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**Contribution of Agroforestry to the Household Income in
Satkhira Sadar Upazila of Satkhira District**



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**FORESTRY AND WOOD TECHNOLOGY DISCIPLINE
KHULNA UNIVERSITY
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2017**

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**Contribution of Agroforestry to the Household Income in
Satkhira Sadar Upazila of Satkhira District**

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Submitted To


21.01.2018

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FORESTRY AND WOOD TECHNOLOGY DISCIPLINE

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2017


Dedicated to ...

My Beloved Parents

*...who were, are and always will be
with me whoever I be & whatever I consist,
learn and create*

APPROVAL

This is to certify that, Md. Tarikul Islam, Student ID: MS-120509 has prepared this thesis entitled “**Contribution of Agroforestry to the Household Income in Satkhira Sadar Upazila of Satkhira District**” under my direct supervision and guidance. Project thesis submitted to the Forestry and Wood Technology Discipline, Khulna University, Khulna, Bangladesh in partial fulfilment of the requirements for M.S degree in Forestry. I have approved the style and format of the project thesis.


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DECLARATION

I, **Md. Tarikul Islam**, hereby declare that this project thesis is based on my original work except quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Khulna University or other institutions.

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.....

Md. Tarikul Islam

Abstract

Agroforestry is multifunctional systems that can provide a wide range of economic, socio-cultural, and environmental benefits. In Satkhira Sadar Upazilla, different types of agroforestry are practiced such as home garden, aquasilviculture, boundary plantation with mixed crops and intercropping. Income from agroforestry can be cash and non-cash. In agroforestry related study, only cash income are generally tend to be better recognized. On the other hand non-cash can be very important in the total livelihood earnings of rural community. The study focused on non-cash income in order to realize the actual contribution of agroforestry in household income. A semi-structured questionnaire survey was conducted for field data collection following a snowball sampling approach. Sixty respondents were surveyed for data acquisition. The output showed that among the different types of agroforestry practices boundary plantation with mixed crops are predominant in the study areas. More than seventy percent families earned their income from agroforestry related practices. The study compared the income (cash and non-cash) from different agroforestry products and services. Fuel wood has shown the least difference between the cash and non-cash income. It means fuel wood is a major income sources for the respondents in the study areas. Apart from income related to agroforestry non-cash income only constitutes twenty one percent of the total income. However, non-cash income is quite successful to contribute to the household livelihood. So this study might be of interest at other areas as a tool to improve the livelihood strategies of rural community.

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CHAPTER ONE: INTRODUCTION

1.1 Background of the Study:

Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components. Agroforestry can also be defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. In particular, agroforestry is crucial to smallholder farmers and other rural people because it can enhance their food supply, income and health. Agroforestry systems are multifunctional systems that can provide a wide range of economic, socio-cultural, and environmental benefits. (FAO 2015).

In the present study two very striking terms are 'cash income' and 'non-cash income'. Cash income refers to the sum of all receipts from the sale of crops, trees, livestock and farm related goods and services, as well as any direct payments from the government. The non-cash income refers to the value of home consumption of self-produced food from crops and vegetables, fish, livestock, fuel wood, fodder for own livestock etc. Both cash and non-cash income are important for an agroforestry farm activities because to gross farm income is calculated by summing up both the cash and non-cash income. Cash income is important because purchase of the necessary goods and services which are not produced in the farm and required for both consumption and running and maintaining the farms requires cash which is supplied by cash income. On the other hand non-cash income is the monetary value of the consumption and use of produce from the farm which lessens spending of cash which can be either utilized for the purchase of other bare necessities or saved for future expenses. Money saved by the non-cash income can be invested for the development of the farm.

In the Satkhira district, Satkhira Sadar Upazila is an important place as it is highly populated. Most of the people of Satkhira Sadar Upazila are directly or indirectly dependent on agroforestry system due to their household income. So household

income study of Satkhira Sadar Upazila is very important for measuring the dependency on agroforestry system and developing innovative idea to create alternative source of income rather than depending on only agriculture that may be helpful to ensure the proper utilization of limited land resources for the huge amount of population. We have to raise awareness among the local people regarding agroforestry system for their household income.

1.2 Rationale of the Study

Agroforestry is a sustainable management system for land that increases total production, combines agricultural crops, tree crops and forest plants and / animals simultaneously or sequentially and applies management practices that are compatible with the cultural patterns of the local population. Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components. Agroforestry system as a land use system that integrates trees with agriculture crops, and or animals simultaneously or sequentially to get higher productivity, more economic returns and better social and ecological benefits on a sustainable yield basis than are obtainable from mono-culture on the same unit of land, especially under conditions of low levels of technological inputs on marginal sites. The cash benefits of Agroforestry generally tend to be better recognized, while the noncash contributions of Agroforestry are largely “unseen.” It is important to identify the cash and non-cash income in order to determine the contribution of Agroforestry for sustainable livelihood and greater family income.

1.3 Objectives of the Study:

- i. To assess the contribution of Agroforestry to the household Income.
- ii. To identify the cash income and non-cash income in Agroforestry.

CHAPTER TWO: LITERATURE REVIEW

2.1 Concept of Agroforestry:

The word agroforestry is derived from the combination of two words that is agro, meaning "agriculture crops," and forestry, meaning "forest trees". It is a farming method that allows trees and shrubs to grow along with agriculture crops and/or livestock that means blending agriculture and forestry in the same production system.

Agroforestry is a system which is not only ecologically rational but also economically sound. In recent years, agroforestry is developed as a science for improving the productivity, profitability and sustainability of production of available lands, and soil conservation.

Agroforestry has three components that are forestry (trees), agriculture (crops) and livestock (animals)/fodder and forage. The combination of these components is known as agroforestry. Trees play a very important role in ecosystem and provide a range of products and services to rural and urban people. But now-a-days natural vegetation is cut for agriculture and other types of development due to the increased population. So the benefits that trees provide are best sustained by integrating trees into agricultural system generally this practice known as agroforestry. Agroforestry is the art and science of growing woody and non-woody plants together on the same unit of land for range of benefits.

2.2 Definitions of Agroforestry:

In simple word, agroforestry is a science that combines trees and agriculture crops (food, fruit, vegetables, fodder and forage etc.) together in the same land at the same time. The definitions of agroforestry given by various scientists and institutions are as follows:

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

Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components (Lundgren and Raintree, 1982).

Young (1989) defines agroforestry as a collective name for land use system in which woody perennials (trees, shrubs etc.) are grown in association with herbaceous plants (crops, pastures) and /or livestock in a spatial arrangement, a rotation or both and in which there are both ecological and economic interactions between the tree and non-tree components of the system.

A collective name for land use systems and technologies where woody perennials (trees, shrubs, palm, bamboo etc.) are deliberately used in the same land management unit as agriculture crops and or animals either in same form of spatial arrangement or temporal sequence (Lundgren and Raintree, 1982).

Agroforestry system is defined as a land use system that integrates trees with agriculture crops, and or animals simultaneously or sequentially to get higher productivity, more economic returns and better social and ecological benefits on a sustainable yield basis than are obtainable from mono-culture on the same unit of land, especially under conditions of low levels of technological inputs on marginal sites (Raintree 1982).

GOI (2001) defined agroforestry as “a sustainable management system for land that increases overall production, combines agricultural crops, tree crops and forest plants and or animals simultaneously or sequentially and applies management practices that are compatible with the cultural patterns of local population”. World Agroforestry Centre (ICRAF) defined, “Agroforestry is a dynamic ecologically based, natural resource management system that through the integration of trees in farm and rangeland, diversifies and sustains small holder production for increased social, economic and environmental benefits.”

Agroforestry is a form of multiple cropping which satisfies three basic conditions:

- There exists at least two plant species that interact biologically,
- At least one of the plant species is a woody perennial, and
- At least one of the plant species is managed for forage, annual or perennial crop production.

Summarizing, agroforestry is a land management system with a woody perennial as one of the components. It optimizes land productivity by involving positive interactions between its components in time and space.

2.3 The Characteristics of Agroforestry:

1. A high level of interaction (economic and biophysical) between the woody and the non-woody components.
2. Multiple plant components. At least one of which must be a woody perennial.
3. Usually multiple products, often of different categories (e.g. food, fodder, fuel wood).
4. The most simple agroforestry system is more complex, ecological and economically than a mono cropping system.
5. The cycle of agroforestry is usually more than one.

2.4 Historical Development of Agroforestry in Bangladesh:

The historical development of Agroforestry in Bangladesh is mentioned here –Betagi-pomora community forestry project (1979): This was the first agroforestry program started by the Forest department under social forestry program. Betagi and pomorais the two village of Rangunia Thana of Chittagong district. This were two denuded (devoid of trees) hill were the Govt. rehabilitate families who encroached forest land with a view to plant trees along with the provision of cultivation of agricultural crops in the allotted land for each family. Initially the program was started with the participation of 70 families of Betagi village in 1979. Then it was expanded in Pomora village in khas land and protected forest land. Then 235 families 83 in Betagi and 152 in Pomora village has been rehabilitated in these two villages.

In mid 80s on farm research division (OFRD) in BARI was established where agroforestry as a land use system were evaluated and its potential and essentiality in our farming system has been judged.

In 1987, Bangladesh Forest Research institute (BFRI) was conducted agroforestry research works in Ichamoti in Rangunia. Fashiakhali of Dulahazra and Salna of Gazipur with a view to maximize the productivity of the Govt. forest land.

In 1988, the institute of forestry in Chittagong University introduced the course of agroforestry in its curriculum for the degree of B.SC (honours) in forestry.

In 1988, Village and Farm Forestry Program (VFFP) were initiated under the guidance of Prof. Abdul Haque (The Professor of Crops Botany) with financial assistance of Swiss Agency for Development and Cooperation (SDC). This program deals with the exploration of feasibility of implementing of agroforestry works in different areas in to the country. This program actually helped in establishing Agroforestry department in the Bangladesh Agricultural University.

In 1990, giant NGOs like BRAC, PROSHIKA, SDC and others started agroforestry works in the country.

