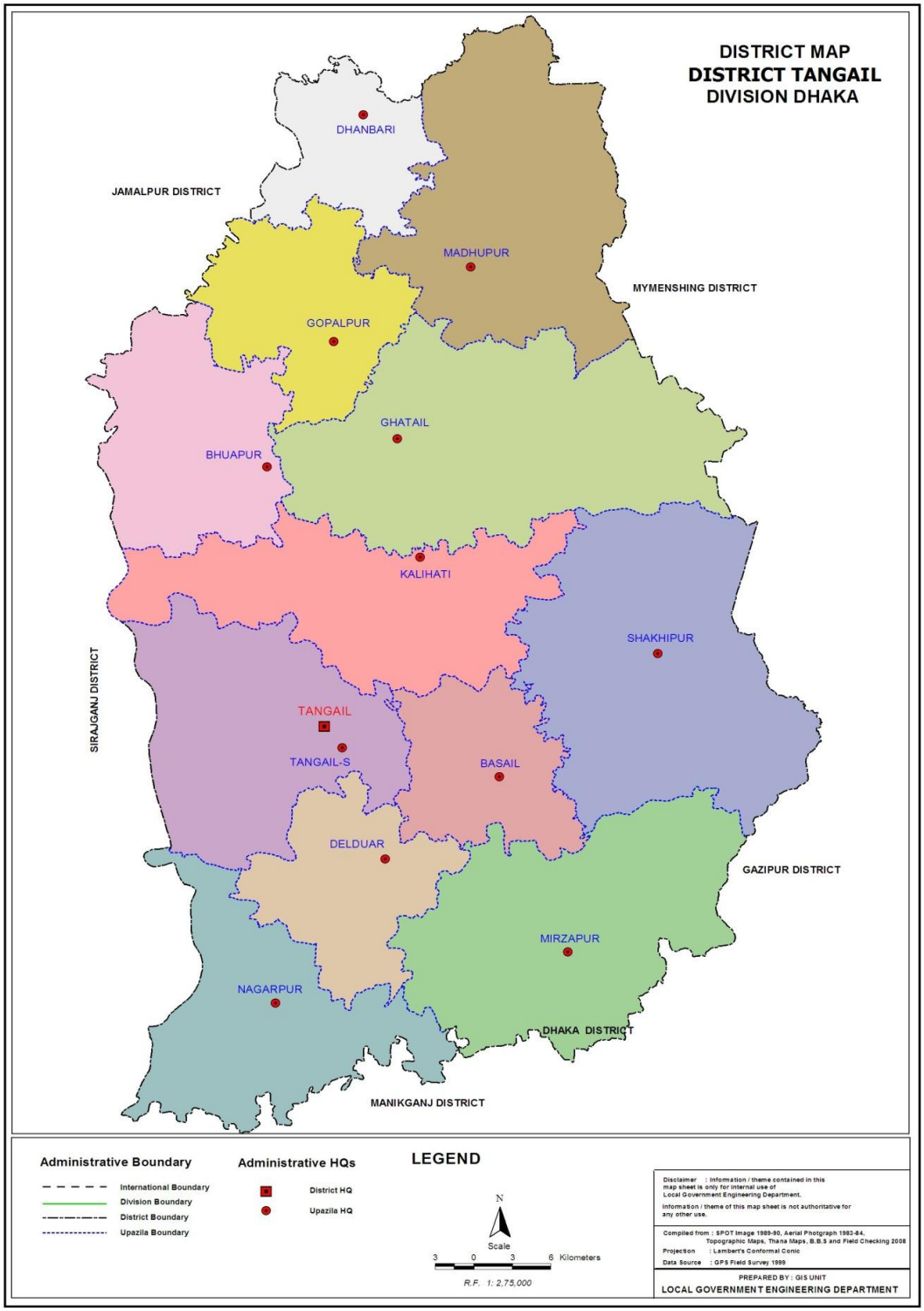

Figure 1. Map of the Tangail district

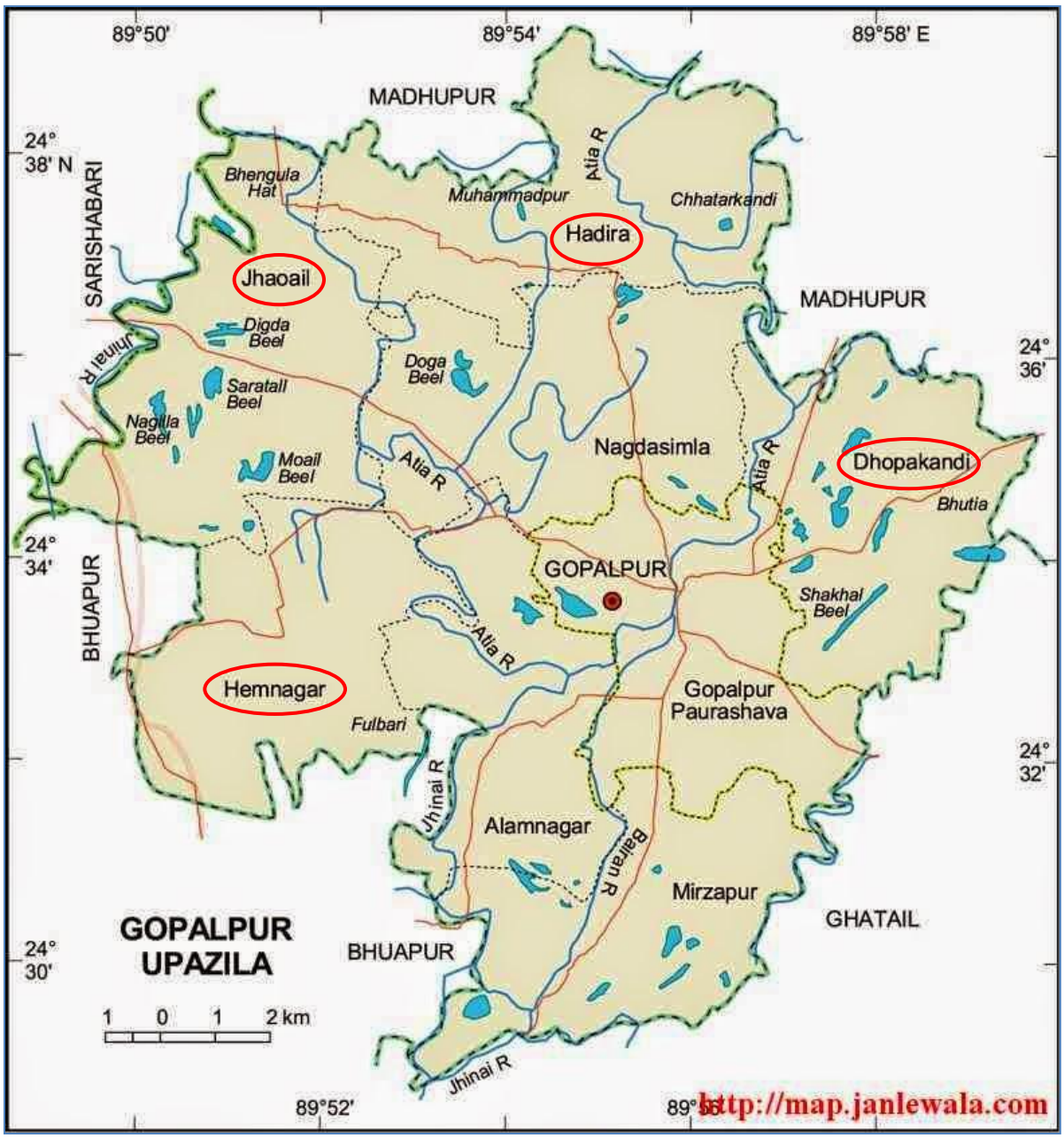

Figure 2. Map of the study area

3.2 Physiography

According to FAO (1988) agro-ecological zoning, the Tangail district belongs to the Agro-Ecological Zone (AEZ)-12 i.e.; Low Ganges River Flood Plain. There were six types of land observed in Tangail district. Out of the total land 13.00 % is high land, 29.00 % medium high land, 31.00 % medium low land, 14.00 % low land and 2.00 % very low land and 11 % household (Figure 3).

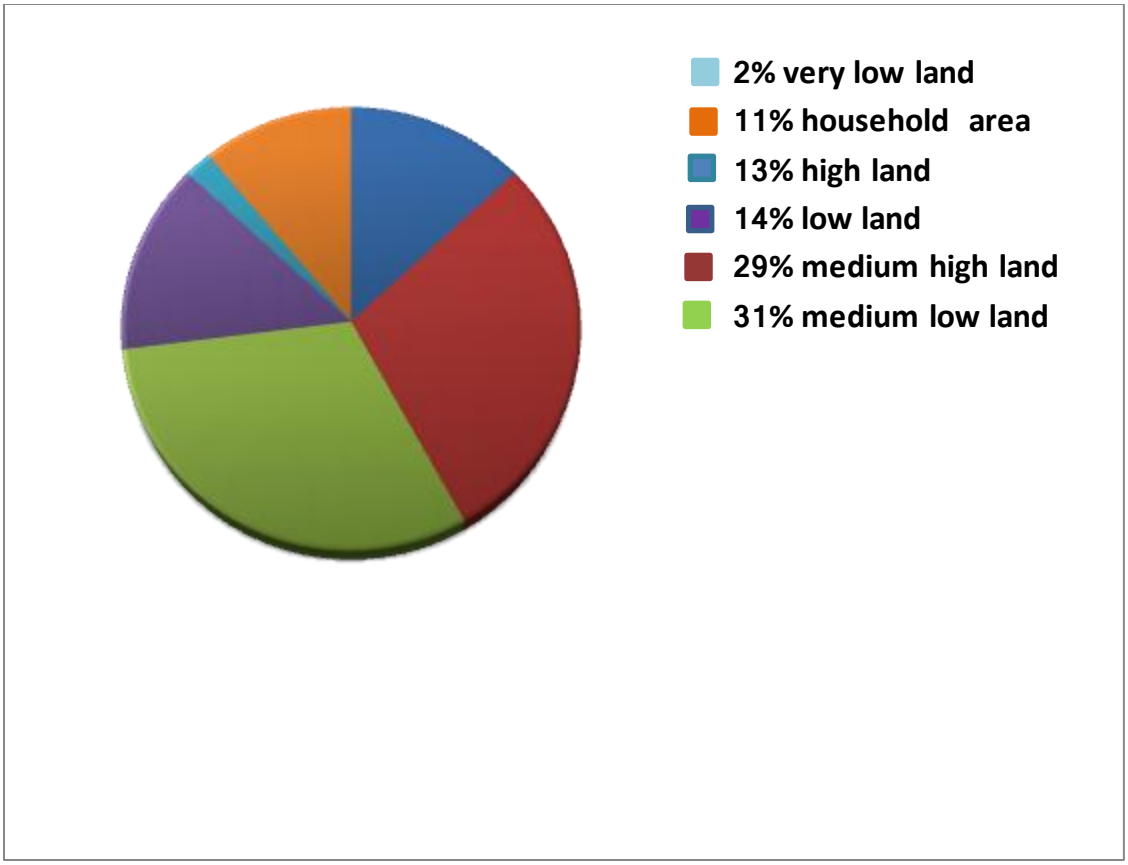

Figure 3. Land distribution of the study area

3.3 Agro-Ecological Zone (AEZ)

The Tangail district belongs to the Argo-Ecological Zone-12 i.e.; Low Ganges River Flood Plain. It has complex relief pattern comprising broad and narrow flood plain ridges and linear depressions. Deep rapidly permeable sandy acidity is in top soil and moderately acidity is in sub-soils as well as rich in sand minerals. Seven general soil types occur in the region. Out of them non-calcareous brown flood plain soils, black soils and non-calcareous dark grey flood plain soils are relatively higher in organic matter contents than other flood plains. The natural fertility of the soil except the coarse textured is moderate but well sustained.

3.4 Soil type

The Low Ganges River Flood Plain occupies most of the land of the Tangail district. There are complex pattern of both sandy or loamy rides intermixed

with shallow channels or basins with mainly loamy soils. The region is developed over grey sandy to silty clay in young flood plain region and silty clay loamy to clay basin, slightly acid to neutral.

3.5 Climate

The climate of the study area is congenial for agroforestry. The summer begins from the middle of March and continues till the middle June. The rainy season starts from the middle of June and continues till the end of September. Average maximum temperature in the month of May is 34.4^0C and minimum temperature in the month of January is 11.0^0C. Rainfall is not evenly distributed throughout the year. Ten years average rainfall, monthly temperature and relative humidity in the study area are presented in the Appendix I and II.

3.6 Land use

Paddy, wheat, potato, tobacco, sugarcane, pulses, groundnut, eggplant, vegetables and fruits are cultivated in the upland soil. Rice, wheat and sugarcane are the major crops in the study area. Vegetables, fruits and many timber trees are the major crops in the homestead area. Non-irrigated land sometimes stays fallow in dry season.

3.7 Households and Population

According to population census (BBS, 2011), the total number of households of Tangail district is 202 thousand which is 1.1 % of total households of the country and the population is 1120 thousand which is 0.93 % of the total population of the country. The density of the population is 650 per sq. km. The male and female population are 51.16 % and 48.84 %, respectively. The average literacy rate as of the census (BBS, 2011) was 46.8%; male 50%, female 43.8% among 12 upazila of Tangail district.

3.8 Site selection and sampling procedure

The study was conducted in Tangail district that consists of 12 upazilas. Among them, Gopalpur upazila was selected purposively. It consists of 10 unions. Among them, 4 unions were selected randomly. They are Hadira, Dhopakandi, Jhaoail and Hemnagar unions. 3 villages namely Vadurirchor, Gonipur and Koriata from Hadira union, 3 villages namely Shahapur, Ramnagar and Boroma from Dhopakandi union, 3 villages namely Jawail, Moail and Patalia from Jhaoail union, and 3 villages name Natuarpara, Sonamukhi and Chaltapur from Hemnagar union were selected randomly. There are total of 3334 different homesteads in this selected area. Out of 3334 homesteads, a sample of 12%, i.e., 400 homesteads were selected by random sampling method. Finally 80 representative homesteads were selected for questionnaire survey, to find out the effect of multipurpose tree species on the livelihood of the farmers and tree diversity measurement. Final selection of homesteads had been done by using Yamane formula (Jahan, M.A. 2010);

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

Where,

n=Sampling size

N=Population

e=Error of precision

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

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

3.9 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, level of education, occupation, family size, farm size, homestead area, annual income, organizational participation, knowledge on MPTs in homestead agroforestry, and problem confrontation of the farmers. Impact of MPTs on the livelihood of the farmers was the dependent variable. Ultimately ten independent and one dependent variable were selected for this study. These variables are described below:

3.9.1 Measurement of independent variables

The following independent variables were included in the study:

i) Age
ii) Education
iii) Occupation
iv) Family member
v) Farm size
vi) Homestead size
vii) Annual income
viii) Organizational participation
ix) Knowledge on MPTs in homestead agroforestry
x) Problem confrontation.

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.