In 1990, Department of Agroforestry and Environment in IPSA was established now Banghabondhu Sheikh Mujibar Rahman Agricultural University (BSMRAU) often MS in Agroforestry.

In 1996, Department of Agroforestry was established by the indefatigable works of Prof. Abdul Haque. With the incorporation of courses of agroforestry for the undergraduate students of the faculty of Agriculture, the agroforestry movement gained momentum. In the newly established department he (Prof. Adbul Haque) was the founder head.

In 1997, the National Agroforestry Working Group was formed by the active initiation of the personnel engaged in the Bangladesh Agricultural Research Council (BRAC).

In 1998, first National Agroforestry Workshop was held at BRAC organized by NAWG during 21-25 June (Hassanuzzaman, 2009). The history of agroforestry intimately associated with the practice of shifting cultivation and taungya system.

2.5 Shifting cultivation:

The term shifting cultivation refers to farming or agricultural systems in which land under natural vegetation is cleared, cropped with agricultural crops for a few years, and then left untended while the natural vegetation regenerates. The cultivation phase is usually short (2-3 years), but the regeneration phase, known as the fallow or bush fallow phase, is much longer (traditionally 10-20 years). The clearing is usually accomplished by the slash-and-burn method (hence the name slash-and-burn agriculture), employing simple hand tools. Useful trees and shrubs are left standing, and are sometimes lightly pruned, other trees and shrubs are pruned down to stumps of varying height to facilitate fast regeneration and support for climbing species that require staking. The lengths of the cropping and fallow phases vary considerably, the former being more variable; usually the fallow phase is several times longer than the cropping phase. The length of the fallow phase is considered critical to the success and sustainability of the practice. During this period the soil, having been depleted of its fertility during the cropping period, regains its fertility through the regenerative action of the woody vegetation (Hassanuzzaman, 2009).

2.6 Taungya System:

In Burmese, "taung" means hill and "ya" means cultivation. So the word taungya means hill cultivation. The Taungya system in the tropics is, like shifting cultivation, a forerunner to Agroforestry. The Taungya system consists of growing annual agricultural crops along with the forestry species during the early years of establishment of the forestry plantation. The land belongs to the forestry departments or their large scale lessees, who allow the subsistence farmers to raise their crops. The farmers are required to tend the forestry seedlings and, in return, retain a part or all of the agricultural produce. This agreement would last for two or three years, during which time the forestry species would grow and expand its canopy.

Usually during this period the soil fertility declines, some soil is lost to erosion, and weeds infest the area, thus making crop production non-remunerative, if not impossible (Hassanuzzaman, 2009).

2.7 Features of Agroforestry:

Agroforestry practices are intentional systematic combinations of trees with crops and/or livestock that involve intensive management of the interactions between the components as an integrated agro ecosystem. These key features are the essence of agroforestry and are what distinguish it from other farming or forestry practices. To be called agroforestry, a land-use practice must satisfy following criteria:

- **Intentional:** Combinations of trees, crops and/or animals are intentionally designed and managed as a whole unit, rather than as individual elements that may occur in close proximity but are controlled separately.
- **Intensive:** Agroforestry practices are intensively managed to maintain their productive and protective functions; these practices often involve annual operations such as cultivation and fertilization.
- **Interactive:** Agroforestry management seeks to actively manipulate the biological and physical interactions between the tree, crop and animal components. The goal is to enhance the production of more than one harvestable component at a time, while also providing conservation benefits such as non-point source water pollution control or wildlife habitat.
- **Integrated:** The tree, crop and/or animal components are structurally and functionally combined into a single, integrated management unit. Integration may be horizontal or vertical, and above or below ground. Such integration utilizes more of the productive capacity of the land and helps balance economic production with resource conservation. (Hassanuzzaman, 2009).

2.8 Components of Agroforestry:

Agroforestry has mainly three components. They are –

2.8.1 Agrisilvicultural Systems

In this system, agricultural crops are intercropped with tree crops in the inter space between the trees. Under this system agricultural crops can be grown up to two years under protective irrigated condition and under rain fed farming up to four years. The crops can be grown profitably up to the above said period beyond which it is uneconomical to grow grain crops. However fodder crops, shade loving crops and shallow rooted crops can be grown economically. Wider spacing is adopted without sacrificing tree population for easy cultural operation and to get more sunlight to the intercrop. Performance of the tree crops is better in this system when compared to monoculture. (Anon, 2008).

2.8.2 Silvopastoral Systems

The production of woody plants combined with pasture is referred to Silvipasture system. The Trees and shrubs may be used primarily to produce fodder for livestock or they may be grown for timber, fuel wood, and fruit or to improve the soil. (Anon, 2008)

This system is classified in to three categorized (Anon, 2008)

- Protein bank
- Live fence of fodder trees and hedges
- Trees and shrubs on pasture

2.8.2.1 Protein bank:

In this Silvopastoral system, various multipurpose trees (protein rich trees) are planted in or around farmlands and range lands for cut and carry fodder production to meet the feed requirement of livestock during the fodder deficit period in winter. (Anon, 2008)

Example: *Acacia nilotica*, *Albizia lebbeck*, *Azadirachta indica*, *Leucaena leucocephala*, *Gliricidia sepium*, *Sesbania grandiflora*

2.8.2.2 Live fence of fodder trees and hedges:

In this system, various fodder trees and hedges are planted as live fence to protect the property from stray animals or other biotic influences. (Anon, 2008)

Example: *Gliricidia sepium*, *Sesbania grandiflora*, *Erythrina sp*, *Acacia sp*.

2.8.2.3 Trees and shrubs on pasture:

In this system, various tree and shrub species are scattered irregularly or arranged according to some systemic pattern to supplement forage production. (Anon, 2008)

Example: *Acacia nilotica*, *Acacia leucophloea*, *Tamarindus indica*, *Azadirachta indica*.

2.8.3 Agrosilvopastoral Systems

The production of woody perennials combined with annuals and pastures is referred Agrisilvopastural system (Anon, 2008).

This system is grouped into two categories. (Anon, 2008)

- a) Home gardens.
- b) Woody hedgerows for browse, mulch, green manure and soil conservation.

2.8.3.1 Home gardens

This system is found extensively in high rainfall areas in tropical South and South East Asia. This practice finds expression in the states of Kerala and Tamil Nadu with humid tropical climates where coconut is the main crop. Many species of trees, bushes, vegetables and other herbaceous plants are grown in dense and in random or spatial and temporal arrangements. Most home gardens also support a variety of animals. Fodder grass and legumes are also grown to meet the fodder requirement of cattle. In India, every homestead has around 0.20 to 0.50 ha land for personal production. (Anon, 2008)

Home gardens represent land use systems involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial

agricultural crops and livestock within the compounds of individual houses. The whole tree- crop- animal units are being intensively managed by family labor. Home gardens can also be called as Multitier system or Multitier cropping. Home gardens are highly productive, sustainable and very practicable. Food production is primary function of most home gardens (Anon, 2008).

2.8.3.2 Woody Hedgerows:

In this system various woody hedges, especially fast growing and coppicing fodder shrubs and trees are planted for the purpose of browse, mulch, green manure, soil conservation etc. The following species viz., *Erythrina spp*, *Leucaena luecocephala*, *Sesbania grandiflora* are generally used.

2.9 Attributes of Agroforestry:

Additionally, there are three attributes which, theoretically, all agroforestry systems possess. These are:

- **Productivity:** Most, if not all, agroforestry systems aim to maintain or increase production (of preferred commodities) as well as productivity (of the land). Agroforestry can improve productivity in many different ways. These include: increased output of tree products, improved yields of associated crops, reduction of cropping system inputs, and increased labor efficiency.
- **Sustainability:** By conserving the production potential of the resource base, mainly through the beneficial effects of woody perennials on soils, agroforestry can achieve and indefinitely maintain conservation and fertility goals.
- **Adoptability:** The word "adopt" here means "accept," and it may be distinguished from another commonly-used word adapt, which implies "modify" or "change." The fact that agroforestry is a relatively new word for an old set of practices means that, in some cases, agroforestry has already been accepted by the farming community. However, the implication here is that improved or new agroforestry technologies that are introduced into new areas should also conform to local farming practices. These attributes are so characteristic of all agroforestry systems that they form the basis for evaluation of various agroforestry systems (Hassanuzzaman, 2009).

2.10 Benefits of Agroforestry

2.10.1 Environmental/Ecological Benefits:

- Better protection of crops and lives from environmental hazards such as flood, drought, cyclone etc.
- Conserved biodiversity
- Improved microclimate- such as reduce soil temperature, reduces evaporation of soil moisture.
- Purification of air and water.
- Reduce use and chemical fertilizer
- Reduce pressure on forests.
- Protect lands through reduction of surface run-off and soil erosion.
- Increase soil nutrients through of addition decomposition of litter fall.
- More efficient recycling of nutrients by deep-rooted trees.
- Improve soil structures through the constant addition of organic matter from decomposed litter.

2.10.2 Economic benefits:

- Diversifies the range outputs a given area
- Increase the value of outputs from a given area of land.
- Reduces in incidence of total crop failure, common to single or mono cropping systems.
- spread the needs for labour inputs more evenly through the year.
- Provides productive use of underutilized land, labour and capital.
- Increases in levels of farm incomes due to improved and sustained productivity.

2.10.3 Social benefits:

- Improved in rural living standards from sustained employment higher incomes.
- Improved in nutrition and health due to increased quality and diversity of food outputs
- Stabilization and improvement of upland communities through elimination of the need to shift sites of farm activities.

2.10.4 Biological benefits:

- Increase crop productivity.
- Sustain crop productivity.
- Produce diversified foods.
- Increase forest productivity.
- Increase fruit supply.
- Decrease weed infection.