Level of education

Education of a respondent was measured in terms of classes passed by him. For example, if a respondent passed the final examination of class V in the school,

a score of 5 was taken for calculating his education score. If a respondent had education outside the school and if the levels of education was seemed to equivalent to that of class V of the school, then his education score was taken as 5. A respondent who did not know reading or writing had education score of zero (0).

Occupation

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

Family member

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

Farm size

Land is the most important capital to a farmers and size influences on personal characteristic of farmer. Farm size was expressed as hectare and was computed by using the following formula (Moontasir, 2009):

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

Homestead size

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

Annual income

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

Organizational participation

Organizational participation of respondents was measured on the basis of the nature of his involvement and duration of participation in different local formal and informal groups or organizations in the study area (Chandra, G. 2011). For computing organizational participation score, the formula is given below:

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

Where,

A = Activity score

D = Duration score

Participation score was assigned in the following manner for activities of a farmer in each group or organization.

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

Duration score was assigned in the following manner:

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

Organizational participation score of respondent is obtained by adding the score according to the above mentioned formula for his activities in the respective group or organization.

Knowledge on MPTs in homestead agroforestry

It refers to the knowledge gained by the farmers from different sources and also through their experiences of homestead agroforestry and farming. The farmers were asked 15 questions on different aspects of homestead agroforestry. The total assigned score on the entire question was 75. A respondent answering a question correctly obtained the full score of 5 while for partial answer he obtained partial score and for wrong answer he obtained zero score. The total score obtained by a respondent was taken as his knowledge on homestead agroforestry score.

Problem confrontation

Problem was measured one way such as using of closed form of questions as shown in item number 17 of the interview schedule. The respondents were asked to give their opinion of the questionnaires along with their extent of confrontation in use of homestead agroforestry practices. As four-point scale was used for computing the problem confrontation score of a respondent. The weights were assigned 3 (three) for 'high', 2 (two) for 'medium', 1 (one) for 'low' and 0 (zero) for 'not at all'. The problem confrontation score of the respondents could range from 0 to 51. Zero indicating no problem and 51 indicating high problem confrontation.

3.9.2 Measurement of dependent variable

Impact of MPTs in homestead agroforestry on the livelihood of the farmers was the dependent variable of the study. It consists of change in socio-economic aspects of the farmers.

Change in socio-economic aspect

The change in socio-economic aspect of the farmers was defined as the improvement of social as well as economic status. The farmers were asked to give their opinion regarding the improvement of their livelihood due to the direct or indirect contribution of MPTs in homestead argoforestry. It was

measured on the basis of opinion obtained from the respondents on 18 statement containing information on the improvement of socio-economic aspect of their livelihood. A-4 point modified Liked type scale such as strongly agree, agree, disagree and strongly disagree was used to measure to extent of agreement of farmers with the statement. The score assigned to each of the scale for measuring the extent of agreement was 3, 2, 1 and 0, respectively for each of the 18 statements. Cell of the scale of individual consequence with its considering score such as 3 for 'strongly agree', 2 for 'agree', 1 for 'disagree' and 0 for 'strongly disagree'. Finally adding all the frequency count of each of the cell of the scale, the value was calculated.

3.9.3 Diversity of MPTs in homestead agroforestry

Species diversity is the variety of species on earth. It is measured the total number of species within a given area under study. Species diversity can be expressed by species diversity index (both in richness and abundance of the species). The most commonly used method of species diversity is the Shanon-Wiener index (H) which is given below;

It is calculated as follow:

$$H = -\sum PiInPi$$

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

3.10 Collection of data

Data for the study were collected through personal interview by the researcher himself during 15 September to 25 December, 2014 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.

3.11 Analysis of data

After completion of data collection, the data were coded, tabulated and analyzed according to the objectives of the study. Local units were converted into standards units. The response to the questions in interview schedules was transferred to a master sheet to facilitated tabulation. Necessary tabulation and cross tabulation were also computed.

3.12 Statistical analysis

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 graphs were also used for presentation the data. Pearson's Product Moment Correction Co-efficient (r) was used to find out the relationship between selected characteristics of the farmers and their opinion regarding the effectiveness of farmers. Five percent (0.05) level of probability was used as the basis for rejection of any null hypothesis throughout the study. The statistical analysis was done by using SPSS program.

3.13 Hypothesis

The research hypothesis was put forward to test the relationship between the effect of MPTs in homestead agroforestry on socio-economic condition and each of 10 selected characteristics of the farmers. The null hypothesis is, "There is no relation between the impact of MPTs in homestead agroforestry on socio-economic condition and each of the selected characteristics of the farmers".

CHAPTER IV

RESULTS AND DISCUSSION

The findings of study and their logical interpretations have been presented in this chapter according to the objectives of the study. This chapter has been divided into four sections.

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

Ten characteristics of independent variables of the study have investigated and the descriptions of each of the individual characteristics are presented in Table 1.

Table 1 Description of farmers characteristics treated as independent variables of the study (N=80)

Characteristics	Measuring unit	Observed range	Mean	Standard deviation
Age	Years	18-70	47.36	12.16
Education	Level of class	00-14	4.50	2.96
Occupation	---	---	---	---
Family member	Numbers	2-12	5.4	1.93
Farm size	Hectare	0.4-4.0	1.38	0.799
Homestead size	Hectare	0.01-0.27	0.07	0.064
Annual income	Thousand	33-550	114.62	82.34
Organizational participation	Scale scores	5-15	11.64	3.83
Knowledge on MPTs in Homestead Agroforestry	Scale scores	10-30	16.92	5.45
Problem confrontation	Scale scores	10-30	13.45	3.23

4.1.1 Age

The age of the respondents ranged from 18 to 70 years. The respondents were grouped into three categories- young (up to 35 years), middle (36 to 50 years) and old (above 50 years) on the basis of their age. Number and percentage distribution of farmers according to their age group has been shown in the Table 2.

Table 2. Distribution of respondents according to their age

Category	Respondent (Number)	Percent	Average	Standard deviation
Young age (up to 35 years)	14	17	47.36	12.16
Middle age(36 to 50 years)	35	44		
Old age (above 50 years)	31	39		
Total	80	100		

Data presented in Table 2, the majority respondents (35) were in the middle aged category which constitute 44 %, 31respondents were in the old aged category which constitute 39 % and only 14 respondents were young aged category which constitute 17 % in the study area.

4.1.2 Education

The education level of the farmers ranged from 00-14 with an average of 4.5 and standard deviation was 2.96. In this study, 49 respondents have primary level education which constitute 61.25%, 16 respondents have secondary level education which constitute 20%, 13 respondents have no education which constitute 16.25%, 2 respondents have higher level education which constitute 2.5%, (Table 3).

Table 3. Categorization of respondents according to their education

Category	Respondent (Number)	Percent	Average	Standard deviation
Illiterate (0)	13	16.25	4.50	2.96
Primary level (class 1 to 5)	49	61.25		
Secondary level (class 6 to 10)	16	20.00		
Higher level (above 10)	2	2.50		
Total	80	100		

4.1.3 Occupation

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

Table 4. Distribution of the farmers on the basis of their occupation

Categories of occupation	Respondents (Number)	Percentage
Agriculture	57	71.25
Grocery	7	8.75
Medicineshop employee	2	2.50
Day laborer	7	8.75
Fishermen	5	6.25
Book shop employee	2	2.50
Total	80	100

Data presented in table 4 indicated that majority (71.25 %) of the respondents belonged to 'agriculture' as their major occupation. 8.75 % of them were grocery shop owners and day laborer. 2.5 % of them were medicineshop employees and book shop employees. 6.25 % of them were fishermen.