2.11 Limitations of Agroforestry:

a. Environmental aspect :

- Loss of organic matter, nutrients and damage of crops during tree harvesting: when the trees are harvested a huge loss of organic matter, nutrients and damage of crops occurred.
- Nutrient competition between trees and crops: trees and crops may compete with each other for nutrient and mineral.
- Moisture competition between trees and crops: In the semiarid and dry zones, this is possibly the most serious problem encountered in agroforestry.
- Production of substances which inhibit germination or growth: Some Eucalyptus species produce toxins which can inhibit the germination or growth of some annual herbs. It has also been suggested that the production of allelopathic substances by tree roots could present a problem in agroforestry, but there is little evidence of this.
- Host of insect and other pests: trees planted in the crops may attract the insect and birds which sometimes harmful for crops. They may be the hosts of different pests (Hassanuzzaman, 2009).

b. Socio-economic aspect :

- Agroforestry is more complex practice.
- Required more labour inputs.
- Longer period required to get maturity of trees.
- Competition between trees and crops may reduce the production and thus income (Hassanuzzaman, 2009).

2.12 Classifications of Agroforestry:

Nair (1985) classified the agroforestry systems on the basis of structure, function, socioeconomic and ecological status as the following-

2.12.1 Structural classification:

Structure refers to composition, stratification and dimension of the crop. On the basis of structure, Agroforestry systems classified into two categories:

- Nature of components
- Arrangement of components.

The classification of the agroforestry systems on the basis of the nature of composition is widely recognized and several workers have classified agroforestry systems on basis of composition into the followings -

- Agrisilvicultural systems.
- Silvopastoral systems.
- Agrosilvopastoral systems and
- Multipurpose tree plantation systems or other systems.

Agrisilvicultural systems:

The silvipastoral system means a land management system in which forests are managed for the production of wood as well as for rearing of domesticated animals.

Agrosilvopastoral systems:

In this system, agricultural crops, trees are produced with animals in the same piece of land. For examples, the Aman paddy is grown in the mango garden in Rajshahi and Dinajpur. After harvesting the paddy, the people sowed the kolai for fodder and their cattle are grazed in this garden. This system is a combination of the agrisilviculture and silvopasture systems.

Multipurpose tree plantation systems:

The system in which forest tree species are produced and managed to produce not only wood but also leaves and/or fruits that are suitable for food and/or fodder.

2.12.2 Functional classification:

Agroforestry system produce not only various products but also perform various functions.

According to these functions, agroforestry can be classified as the following.

- Productive agroforestry systems
- Protective agroforestry systems
- Multipurpose agroforestry

Socioeconomic basis:

It refers to the level of inputs of management (low input, high input) or intensity or scale of management and commercial goals. Based on this agroforestry can be classified into

- Subsistence
- Commercial
- Intermediate

Ecological basis:

It refers to the environmental condition and ecological suitability of systems, based on the assumption that certain types of systems can be more appropriate for certain ecological conditions; i.e., there can be separate sets of agroforestry systems for arid and semiarid lands, tropical highlands, lowland humid tropics, etc. The agroforestry systems on the basis of climate may be as the following types

- Tropical
- Subtropical
- Temperate

2.13 Agroforestry Systems in Bangladesh

Agro forestry systems can broadly be categorized into two major types-

- a. Farm land Agro forestry
- b. Forest based Agro forestry

2.13.1 Farmland Agro forestry:

It is subdivided into three types-

- i. Homestead Agro forestry
- ii. Cropland Agro forestry
- iii. Commercial crop under shade tree.

Homestead Agroforestry:

Homestead agroforestry consisting of an assemblage of plants which includes trees, shrubs, and herbaceous plants, growing in or adjacent to a homestead or home compound, has a long tradition in the study site. These are planted and maintained by members of the household with their products intended primarily for household consumption; they have considerable ornamental value and provide shade to people and animals. (Sourovi et al., 2010).

Cropland Agroforestry:

The innovative peasant on their land through informal research; trial and error basis has developed Cropland Agroforestry. The cropping pattern and choice of species varies in different Agro-ecological zones of the country.

Commercial crop under shade tree:

Commercial crop means the crop which has economic importance. In Agroforestry system commercial crop refers to tea (*Camellia sinensis*) where tea cultivation is practiced under shade tree. Shade tree is transplanted both as boundary and in-field plantation which provide protection to tea and ensures good return in form of fuel wood and cash. This system is tremendously followed in greater Sylhet and Chittagong districts where tea cultivation is being practiced.

2.13.2 Forest based agroforestry:

In Bangladesh forest land is rampantly encroached by the land grabber. In considering that condition, the forest department has innovated a system of Agroforestry in the forest area to rehabilitate and regain forest land. The systems are following-

i. Alley cropping:

In some encroached and denuded land, alley cropping mostly with 10 mx10m spacing in the north-south direction has been practiced in Sal forests. Because of irregular size of the plots given to the farmers, the alley size cannot be stringently maintained. The land has become too hard to cultivate. One NGO (Prosika) has assisting the forest department, has promised to give cattle on credit. Now the forest department and NGO have extended their hand to co-operate with the peasant (Alam, et al., 1997).

ii. Community Forestry Project:

The most systematic and planned Agroforestry practice initiated in Bangladesh in 1985 in the denuded plain land forests of North Bengal (Dinajpur, Rangpur and Rajshahi) with the financial support of ADB and technical assistance of UNDP/FAO under the community forestry project (CFP) implemented during 1982-87 to replenish the depleted forest land (GOB 1982). The main tree species are Eucalyptus, Akashmony, Sissoo, Koroi, and Minjiry in conjunction with agricultural crops like paddy, wheat, banana, mango, lemon, jackfruit etc.

iii. Strip plantation:

Strip plantations are being practiced by the side of national highways and embankments. It was first introduced Dhaka-Aricha highways where napier grass, papaya, lemon, date palm, jack fruit, koroi, ipil-ipil, mahogoni, sissoo etc. were raised. Now under system, babul, koroi, eucalyptus, etc. trees in association with agricultural crops are being cultivated (Dey, 1996).

iv. Tungya:

This practice is indigenous to Myanmar and had been introduced in Bangladesh in 1871. It is the modification of shifting cultivation. In this method, simultaneous

planting of agricultural crops (mainly paddy, vegetables) and forest tree species are sown by dibbling during the initial stage of plantation development. After collecting of agricultural crops, tree species are retained to attain mature. It is induced to reduced soil erosion (Dey, 1996).

v. Woodlot :

In Bangladesh woodlots of different tree species are also found. The main purposes of establishing woodlots are to protect the agricultural fields from soil erosion, prevent drying up of water springs, landslips and landslide, and maintain the stream regime. In many parts, farmers grow trees in separate blocks as wood-lots along with agricultural fields. Now the practice is expanding fast due to shortage of fuel-wood and demand of poles or pulp-wood in industry.

vi. Other Systems:

a) Apiculture with trees: In this system various honey (nectar) producing trees frequently visited by honeybees are planted on the boundary of the agricultural fields. (Anon, 2008)

b) Aqua forestry: In this system various trees and shrubs preferred by fish are planted on the boundary and around fish ponds. Tree leaves are used as feed of Fish. (Anon, 2008). The main role of this system is fish production and bund stabilization around fish ponds. It may be called Aqua forestry or aquasilviculture.

c) Mixed wood lots: In this system, special location specific multipurpose trees (MPTs) are grown mixed or separately planted for various purposes such as wood, fodder, soil conservation , soil reclamation etc.(Anon, 2008).

CHAPTER THREE: MATERIALS AND METHOD

3.1 Geography of the Study Area

Satkhira Sadar Upazila (Satkhira district) area 400.82 sq km, located in between 22°37' and 22°50' north latitudes and in between 88°55' and 89°10' east longitudes. It is bounded by Kalaroa Upazila on the north, Debhata and Assasuni Upazilas on the south, Tala Upazila on the east, West Bengal state of India on the west (Banglapedia 2015).

3.2 Demographics

Satkhira Sadar Upazila (Satkhira district) has a population of 410355 (Source Bangladesh Population Census 2001, Bangladesh Bureau of Statistics). Male population has 211986 and female population has 198369. Literacy rate and educational institutions Average literacy 50.67%; male 55.90%, female 45.09%. Among the population , Muslim 351303, Hindu 57340, Buddhist 854, Christian 39 and others 819. Satkhira Sadar Upazila has 1 municipality, 14 unions, 119 mouzas, 236 villages, the density (per sq km) of population has 1024.

3.3 Economy

Main occupations

Main sources of income Agriculture 56.89%, non-agricultural labourer 3.55%, industry 1.08%, commerce 15.57%, transport and communication 4.56%, service 7.85%, construction 1.39%, religious service 0.22%, rent and remittance 0.46% and others 8.43%.

Crops

Paddy, jute, wheat, sugarcane, mustard, potato, pulse, vegetables.

Main fruits

Mango, blackberry, jackfruit, banana, papaya, coconut, plum, litchi, star apple, guava, sapodilla, plum, lemon.