4.1.4 Family member

Member of sampled farm households were categorized into three groups (Table 5). The categories and distribution of the respondents with their number, percent, mean and standard deviation are furnished below.

Table 5. Family member of sampled farmers

Family member (Number)	Respondent (Number)	Percent	Average	Standard deviation
Small (2-4)	25	31.25	5.4	1.93
Medium (5-6)	35	43.75		
Large (above 7)	20	25.00		
Total	80	100		

Data presented in Table 5 showed that majority of the farmers (43.75 %) belonged to medium size family, 31.25 % of the respondents had small size family and 25.00 % of them belonged to large family.

4.1.5 Farm size

The farm size of the respondents varied from 0.4 to 4.0 hectare with the mean of 1.397 and standard deviation was 0.799. There were four farm categories of the respondents on the basis of their farm holdings. The distribution of the respondents with number, percentage, mean and standard deviation is shown in Table 6.

Table 6. Distribution of respondents according to their farm size

Category	Respondent (Number)	Percent	Average	Standard deviation
Marginal (up to 0.50 ha)	14	17.50	1.397	0.799
Small (0.51 to 1.00 ha)	17	21.50		
Medium (1.00 to 2.00 ha)	34	42.50		
Large (above 2.00 ha)	15	18.50		
Total	80	100		

Data presented in Table 6 showed that the highest proportion (42.50 %) of the respondents were medium while 21.50 %, 17.50 % and 18.50 % of small, marginal and large farm categories, respectively. The farmers having large farm size contain large homestead area whereas, the medium farmers have marginal farm size with small homestead size.

4.1.6 Homestead size

The homestead size of the farmer ranged from 0.01 - 0.27 hectare with an average of 0.069 hectare and standard deviation of 0.064. Among the farmers 22.5 % were landless and marginal, 22.5 % were small, 38.75 % were medium and 16.25 % were large. Homesteads sizes are given below (Table 7).

Table 7. Categorization of respondents according to their homestead size

Category	Respondent (Number)	Percent	Average	Standard deviation
Landless and marginal (up to 0.02 ha)	18	22.50	0.069	0.064
Small (0.03 to 0.05 ha)	18	22.50		
Medium (0.06 to 0.09 ha)	31	38.75		
Large (above 0.09 ha)	13	16.25		
Total	80	100		

4.1.7 Annual income

Annual income of the farm families ranged from Tk. 33 thousand to Tk. 550 thousand with an average 114.62 thousand having standard deviation of 82.34. The respondents were classified three categories basis on their income e.g.; low income (Tk. 33-102 thousand) category, medium income (Tk. 103-250 thousand) and high income (above Tk. 250 thousands) categories.

Table 8. Distribution of respondents according to their annual income

Category	Respondent (Number)	Percent	Average	Standard deviation
Low income	19	24	114.62	82.34
Medium income	36	45		
High income	25	31		
Total	80	100		

Data presented in Table 8 indicated that majority (45 %) of the respondents had medium income category, 31 % of the respondents had high income category and 24 % of the respondents in low income category.

4.1.8 Organization participation

Organizational participation scores of the respondent farmers varied from 5 to 15 with a mean and standard deviation of 11.64 and 3.83, respectively. On the basis of observed scores farmers were classified into three categories (Table 9).

Table 9. Distribution of sample farmers according to organizational participation score

Category	Respondent (Number)	Percent	Average	Standard deviation
Low (up to 8)	29	36.25	11.64	3.83
Medium (9 to 11)	32	40.00		
High (above 12)	19	23.75		
Total	80	100		

Table 9 indicated that major portion of the respondents (40 %) had medium organizational participation, a good number of them (36.25 %) had low

participation and slightly less than one fourth (23.75 %) had high organizational participation.

4.1.9 Knowledge on MPTs in homestead agrofoerstry

The knowledge on homestead agrofoerstry and MPTs were ranged from 10 to 30 scores with a mean and standard deviation of 16.92 and 5.45, respectively. The farmers were classified into three categories on the basis of their knowledge namely- low (up to 15), medium (16-22) and high (above 22).

Table 10. Distribution of the farmers according to their knowledge

Category	Respondent (Number)	Percent	Average	Standard deviation
Low (up to 15)	20	25.00	16.92	5.45
Medium (16-22)	38	47.50		
High (above 22)	22	27.50		
Total	80	100		

Table 10 indicated that major portion of the respondents (47.50 %) belonged to have medium knowledge while slight more than a quarter (27.50 %) had high knowledge and 25 % being under low knowledge category.

4.1.10 Problem confrontation

Problem confrontation scores of the respondent farmers varied from 10-30 with the mean and standard deviation were 13.45 and 3.23, respectively. It was observed that 46.25 % of the respondents have the highest problem confrontation ability, 36.25 % of the respondents have medium problem confrontation ability and 17.50 % of the respondents have the lowest problem confrontation ability on homesteads agroforestry management, respectively (Table 11).

Table 11. Categorization of respondents according to their problem confrontation on homesteads agroforestry

Category	Respondent (Number)	Percent	Average	Standard deviation
Low (up to 15)	29	36.25	13.45	3.23
Medium (16-22)	37	46.25		
High (above 22)	14	17.50		
Total	80	100		

4.1.11 Multipurpose tree species diversity of homestead agroforestry

Different tree species were observed in the homestead area with diversified uses. Total 75 tree species were recorded from the study area of which 22 timber species, 24 fruit species, 13 medicinal species, 8 fodder species and 8 fuel wood trees (Table 12). In case of percent, there are 29.34% timber trees, 32% fruit trees, 17.34% medicinal trees, 10.66% fodder trees and 10.66% fuel wood trees in study area (Figure 4).

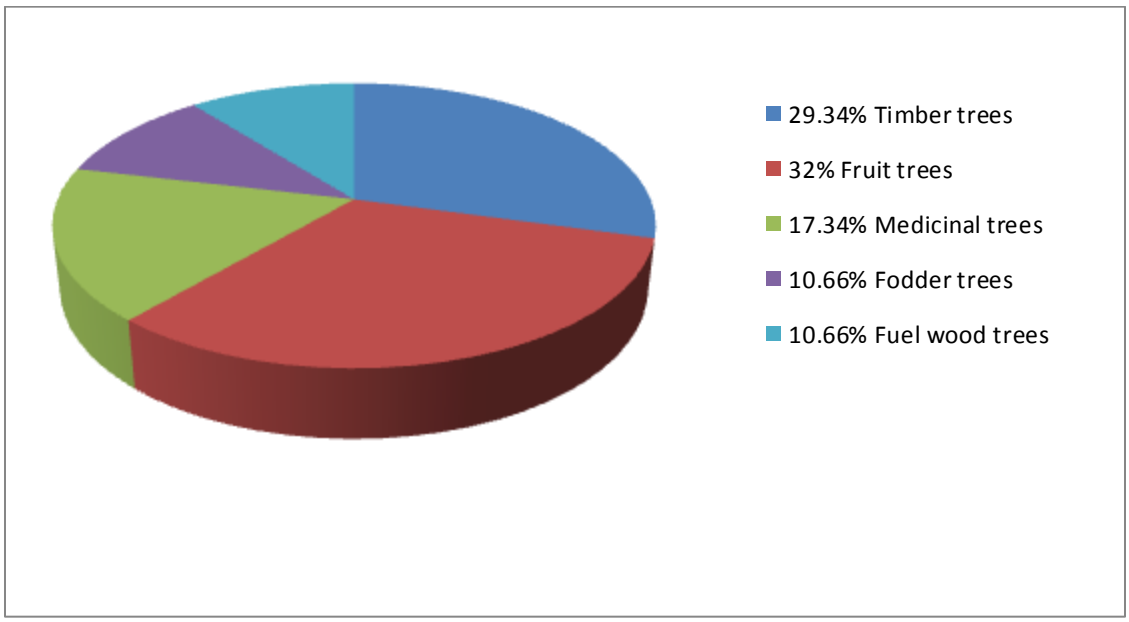

Figure 4. Percentage of fruit, timber, medicinal, fodder and fuel wood trees in the study area

Among 22 different timber trees, Akashmoni (12.53 %), Mahogany (8.43 %) and Eucalyptus (7.29 %) were found as dominant trees. Among 24 different fruit trees, Jackfruit (18.28 %) and Mango (14.89 %) were dominant trees.