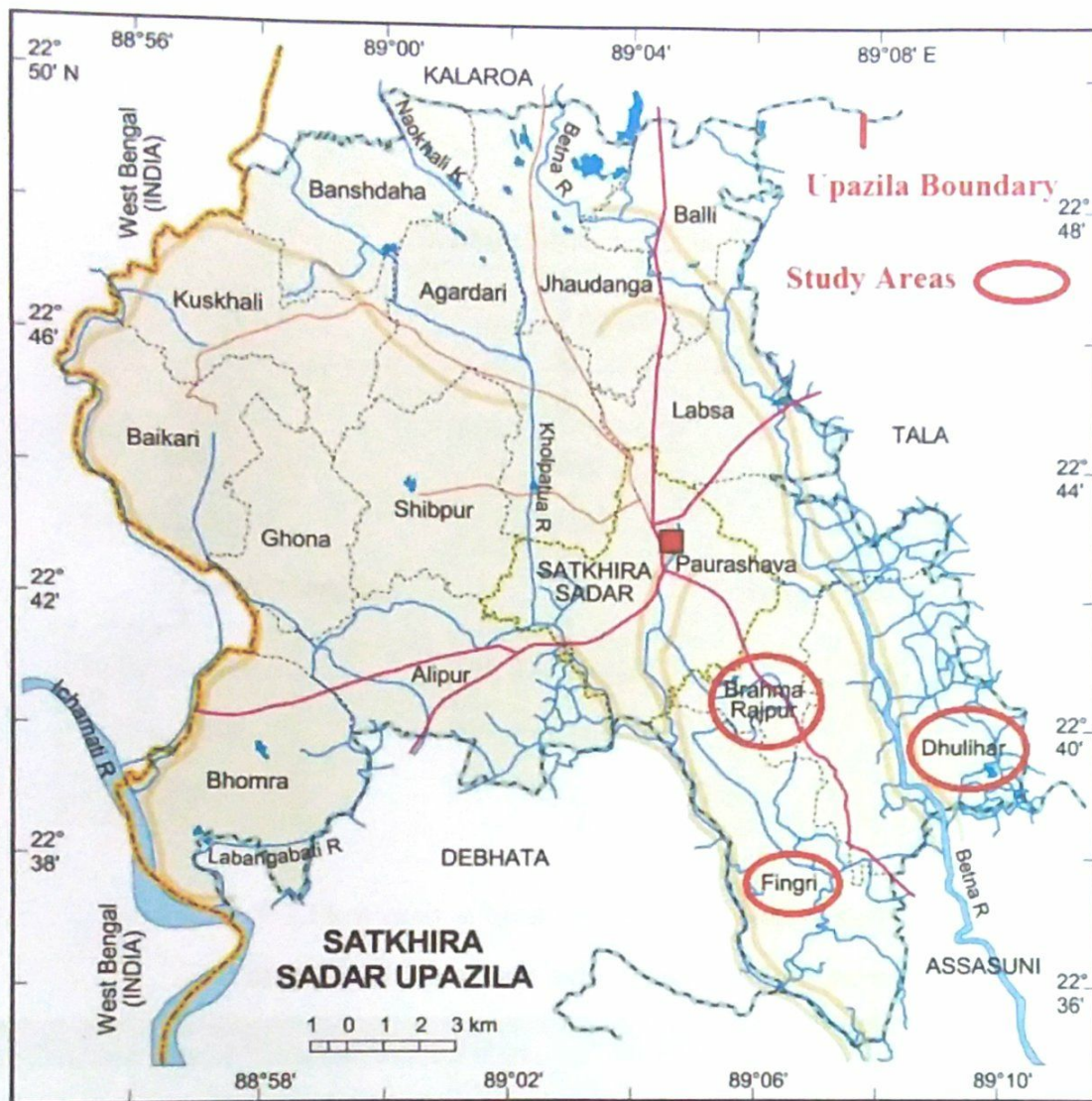


Figure 3. 1 Map of the study area (Source: Banglapedia)

3.4 Data Collection Process

Satkhira Sadar upazila of Satkhira district was selected purposively. ‘Three’ unions (Brahma Rajpur, Dhulihar and Fingri) and ‘Ten’ villages were selected purposively from Satkhira Sadar Upazilla. Author selected respondents from the villages by following snowball sampling method. For this task, Author prepared a semi-structured questionnaire including the necessary questions to collect relevant information from local respondents. Author surveyed around 60 respondents in total from the study area. On the other hand secondary information such as statistical data, reports, and maps were collected from various Government, Non-government organizations, literature and internet. According to Yen, 60 to 120 samples are handsome enough for

evaluating a fact in a social survey; a higher numbers has been selected because of diversification in population (Yen 1984). Sampling process are given below-

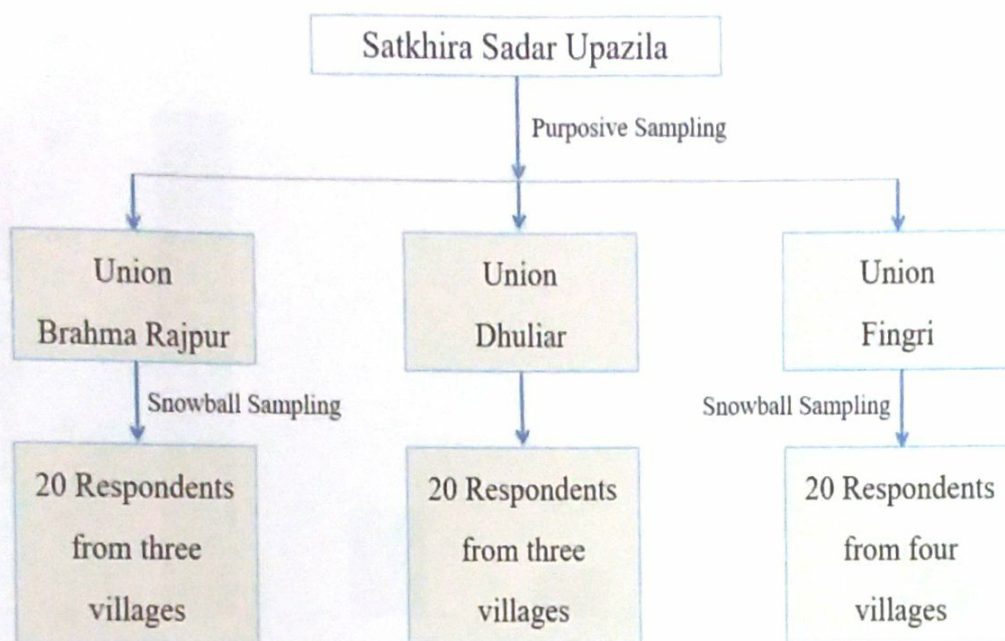


Figure 3. 2 Flow chart of local sample respondents in study area

Table 3. 1 Sample distribution table in study areas

Union		Villages	Sample size
Brahma Rajpur		Brahma Rajpur	12
		Dhokula	04
		Ramchandrapur	04
Dhulihar		Komorpur	13
		Jahanabaj	04
		Dorbesthia	03
Fingri		South Fingri	07
		Gobordari	05
		Habaspur	04
		Jordia	04
Total	03	10	60

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Education Level of the Respondents

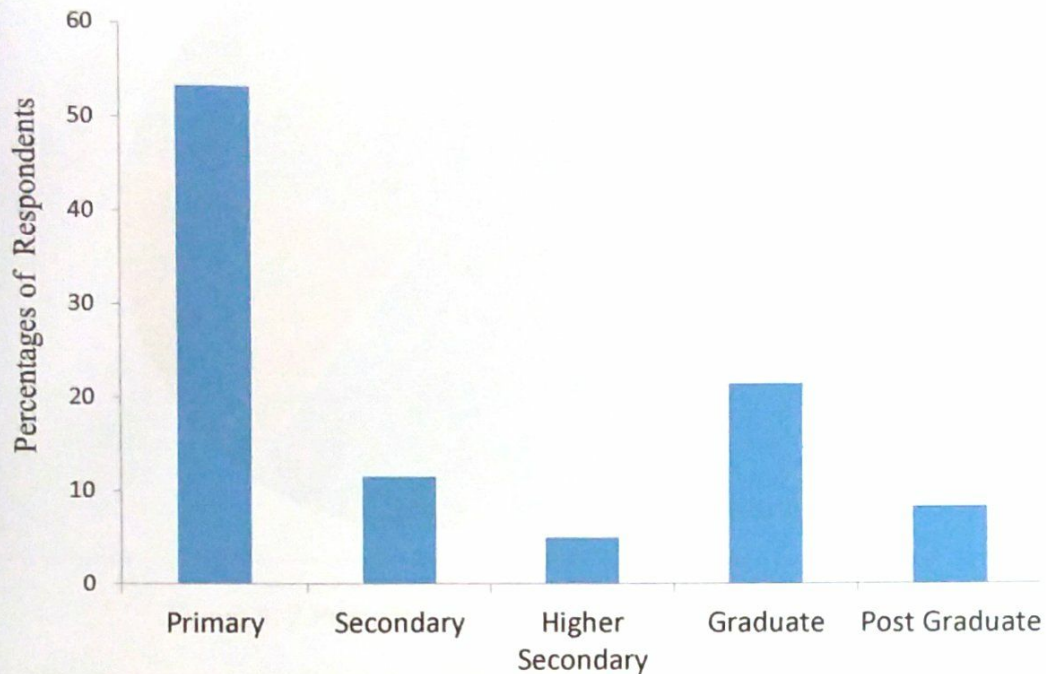


Figure 4. 1 Education Level of the Respondents

In the study, this figure represents education level of the respondents. Here the most of the respondents are primarily educated who are about 53%. The second highest education level is graduate who possess about 22%. The lowest education level is higher secondary who are about 5%. So it is concluded that in the ten study villages the education level is much higher.

4.2 Primary Occupation Pattern of the Respondents:

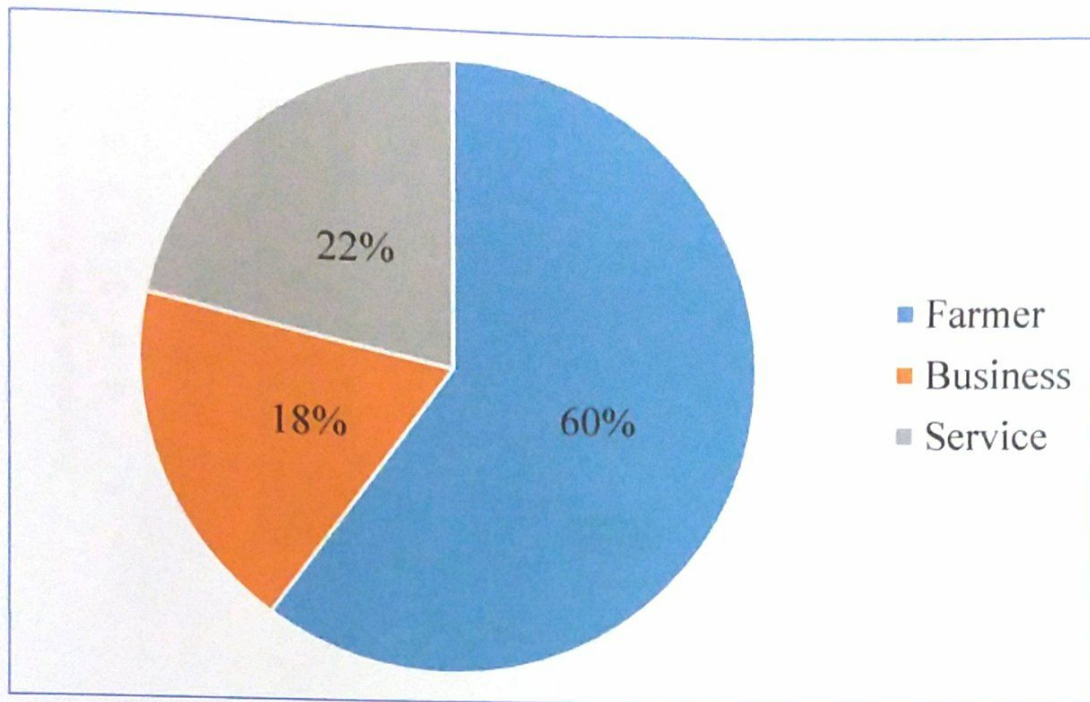


Figure 4. 2 Primary Occupation Pattern of the Respondents

In the study, we it is found that 60% of the respondents are farmers. Their land holdings are used both for the plantation of different tree species and crops which yield to vast amount of cash and non-cash income. The second largest occupation group is Businessmen. They are primarily involved in business but they have land holding with vegetation. The minor portion of the respondents are service holders but they too have land holdings with different types of tree species. So it can be concluded that there is huge potential for agroforestry in the study area because farming community has enough time and scope to take care of the trees and plants.

4.3 Land Holding of the Respondents

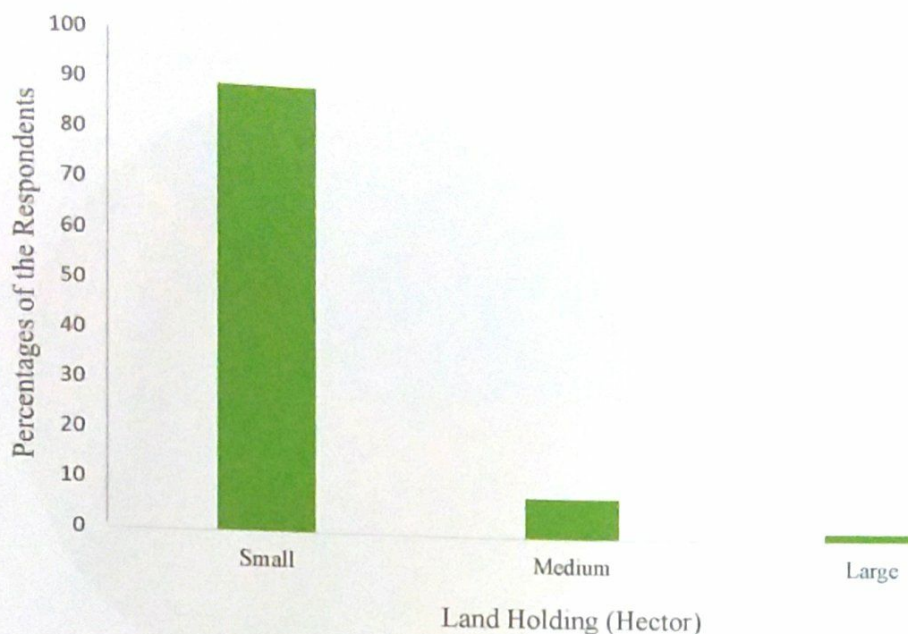


Figure 4. 3 Land Holding of the Respondents

The types of land holding are divided into three categories such as Small (0-1.9 hectors), Medium (2.0-4.9 hectors) and Large (Above 5 hectors). 90% of the respondents own land holdings measured from 0-1.9 hectors when 8.3% of the respondents own land holdings in the second category which is 2.0-4.9 hectors. A small portion of the population (1.7%) has land above 5 hectors. So, it is apparent that most of the respondents have small land holdings in proportion to the total land holdings and very less number of the respondents have land holdings above 5 hectors. Scarce number of land holdings for a great number of respondents is a big problem for agroforestry as it limits the scope to expand the dimensions agroforestry.

4.4 Percentages of Respondents Having Different Types of Agroforestry Practices

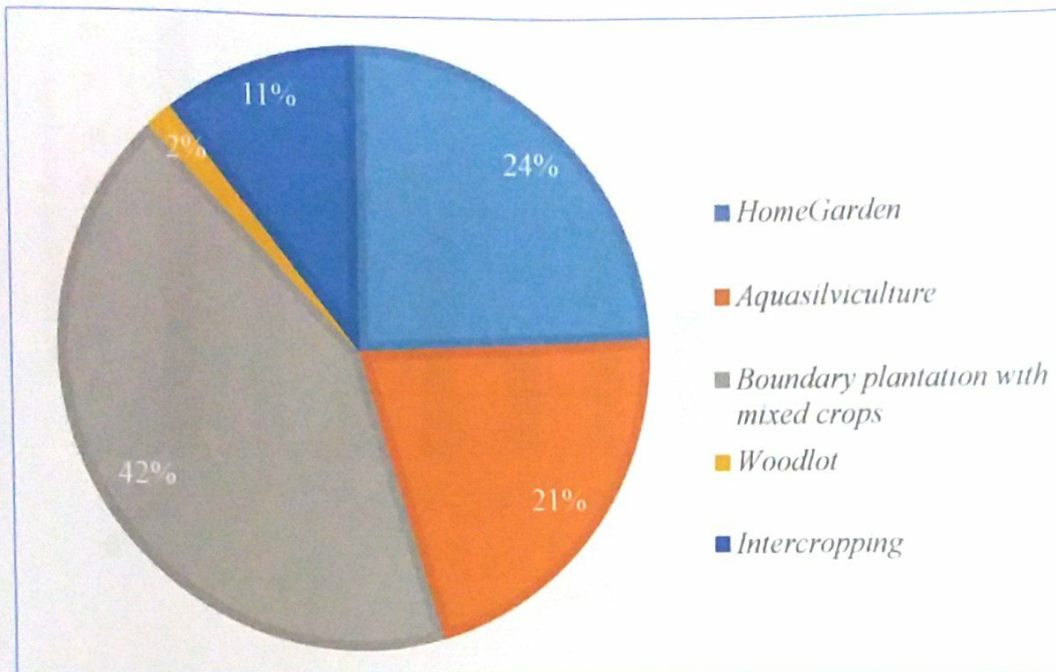


Figure 4. 4 Percentages of Respondents Having Different Types of Agroforestry Practices

In the study area, different types of agroforestry are observed. There are 11% Home Garden, 21% Aquasilviculture, 42% Boundary plantation with mixed crops, 24% intercropping and only 2% woodlot. From the observation it can be concluded that majority of the respondents are very much involved in farming and they are also wise enough to include forestry with the farming process. Plantation in the home gardens is seemingly comparing to the other types like 42% boundary plantation with mixed crops and 24% intercropping. The plantation of woodlot is very small in comparison with the other agroforestry processes although it is quite financially profitable and suitable for the study area. The 21% Aquasilviculture yield to significant amount of non-cash income for the respective population. It can be said that the most popular form of agroforestry in the study area is boundary plantation with mixed crops. So there is huge potential for forestry related extension and expansion.

4.5 Most Common Tree Species in Agroforestry Practices

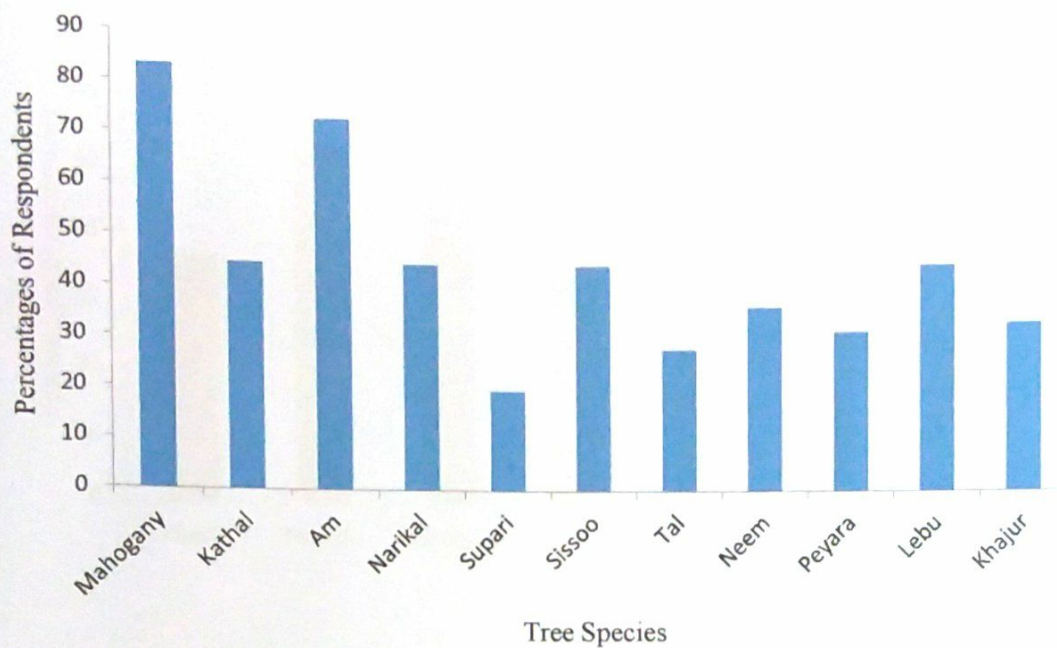


Figure 4. 5 Most Common Tree Species in Agroforestry Practices

From this research we found most common tree species practices in the study areas. About 83% respondents have Mahogany tree where Am (*Mangifera indica*) is the second highest tree species. Only about 20% respondents have practiced Supari. From the analysis it can be said that the most of the respondents expect quick profit from the plantation of wood tree and Mahogany is on that grows faster to be prepared for selling.