Among 13 medicinal trees, Neem (1.45%), and Bel (1.35%) were dominant trees. Among 8 fodder trees, Bamboo (3.72%) and Ipil-ipil (2.86%) were dominant trees. Among 8 fuel wood trees, Mander (2.03%) and Sissoo (0.48%) were dominant trees. Out of 22 timber species Mahogoni, Akashmoni and Euclyptus were found as commonly in almost 80% respondent houses area. The diversity of timber species in the study area was rich compare to medicinal, fruits. Similar type of timber species diversity was observed by Sadat (2007) in Gaibandha and he observed total 21 timber species in his study area.

Table 12.Multipurpose tree species diversity of homestead agroforestry

Sl. No.	Common Name	Scientific Name	Relative prevalence
Timber trees			
1	Akashmoni	*Acacia auriculiformis*	12.53
2	Acacia hybrid	*Acacia sp.*	0.43
3	Mahogany	*Swietenia macrophylla*	8.43
4	Nilotica	*Acacia nilotica*	0.58
5	Jarul	*Leagerstromia specieosa*	0.35
6	Bilati babul	*Acacia farnesiana*	0.38
7	Kalokori	*Albizia lebbeck*	0.43
8	Raintree	*Albizia saman*	0.18
9	Hijal	*Baringtonia acutangula*	0.19
10	Teak	*Tecktona grandis*	0.54
11	Debdaru	*Polyalthia longifolia*	1.43
12	Gab(Deshi)	*Diospyros peregrine*	0.30
13	Eucalyptus	*Eucalyptus camaldulensis.*	7.29
14	Pitraj	*Aphanomixis polystachya*	0.35
15	Katbadam	*Terminalia catappa*	1.36
16	Kadam	*anthocephalus chinensis*	3.66
17	Choto mahogoni	*Swietenia mahogoni*	1.09
18	Dewa	*Artocarpus lacucha*	0.21
19	Chapalish	*Artocuarpus chaplasha*	0.86
20	Bakul	*Mimosops elengi*	0.6
21	Albida	*Acacia albida*	0.4
22	Rajkoroi	*Albizia richardiana*	0.5

Sl. No.	Common Name	Scientific Name	Relative prevalence
Fruit trees			
23	Mango	*Mangifera indica*	14.89
24	Jamrul	*Syzygium samarengense*	0.04
25	Golapsam	*Syzygium jambos*	0.10
26	Jam	*Syzygium cumini*	0.07
27	Jackfruit	*Artocarpus heterophyllus*	18.28
28	Khejur	*Phoenix sylvestris*	0.20
29	Coconut	*Cocos nucifera*	0.03
30	Litchi	*Litchi chinensis*	0.10
31	Sofeda	*Achras sapota*	0.16
32	Dalim	*Punica granatum*	0.06
33	Tal	*Borassus flabellifer*	0.04
34	Amloki	*Phyllanthus embelica*	0.60
35	Arboroi	*Phyllanthus acidus*	1.30
36	Papaya	*Carica papaya*	0.67
37	Ata	*Annona reticulate*	0.37
38	Sharifa	*Annona squamosa*	0.60
39	Lemon	*Citrus limon*	0.12
40	Guava	*Psidium guajava*	0.08
41	Boroi	*Zizypus mauritania*	0.10
42	Jambura	*Citrus grandis*	0.04
43	Bilatiamra	*Spondias dulce*	0.30
44	Deshiamra	*Spondias pinnata*	0.25
45	Jalpai	*Elaeocarpus floribundus*	0.38
46	Amloki	*Phyllanthus embelica*	0.10
Medicinal trees			
47	Bohera	*Terminalia bellirica*	0.01
48	Neem	*Azadirachta indica*	1.45
49	Kadbel	*Feronia* limonia	0.02
50	Khoir	*Acacia catechu*	0.41
51	Horitoki	*Terminalia chubela*	0.01
52	Sonalu	*Cassia fistula*	0.03
53	Bel	*Aegle marmelos*	1.35
54	Tejpata	*Cinnamomum tamala*	0.45
55	Kaju badam	*Anacardium occidentale*	0.15
56	Arjun	*Terminalia arjuna*	0.90
57	Basak	*Adhatoda vasica*	0.39

Sl. No.	Common Name	Scientific Name	Relative prevalence
58	Agar	*Apuilara agallocha*	0.03
59	Supari	*Areca catechu*	0.04
Fodder trees			
60	Ipil-Ipil	*Leucaena leucocephala*	2.86
61	Sesrakoroi	*Albizia chinensis*	0.61
62	Arhar	*Cajanus cajan*	1.43
63	Bot	*Ficus bengalensis*	0.75
64	Sajna	*Moringa oleifera*	0.43
65	Bamboo	*Bambusa spp*	3.72
66	Sil Koroi	*Albizia procera*	0.15
67	Dumur	*Ficus racemosa*	0.1
Fuel wood trees			
68	Mander	*Erythrina orientalis*	2.03
69	Chalta	*Dillenia indica*	0.12
70	Sissoo	*Dalbergia sissoo*	0.48
71	Tentul	*Tamarindus indica*	0.29
72	Shimul	*Bombax ceiba*	0.05
73	Jiga	*Garuga pinnata*	0.23
74	Gamar	*Gmelina arborea*	0.16
75	Khoksha	*Ficus hispida*	0.07

Total 24 fruit tree species were found in the study area. Among the fruit species Mango and Jackfruit were dominant and found up to 99% respondent houses. The diversity of fruit species in the study area was rich compared all other species. Similar type of fruit species diversity was observed by Belali (2011) in Narayangonj and he observed total 28 fruit species in Narayangonj area. Species diversity was observed by Hossain and Bari (1996) which they stated that the homesteads in rural Bangladesh are clustered with nearly 25 species of fruit trees and 30 species of timber, fuel wood and industrial wood trees.

4.1.12 Species diversity index

Species diversity index for the Multipurpose Tree Species in the homesteads agroforestry was measured by Shannon-wiener index (H). Shannon-wiener index (H) value ranged from 2.417 to 3.017. In case of timber species, the

highest index (H) value found in Hemnagar union (H=2.937) and the lowest index (H) value found in Jhaoail union (H=2.892). In case of fruits species, the highest index (H) value found in Jhaoail union (H=2.937) and the lowest index (H) value found in Dhopakandi union (H=2.918). In case of medicinal tree species, the highest index (H) value found in Jhaoail union (H=2.881) and the lowest index (H) value found in Dhopakandi union (H=2.731). In case of fodder tree species, the highest index (H) value found in Hadira union (H=2.553) and the lowest index (H) value found in Dhopakandi union (H=2.417). In case of fuel tree species, the highest index (H) value found in Jhaoail union (H=2.635) and the lowest index (H) value found in Hadira union (H=2.421). In case of all species, the highest index (H) value found in Jhaoail union (H=3.017) and the lowest index (H) value found in Dhopakandi union (H=2.967), (Table 13).