4.6 Most Common Seasonal Crops in Agroforestry Practices

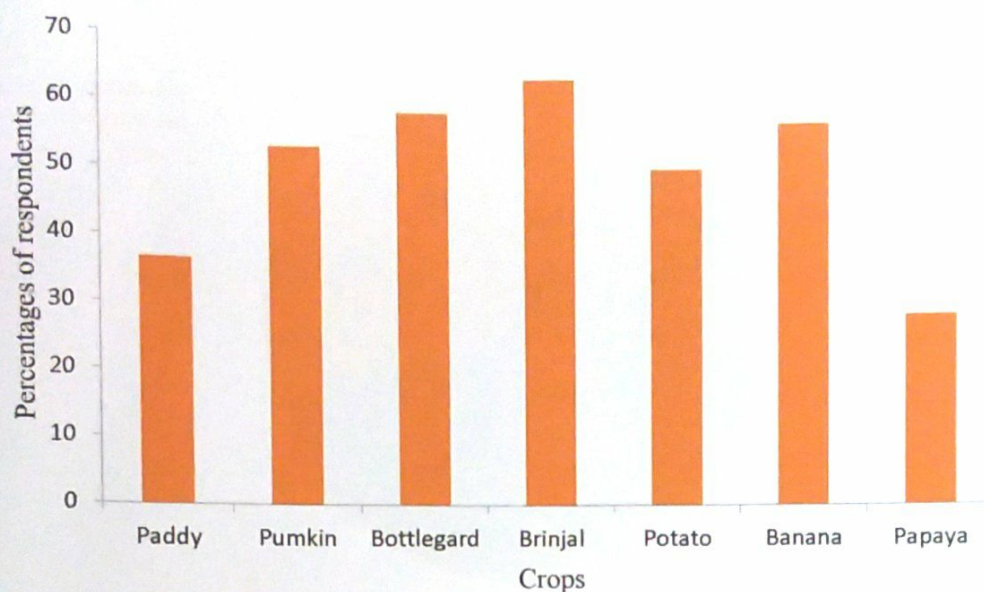


Figure 4. 6 Most Common Seasonal Crops in Agroforestry Practices

This graph is represented the individual percentages of the most seasonal crops. There are some common seasonal crops production practices found in the study areas like Brinjal, Bottlegard, and Banana etc. Among different seasonal crops Brinjal is found the top most seasonal crop practiced by respondents around 63%. Bottlegard (58%), Banana (57%) and Pumkin (53%) have also practiced. Papaya only about the 28% respondents have as a seasonal crops.

4.7 Proportion of Income Related to Agroforestry and Non Agroforestry

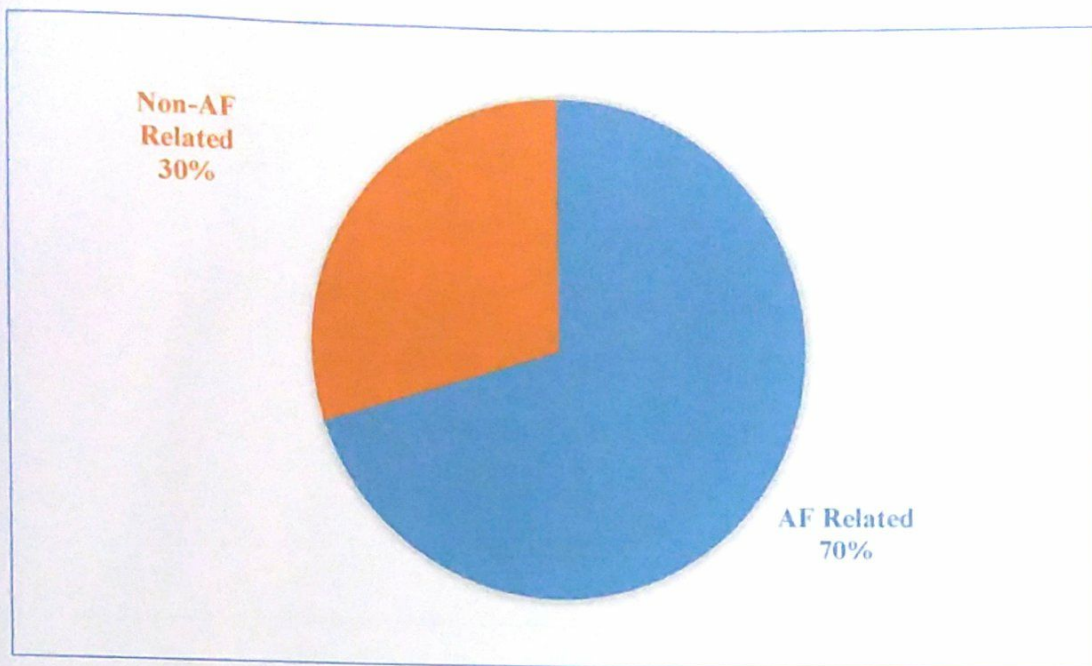


Figure 4. 7 Proportion of Income Related to Agroforestry and Non Agroforestry

This research has calculated the proportion of income related to Agroforestry and Non-agroforestry products. About 70% of the respondents have income from agroforestry and 30% respondents have income from non-agroforestry. From the result it is concluded that Agroforestry is one of the major sectors in income pattern of the respondents.

4.8 Agroforestry Related Cash and Non Cash Income

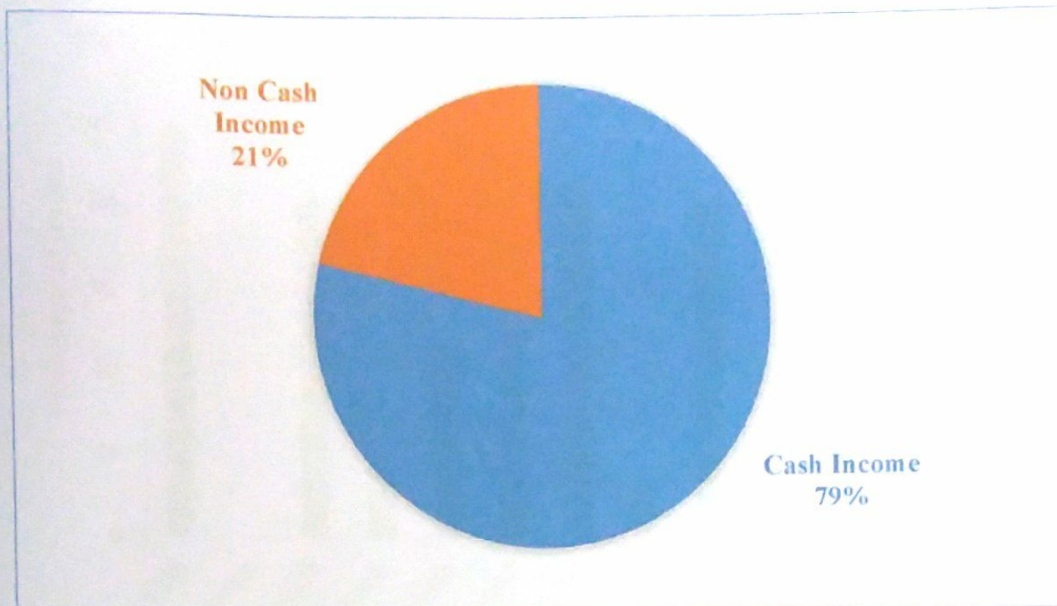


Figure 4. 8 Agroforestry Related Cash and Non Cash Income

The income of the respondents can be segregated into two cluster (such as cash and non-cash). About 79% of the respondents earn from agroforestry through hand cash where only 21% of respondents have non-cash income. Out of income related to agroforestry non-cash income constitutes 21% of the total which is usually not recognized but has very important constitution to the livelihood.

4.9 Income Sources from Agroforestry Products and Services

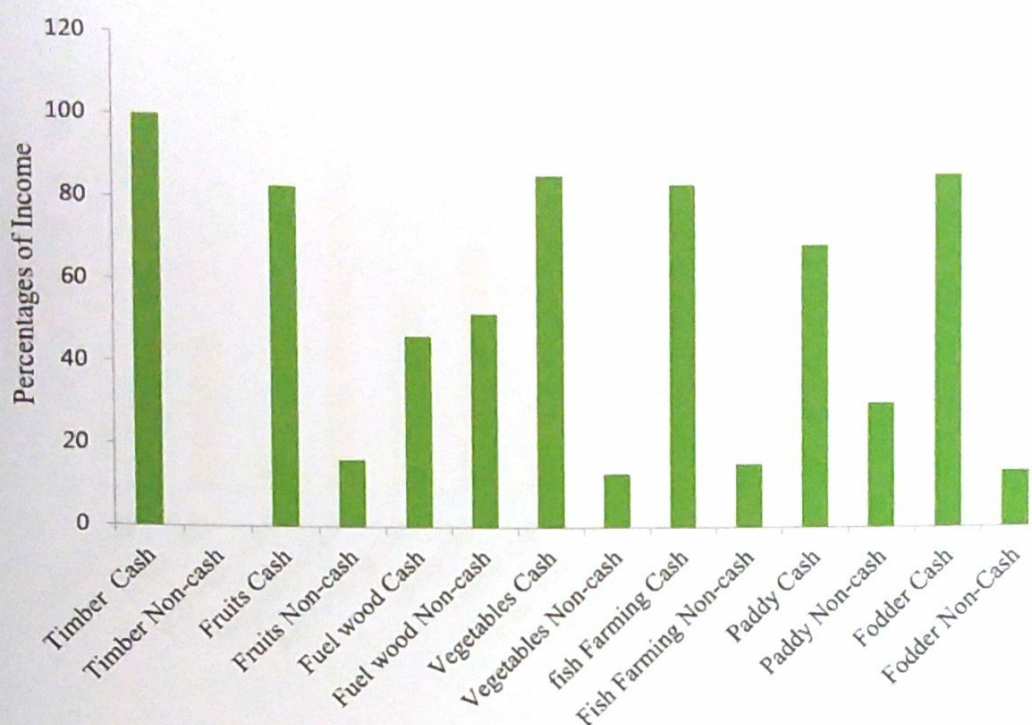


Figure 4. 9 Income Sources from Agroforestry Products and Services

The second objective of this research was to see the cash and non-cash income of the respondents from agroforestry. The cash and non-cash income divided into seven categories of agroforestry products and services. Timber has no non-cash income. On the other hand the other six categories have both cash and non-cash income. Where the fodder cash is the second highest sources of income about 86% of respondents. From non-cash perspectives, vegetables have the lowest percentages of respondents about 13%. However, fuel wood 53% respondents having the most non-cash income and 47% respondents earn cash income from fuel wood. If we compare these income sources we will find that fuel wood has the least difference between cash and non-cash income which means fuel wood is the major income sources of the respondents from agroforestry products and services.