Table 13. Species diversity index of different species

Species	Shannon-wiener index (H)			
	Hadira	Dhopakandi	Jhaoail	Hemnagar
Timber Species	2.913	2.921	2.892	2.937
Fruit Species	2.936	2.918	2.937	2.924
Medicinal Species	2.876	2.731	2.881	2.752
Fodder Species	2.553	2.417	2.432	2.475
Fuel Species	2.421	2.532	2.635	2.573
All Species	2.987	2.967	3.017	2.975

Similar type of species diversity was observed by Roy *et. al.* (2013). The result of Shannon-Winner diversity index value was calculated the highest for tree (3.39), herb (2.56) and shrub (2.48) in rural homestead garden.

4.2 Distribution of respondents according to their income from MPTs

In homestead agroforestry, Multipurpose Tree Species (MPTs) have direct impact on income of the farmers. Farmers are classified into three categories on the basis of MPTs number and standard deviation was 19.42. Small farmers with MPTs number (15–30) have average low income 13.21 thousand taka. Medium farmers with MPTs number (31–50) have average medium income

29.33 thousand taka. And large farmers with MPTs number more than 51 have average the highest income 45.79 thousand taka (Table 14).

Table 14. Categorization of respondents according to their income from MPTs

Category	Respondent (Number)	Percent	Average income (Thousand)	Standard deviation
Small (15-30)	21	26.25	13.21	19.42
Medium (31-50)	35	43.75	29.33	
Large (above 51)	24	30	45.79	

4.3 Distribution of respondents according to their socio-economic aspects

Scores of farmers opinion regarding changes in socio-economic aspects due to homestead agroforestry ranged from 0 to 54. Zero indicated no opinion and 54 indicated high opinion. 16.25% respondents think that MPTs in homestead agroforestry have low impact in improving socio-economic aspects. 53.75% respondents think that MPTs in homestead agroforestry have medium impact in improving socio-economic aspects. 30% respondents think that MPTs in homestead agroforestry have high impact in improving socio-economic aspects (Table 15).

Table 15. Distribution of the farmers according to their socio-economic aspect

Category	Respondent (Number)	Percent	Average	Standard deviation
Low (up to 19)	13	16.25	23.340	7.902
Medium (20 to 32)	43	53.75		
Large (above 32)	24	30.00		
Total	80	100		

4.4 Relationship between the selected charecteristics of the respondents and the impact of multipurpose tree species on the livelihood of the farmers in the homestead agroforestry

This section deals with relationship between ten selected characteristics of the farmers and the impact of multipurpose tree species in the homestead argoforestry system on the livelihood of the farmers. The variables were age,

education, family member, farm size, homestead size, annual income, organnizational participation, knowledge on hoemstead and problem confrontation. To explore the relationships Pearson's Product Moment Co-efficient of Correlation (r) has been used (Table 16) with description of the meaning of 'r' (Cohen and Holiday, 1982).

Table 16. The meaning of correlation co-efficient (r)

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

The relationships of the selected characteristics of the respondents and the impact of multipurpose tree species on the livelihood of the farmers have been shown in Table 17.

Table 17. Computed co-efficient of correlation (r) between farmers selected characteristics and Impact of multipurpose tree species on the livelihood of the farmers in homestead agroforestry (N = 80)

Dependent variable	Independent variables	Correlation co-efficient 'r'
Impact of Multipurpose tree species on the livelihood	Age	0.322^{NS}
	Education	-0.572^{**}
	Family member	0.193^{NS}
	Farm size	0.570^{**}
	Homestead size	0.301^{**}
	Annual income	0.651^{**}
	Organizational participation	0.664^{**}
	Knowledge on MPTs in homestead agroforestry	0.569^{**}
	Problem confrontation	0.813^{**}

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

4.4.1 Relation between age of the farmers and the impact of multipurpose tree species on the livelihood of the farmers

The age of the farmers and the impact of multipurpose tree species on the livelihood of the farmers was examined against the null hypothesis as "there is no relationship between the age of of the farmers and the impact of multipurpose tree species on the livelihood of the farmers". The value of correlation 'r' was found 0.322 which was non-significant. Thus the concerned null hypothesis could not be rejected. The findings indicated that age of the respondents had no relationship with the impact of multipurpose tree species on the livelihood of the farmers. Aearwal (2001) also observed same relation in northern Bangladesh.

4.4.2 Relation between education of the farmers and the impact of multipurpose tree species on the livelihood of the farmers

The education of the farmers and the impact of multipurpose tree species on the livelihood of the farmers was examined against the null hypothesis as "there is no relationship between the eduaction of the farmers and the impact of multipurpose tree species on the livelihood of the farmers. The value of correlation 'r' in such case was found -0.572 which was significant at 0.01 level of probability. It means that a person having more education was likely to have less impact with multipurpose tree species on his livelihood. Sudmeye *et. al.* (2004) also found similar type of result in Rongpur district.

4.4.3 Relation between family member of the farmers and the impact of multipurpose tree species on the livelihood of the farmers

The family member of the farmers and the impact of multipurpose tree species on the livelihood of the farmers was examined by testing the following null hypothesis: "there is no relationship between the family member of the farmers and the impact of multipurpose tree species on the livelihood. The value of correlation 'r' in such case was found 0.193 which was non-significant. Thus the concerned null hypothesis could not be rejected. The findings indicate d that

family member of the respondents had no relationship with the impact of multipurpose tree species on the livelihood of the farmers. Halim and Hossain (1994) also observed the same result in Tangail district.

4.4.4 Relation between farm size of the farmers and the impact of multipurpose tree species on the livelihood of the farmers

The farm size of the farmers and the impact of multipurpose tree species on the livelihood of the farmers was examined by testing the following null hypothesis: "there is no relationship between the farm size of the farmers and the impact of multipurpose tree species on the livelihood of the farmers". The value of correlation 'r' in such case was found 0.570 which was significant at 0.01 level of probability. The relationship between the two concerned variables also showed positive trend. Hence, the concerned null hypothesis could be rejected. The findings indicate that farm size of the respondents had a positive significant relationship with the impact of multipurpose tree species on the livelihood of the farmers. The farmer who has large farm size, he has a better livelihood than small farm owners. It showed positive relation between farm size and livelihood of the farmers.

4.4.5 Relation between homestead size of the farmers and the impact of multipurpose tree species on the livelihood of the farmers

The homestead size of the farmers and the impact of multipurpose tree species on the livelihood of the farmers was examined by testing the following null hypothesis: "there is no relationship between the homestead size of the farmers and the impact of multipurpose tree species on the livelihood of the farmers". The computed value of 'r' was found 0.301 which was significant at 0.01 level of probability. The relationship between the two concerned variables also showed positive trend. Hence, the concerned null hypothesis could be rejected. The findings indicated that homestead size of the respondents had a positive significant relationship with the impact of multipurpose tree species on the livelihood of the farmers. This implies that farmers with larger homestead size

had higher level of the impact of multipurpose tree species on the livelihood of the farmers.

4.4.6 Relation between annual income of the farmers and the impact of multipurpose tree species on the livelihood of the farmers

The relation bwtween annual income of the farmers and the impact of multipurpose tree species on the livelihood of the farmers was examined by testing the null hypothesis: "there is no relationship between annual income of the farmers and their attitude towards homestead agroforestry". The computed value of 'r' was found 0.651 which was significant at 0.01 level of probability. The relationship between the two concerned variables also showed positive trend. Hence, the concerned null hypothesis could be rejected. The findings indicate that annual income of the respondents had a positive significant relationship with the impact of multipurpose tree species on the livelihood of the farmers. This implies that farmers with larger annual income had higher level of the impact of multipurpose tree species on the livelihood of the farmers. Halim and Hossain (1994) also observed the same result in Tangail district.