4.10 Proportion of Different Sources of Cash and Non-cash

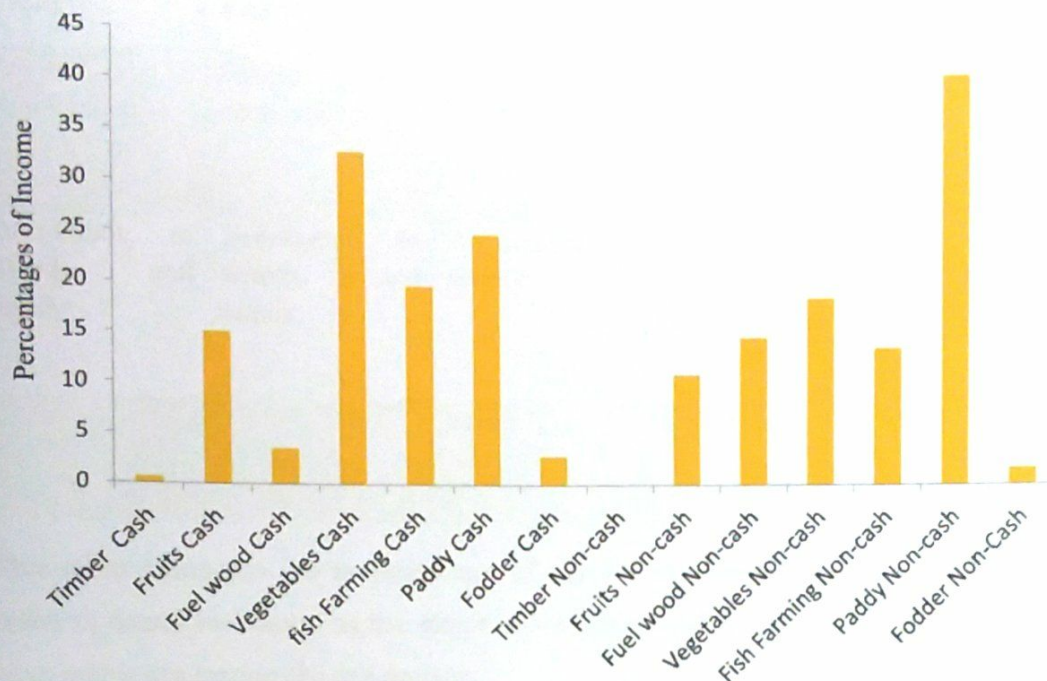


Figure 4. 10 Proportion of Different Sources of Cash and Non-cash

This graph represents the total cash and non-cash income of the respondents from different sources of agroforestry practices. The income is presented as a proportion to income sources. Here we see the cash income total is 100% as well as non-cash income. For the cash income the proportion of income from vegetables is found higher. Paddy is the second source of cash income where fish farming is the third source of cash income. The proportion of these cash sources are 33%, 24%, 20% respectively. On the contrary, paddy is the highest non-cash income source (40%) where vegetables non-cash is the second. We see fuel wood and fish farming have approximately same non-cash income source in the study area. Timber has no non-cash income while timber has the lowest proportion of cash income found in the study areas.

Table 4. 1 Non-cash Use of Agroforestry Product and Services

Fruits	Vegetables	Fuel wood	Fodder	Paddy
Family consumption	Family consumption	Leaves and branches	Cattle consumption	Family consumption
Distribution to friends and family	Distribution to friends and family	Agricultural residue		
		Seeds		

This table represents the non-cash use of agroforestry products and services. This research found fuel wood as the major income sources that means fuel wood should have major use among the respondents.

4.11 Land Holding Basis Cash and Non-cash Income from Agroforestry

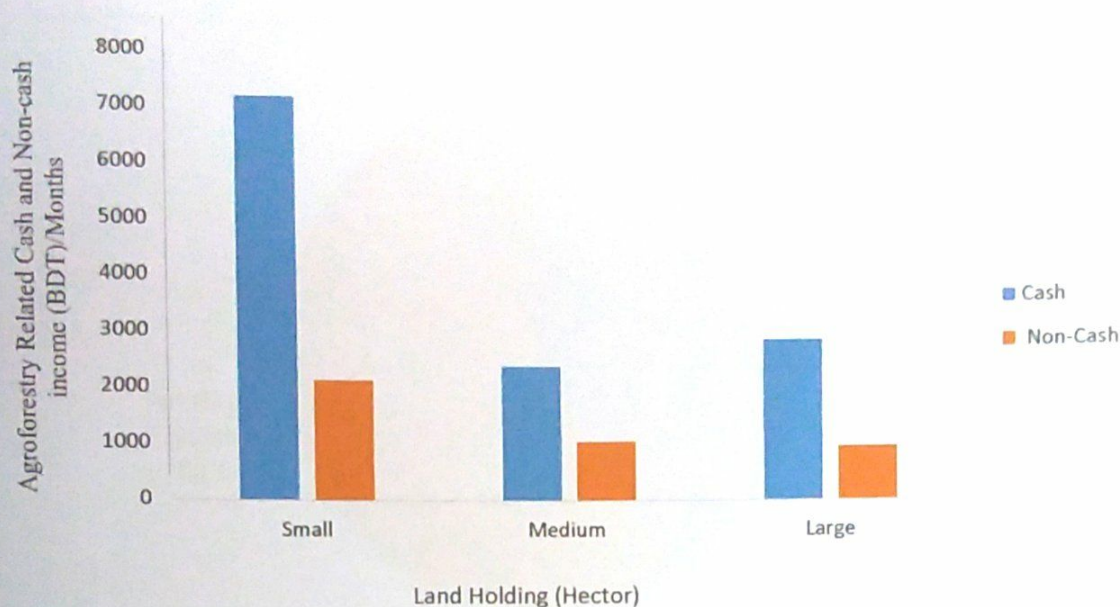


Figure 4. 11 Land Holding Basis Cash and Non-cash Income from Agroforestry

In the above chart land holding basis cash and non-cash income is presented. For first category small land holder which ranges from 0 to 1.9 hectors, the most cash income earned which is 7212.25 taka per months in an average per individual and the non-cash income is equal to 2166.86 taka. For the second category of land holding ranging from 2.0 to 4.9 hectors, cash income is 2415.63 taka and non-cash income is equal to 1057.14 taka. Again, for last category with land above 5 hectors cash income is 2887.5 and non-cash income is equal to 957.14 taka. From the analysis it can be said that for the land holdings ranging from 0-1.9 hectors a major portion of both cash and non-cash income occurs. So there is huge potential for growth within this range.

4.12 Livestock Status of the Respondents

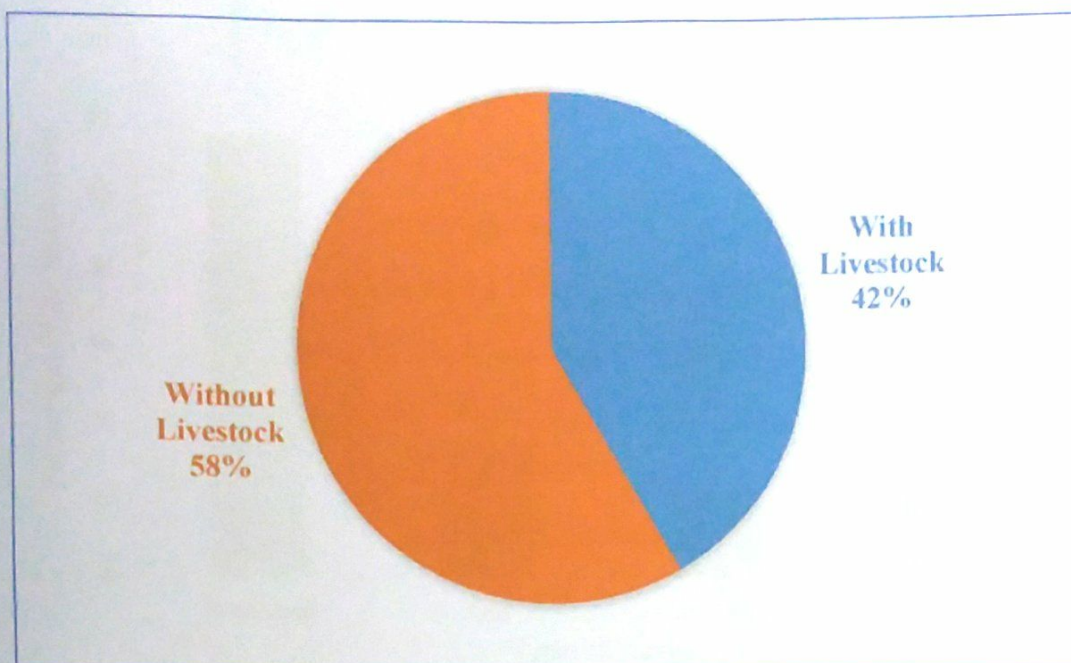


Figure 4. 12 Livestock Status of the Respondents

Agroforestry and livestock rearing are very much interdependent because feedings for the cattle come from the vegetation. This bar chart shows that 42% respondents in the study areas have livestock while 58% respondents don't have that. If managed in an efficient manner, livestock rearing can improve forestry related activities. The manure got from the cattle can be a good source of fertilizer for trees, plants and crops.