4.4.7 Relation between organizational participation of the farmers and the impact of multipurpose tree species on the livelihood of the farmers

The relation bwtween organizational participation of the farmers and the impact of multipurpose tree species on the livelihood of the farmers was examined by testing the null hypothesis: "there is no relationship between organizational participation of the farmers and the impact of multipurpose tree species on the livelihood of the farmers". The computed value of 'r' 0.664 was found significant at 0.01 level of probability. The relationship between the two concerned variables showed positive trend. Hence, the concerned null hypothesis could be rejected. It means that a person having more organizational participation was likely to have more impact of multipurpose tree species on his livelihood.

4.4.8 Relation between knowledge on MPTs in homestaed agroforestry and the impact of multipurpose tree species on the livelihood of the farmers

The knowledge on homestaed agroforesrty and the impact of multipurpose tree species on the livelihood of the farmers was examined by testing the null hypothesis: "there is no relationship between knowledge on MPTs in homestaed agroforesrty and the impact of multipurpose tree species on the livelihood of the farmers". The computed value of 'r' 0.569 was found significant at 0.01 level of probability. It means that a person having more knowledge was likely to have more impact of multipurpose tree species on the livelihood of that farmers and it means that the person having higher knowledge will have similar behaviour like organizational participation. Halim and Hossain (1994) also observed the same result in Tangail district.

4.4.9 Relation between problem confrontation and the impact of multipurpose tree species on the livelihood of the farmers

The relation between problem confrontation and the impact of multipurpose tree species on the livelihood of the farmers was examined by testing the null hypothesis: "there is no relationship between problem confrontation and the impact of multipurpose tree species on the livelihood of the farmers". The computed value of 'r' 0.813 was found significant at 0.01 level of probability. Hence, the concerned null hypothesis could be rejected. It means that a person having more knowledge about problem confrontation was likely to have more impact of multipurpose tree species on his livelihood and it means that the person having higher knowledge about problem confrontation will have similar behaviour like organizational participation. Halim and Hossain (1994) also observed the same result in Tangail district.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

The study was conducted in twelve villages under four unions of Gopalpur upazila in Tangail district. Study sites were selected purposively as the location. There are 3334 farm families in those villages. A total of 400 farmers of the 12 villages constituted the population of study. A sample of 12% farm families was selected based on stratified random sampling procedure. However, 80 farmers were selected from farmers by using Yamane formula. Therefore, these 80 farmers constitute the sample of this study. Direct and open form question and different scales were used to obtain information from the sampled farmers during 15 September to 25 December, 2014. Farmer's opinion regarding impact of Multipurpose Tree Species (MPTs) in homestead agroforestry on socio-economic development was the dependent variables of the study. Ten characteristics viz; age, education, occupation, family member, farm size, homestead area, annual income, socio-economic aspects, knowledge on MPTs in homestead agroforestry and problems confrontation constituted the independent variables of this study. Descriptive statistics like range, mean standard deviation, frequency, percentage and range orders were used to describe both the independent and dependent variables. For test of hypothesis Pearson's Product Moment Correlation Co-efficient (r) was used. Five percent (5 %) level of significant was used as the basis for rejecting a null hypothesis. Different tree species were observed in the homestead area as diversified condition. Total 75 tree species were recorded from the study area. Among 22 different timber trees, Akashmoni (12.53 %), Mahogany (8.43 %) and Eucalyptus (7.29 %) were found as dominant trees. Among 24 different fruit trees, Jackfruit (18.28 %) and Mango (14.89 %) were dominant trees. Among 13 medicinal trees, Neem (1.45%), and Bel (1.35%) were dominant trees. Among 8 fodder trees, Bamboo (3.72%) and Ipil-ipil (2.86%) were dominant

trees. Out of 22 timber species Mahogoni, Akashmoni and Euclyptus were found as commonly in almost 80% respondent houses area. Species diversity index for the Multipurpose Tree Species (MPTs) in the homesteads agroforestry was measured by Shannon-wiener index (H). In case of timber species, highest index (H) value found in Hemnagar union (H=2.937) and lowest index (H) value found in Jhaoail union (H=2.892). In case of fruits species, highest index (H) value found in Jhaoail union (H=2.937) and lowest index (H) value found in Dhopakandi union (H=2.918). In case of medicinal tree species, highest index (H) value found in Jhaoail union (H=2.881) and lowest index (H) value found in Dhopakandi union (H=2.731). In case of fodder tree species, highest index (H) value found in Hadira union (H=2.553) and lowest index (H) value found in Dhopakandi union (H=2.417). In case of fuel tree species, highest index (H) value found in Jhaoail union (H=2.635) and lowest index (H) value found in Hadira union (H=2.421). In case of all species, highest index (H) value found in Jhaoail union (H=3.017) and lowest index (H) value found in Dhopakandi union (H=2.967). The finding in respect of farmer's opinion, mojority of the respondents had positive to highly positive consideration towards MPTs in homestead agroforestry while the rest of them considered MPTs in homesteads agroforestry as less positive. The characteristics viz; education, occupation, farm size, homestead area, annual income, socio-economic aspects, knowledge on MPTs in homestead agroforestry and problems confrontation aspects were shown significant results. The characteristics viz; age and family size were shown non-significant results. MPTs had direct impact on income of the farmers. Small farmers had average income 13.21 thousand taka from MPTs. Medium farmers had average income 29.33 thousand taka from MPTs. And large farmers had average income 45.79 thousand taka from MPTs.

Conclusion

Total 75 tree species were recorded from the study area. Among them 22 species were timber species, 24 species were fruit species, 13 species were medicinal species, 8 species were fodder species and 8 species were fuel wood species. Top timber species is Akashmoni (12.53 %). Top fruit species is Jackfruit (18.28 %). Top medicinal species is Neem (1.45%). Top fodder species is Bamboo (3.72%). Top fuel wood species is Mander (2.03%). The highest diversity index value (H) for all species was found in Jhaoail union (H=3.017) and lowest index (H) value was found in Dhopakandi union (H=2.967). The average size of the homestead was 0.096 ha and almost all the farmers of the study area had positive feeling towards the impact of the MPTs in homestead agroforestry. Education, occupation, farm size, homestead area, annual income, socio-economic aspects, knowledge on MPTs in homestead agroforestry and problem confrontation showed the significant results, age and family size showed the non-significant results.

Recommendations

The following recommendations are made on the basis of finding of the current study:

1. In homestead agroforestry system, the diversity of Multipurpose Tree Species (MPTs) can be improved by proper care and management.
2. More research should be implemented to know present condition of MPTs and their future prospects in homesteads agroforestry.
3. Farmers training should be introduced on raising seedling, nursery establishment and proper land use management system by proper authority.