4.13 Sources of Cooking Energy

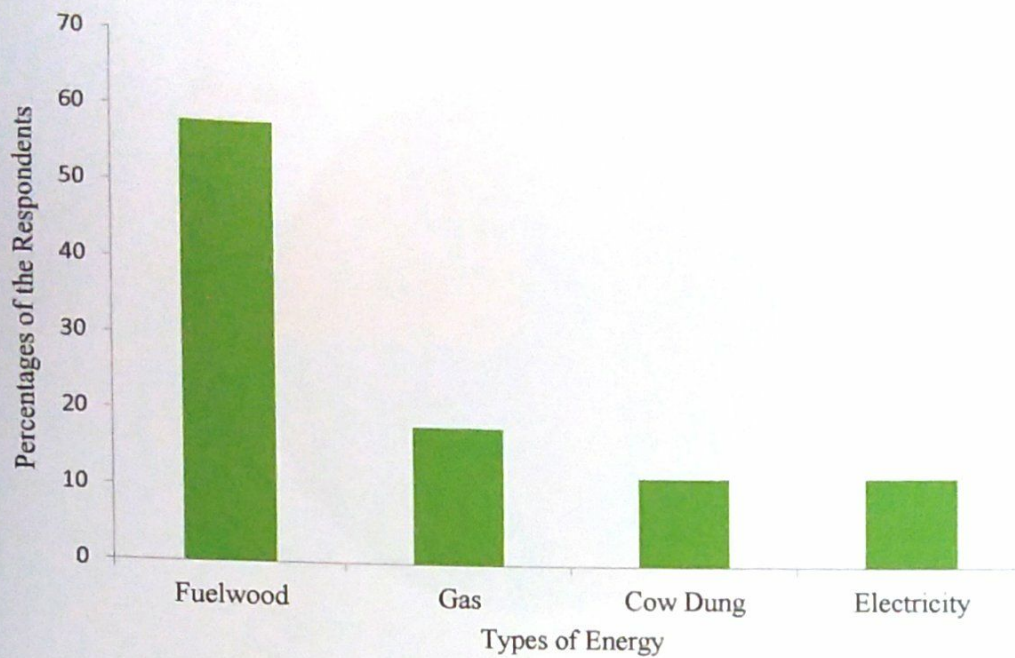


Figure 4. 13 Sources of Cooking Energy

From this research it is seen that fuel wood is the most used source of cooking energy about 58%. About 18% respondents use gas as cooking. Cow dung and electricity's are used by about 12% of respondents individually. So it is concluded that most of the respondents in the study area used fuel wood as a source of cooking energy which is collected from different agroforestry products.

4.14 Sources of Fuel Wood

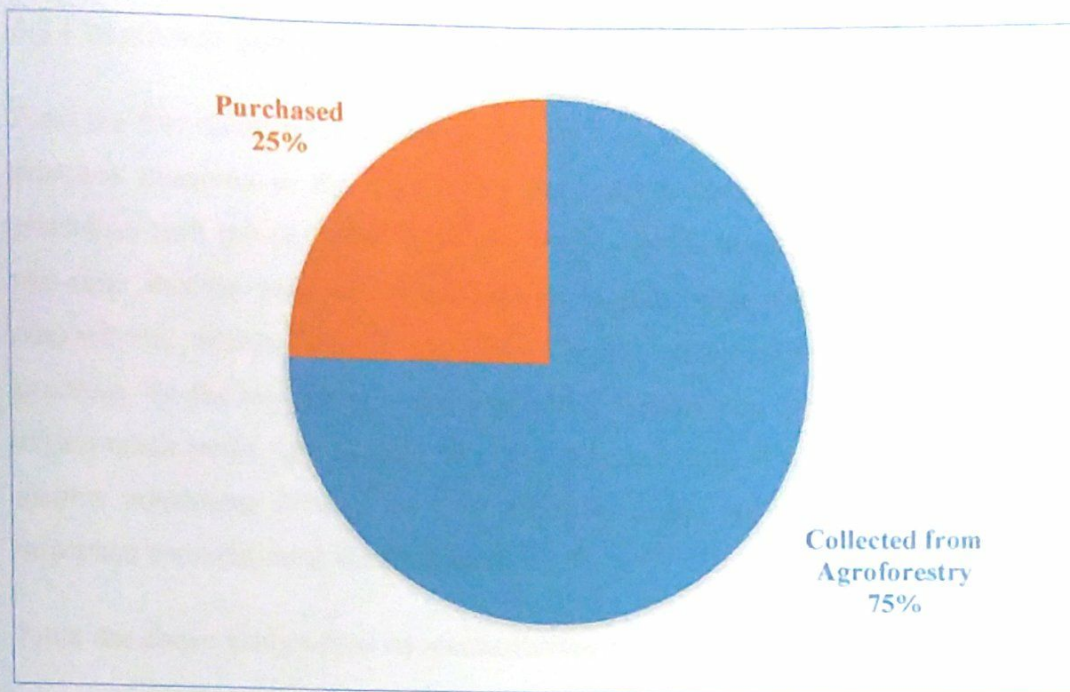


Figure 4. 14 Sources of Fuel Wood

Trees are an importance source of fuel providing fire woods. In the final research finding is the source of fuel wood. About 25% respondents' uses fuel wood by purchasing while 75% respondents collect fuel wood from agroforestry. It contributes to major amount of non-cash income. It is a concern for environment but in economic sense, most of the non-cash income occurs here.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion and Recommendations

From the discussion, it can be concluded that there are different types of agroforestry practices observed in the study areas but most predominant types are boundary plantation with mixed crops. In the study areas agroforestry yield to huge cash and non-cash income both of which help to sustain economic security among the respondents. About 79% of the family cash income comes from agroforestry practices. So the key focus of the respondents is mostly on the cash income as they expect quick profit. On the other hand out of income related to agroforestry non-cash income constitutes 21% of the total which is usually not recognized but has very important constitution to the livelihood.

From the above study below recommendations can be followed-

By practicing different types of agroforestry methods, the respondents could gain moderate increase in their household income. To sustain the livelihood people should be encourage to practice different types of agroforestry in an efficient way.

More detailed study on intangible benefits of agroforestry practices on soil fertility, sustained and improved productivity and socio-economic aspects should be carried out at larger scale.

If the embankments of the *Ghers* are made wider on the space different tree species can be planted which will further contribute to the livelihood of the people.

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APPENDIX: 1

Questionnaire for contribution of Agroforestry to the household income in Satkhira Sadar Upazilla

Date:/...../.....

Respondents' Name.....
Age.....

Village..... Union.....

1. Household information

Family size:and family information:

Age group	Sex		Education	Occupation
	M	F		
<5				
5-10				
10-20				
20-30				
30-40				
40-50				
>50				
Total				

2. Land Holdings (decimal):

Category	Size (decimal)	Tenure	
		Own	Leased
Large farmer			
Medium farmer			
Small farmer			
Marginal			

3. Types of Agro forestry usually practiced

Types of AF	Tick mark	Species/Agroforestry Components
Home garden		
Boundary Plantation with mixed crops		
Aquasilviculture		
Woodlot		
Intercropping		
Others		

4. Agroforestry Tree and Crop Species

Species	Tick mark
Mahogany	
Kathal (Jackfruit)	
Amm (Mango)	
Narikel (Coconut)	
Supari (Batel nut)	
Payeare (Guava)	
Jam (Blackberry)	
Khajur (Date Plam)	
Lebu (Lemon)	
Sissoo	
Sabada	
Bel	
Jamrul	
Tal	
Litchi	
Neem	
Pumpkin	
Ginger	
Paddy	
Turneric	
Corn	
Bottle gourd	
Others	

Sources of Income

AF related								
Source of income	Timber	Fruits	Fuel wood	Fodder	Fish farming	Vegetables	manure	others
Amount in TK/month								
Total income/month								

Non-AF related									
Source of income	Own Agriculture	Agriculture labour	Rickshaw /van	Fish labour	Small business	Motor cycle driver	Day labour	Service	others
Amount in TK/month									
Total income/month									

5. Do you have livestock? Yes / No

If yes, income from livestock-

Name of livestock	Income
Cattle	
Poultry	
Others	

6. Source of energy/ energy consumption-

Types of energy used	Amount/day /week/month	Gathered from AF	Purchased
Fuel wood			
Coal			
Electricity			
Cow dung			
Gas			
Others			

7. Differentiate between cash income and non- cash income

Source of income	Timber	Fruits	Fuel wood	Fodder	vegetables	Manure	Others
Cash income							
Non – cash income							

APPENDIX: 2



Picture 1: Respondent surveyed at Brahma Rajpur



Picture 2: Respondent surveyed at Dhulihar



Picture 3: Respondent surveyed at Fingri



Picture 4: Home garden at Dhulihar



Picture 5: Boundary plantation with mixed crops at Dhulihar



Picture 6: Inter cropping at Brahma Rajpur



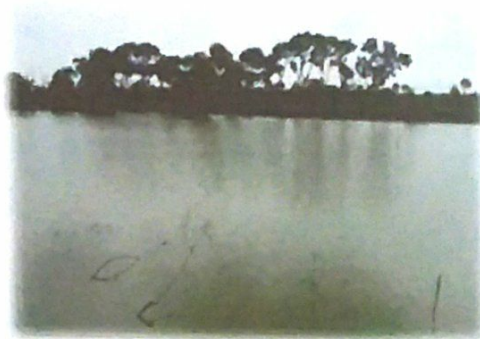
Picture 7: Boundary plantation with mixed crops at Fingri



Picture 8: Inter cropping at Dhulihar



Picture 9: Aquasilviculture at Brahma Rajpur



Picture 10: Aquasilviculture at Fingri



Picture 11: Aquasilviculture at Brahma Rajpur



Picture 12: Aquasilviculture at Brahma Rajpur