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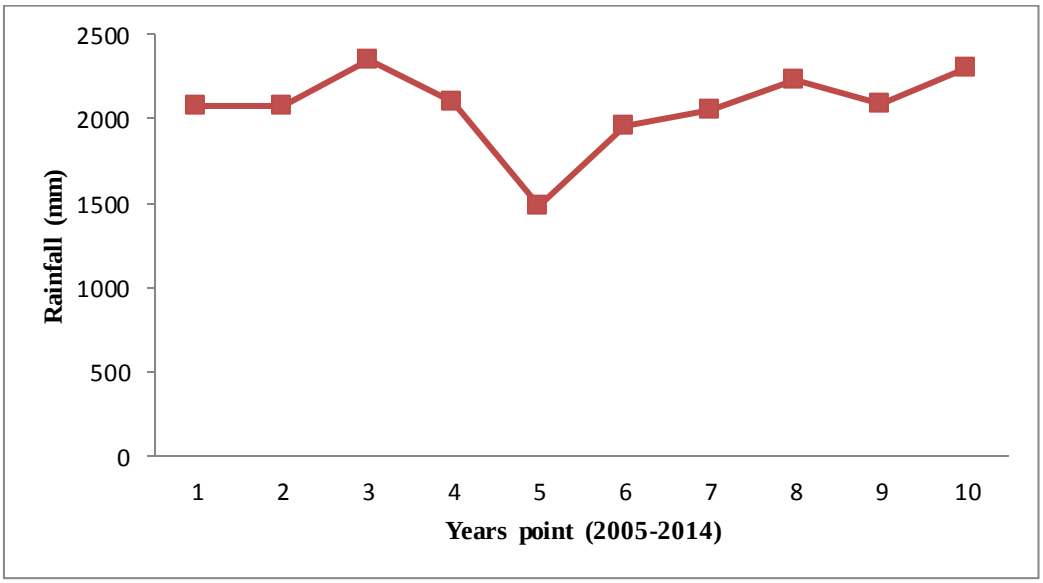
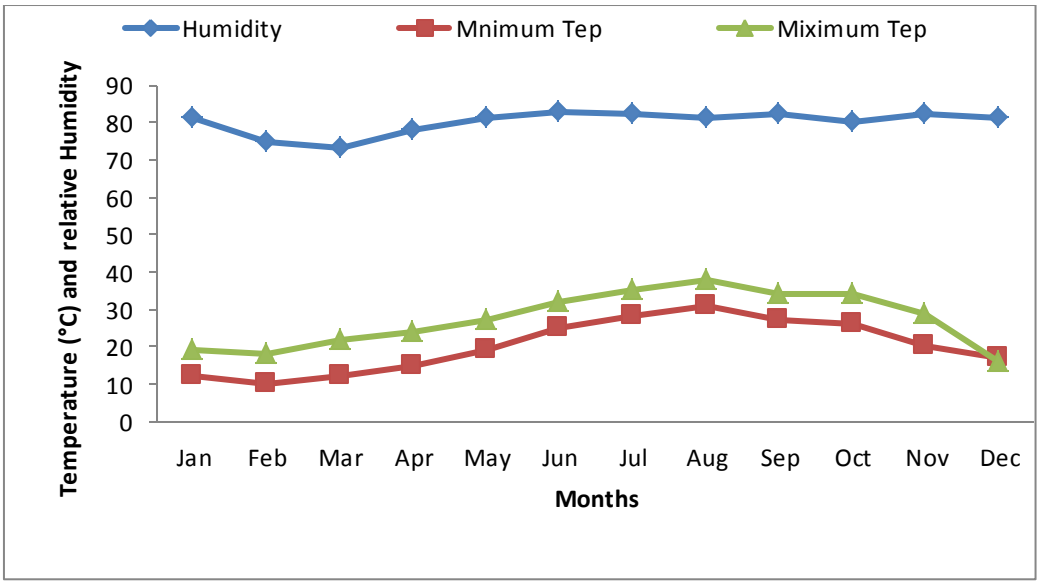
APPENDICES

Appendix I. Average annual rainfall for the years 2005-2014 in the study area



Appendix II. Average monthly temperature (^{0}C) and relative humidity (%) of the study area (2014)



Source: Bangladesh Meteorological Department (Climate & weather division), Agargoan. Dhaka – 1207

Appendix III. English version of the questionnaire of the study

Department of Agroforestry and Environmental Science
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

"DIVERSITY OF MULTIPURPOSE TREE SPECIES IN THE HOMESTEADS AND IT'S IMPACT ON THE LIVELIHOOD OF THE FARMERS OF GOPALPUR UPAZILA IN TANGAIL DISTRICT"

Sample no. :
Date:
Village :
Union :
Please answer the following questions.

Upazila :

1. Age

How old are you?.....Years

2. Education

Please state your level of education

a. Don't know
b. Can sign
c. 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)		
7.	Total		

6. Homestead Size

Sl. No.	Description	Number	Area	
			Local Unit	**Hectare**
1.	Living Room			
2.	Cowshed			
3.	Area under Vegetation			
4.	Area covered with fruit trees			
5.	Area covered with timber trees			
6.	Area covered with agricultural crops			
7.	Area covered with MPTs			
8.	Area covered fodder trees			
9.	Fellow			
10.	Pond			
11.	Total			

7. Annual Income

Sl. No.	Source	Amount(Tk.)
1.	Field Crop	
2.	Vegetables	
3.	Nurseries	
4.	Fruit and Forest Trees	
5.	Livestock	
6.	Fisheries	
7.	Business	
8.	Labor	
9.	Other	
10.	Total	

8. Organizational Participation;

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

9. Knowledge on MPTs in Homestead Agroforestry

Sl. No.	Question	Full Marks	Obtained
1.	What is Homestead Agroforestry	5	
2.	Please Mention the name of 5 Fruit Teees	5	
3.	Please Mention the name of 5 Timber trees	5	
4.	Please Mention the name of 5 MPTs	5	
5.	Please Mention the name of 5 Medicinal plants	5	
6.	Please Mention the name of 5 N_2 fixing trees	5	
7.	Please Mention the name of 5 shade loving crops	5	
8.	Please Mention the name of 5 fodder trees	5	
9.	Please Mention the name of 2 trees which can be planted in flood area	5	
10.	Please Mention the name of 2 trees which can be planted in saline area	5	
11.	Which month is suitable for the tree plantation	5	
12.	Please Mention the name of 5 trees which can be planted on the pond bank area	5	
13.	Please Mention 5 name of disease of trees	5	
14.	Please Mention 5 name of cash crops	5	
15.	Please Mention 5 name of trees for future plantation	5	

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

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

11. Income from multipurpose tree species

S.L No.	Type of tree species	Income(taka)
1.	Timber trees	
2.	Fruit trees	
3.	Medicinal trees	
4.	Fodder trees	
5.	Fuel wood trees	
Total		

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

Sl. no.	Statement regarding changes in socio-economic aspect due to homestead Agroforestry	Nature of Problems			
		Strongly agree	Agree	Disagree	Strongly Disagree
1.	Increasing economic security during crisis period.				
2.	Increase in the supply of timber, house making materials for industry due to increases of number of plant in homestead area.				
3.	Increasing the supply of animal feed from plantation.				
4.	Increasing the quantities of vegetable.				
5.	Timber, fruits, medicinal, fuel, vegetable etc.				
6.	MPTs in Homestead Agroforestry increase employment opportunity.				
7.	MPTs in Homestead Agroforestry sometimes				

	lead to quarrel among the farmers due to quarrel among the farmers due to shadow of the tree				
8.	Increasing the income due to plantation of MPTs				
9.	Increasing the availability of fuel materials due to plantation.				
10.	Decreasing family malnutrition				
11.	Opportunity for use of fallow land for plantation.				
12.	Increasing of ginger, turmeric cultivation under the shady plant in homestead				
13.	Improvement of social status				
14.	Reducing the soil erosion.				
15.	Assistance for medicinal plant from home garden				
16.	Full the demand of bamboo				
17.	Full the demand of vegetables from home garden				
18.	Full the demand of agricultural crops from home garden				

13. Please answer the following questions

Sl. No.	Questions	Yes	No
1.	Increase aesthetic value		
2.	Beneficial for environmental aspects		
3.	Do you work in your home garden regularly ?		
4.	Is your home garden productive?		
5.	Do you practice any mixed combinations agriculture?		

Thanks for your kind co-operation. …….

Signature of interviewer