



Khulna University
Life Science School
Forestry and Wood Technology Discipline

Author(s): Pallob Kumar Das

Title: Assessment of suitability to plant *Mangifera indica* & *Ziziphus mauritiana* in agroforestry practice in Jessore district

Supervisor(s): Arifa Sharmin, Associate Professor, Forestry and Wood Technology Discipline, Khulna University

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ASSESSMENT OF SUITABILITY TO PLANT *Mangifera*
indica & *Ziziphus mauritiana* IN AGROFORESTRY
PRACTICE IN JESSORE DISTRICT

PALLOB KUMAR DAS

Roll: MS-130503



FORESTRY AND WOOD TECHNOLOGY DISCIPLINE
LIFE SCIENCE SCHOOL
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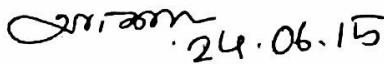
**Assessment of Suitability to Plant *Mangifera indica* & *Ziziphus mauritiana*
in Agroforestry Practice in Jessore District**

***Course Title:* Thesis Work**


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This exposition has been prepared and submitted to Forestry and Wood Technology Discipline, Khulna University for the partial fulfillment of the requirement for the one year professional degree of Master of Science (MS) in Forestry.

Supervisor:


Arifa Sharmin
Associate Professor
Forestry and Wood Technology Discipline
Khulna University
Khulna-9208
Bangladesh.

Prepared By:


Pallob Kumar Das
Student ID: MS.130503
Forestry and Wood Technology Discipline
Khulna University
Khulna-9208
Bangladesh.

DECLARATION

I, Pallob Kumar Das, declare that this thesis is the result of my own effort and extensive work and this work has not previously been accepted in substance for any degree, and that it must not be approached to any other University or Institution to achieve any other degree whether it is accepted by the Board of Examiner or not.

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Date: 24.06.2015

Name of candidate: Pallob Kumar Das.

Dedicated To

MY BELOVED PARENTS AND MY WELL WISHER

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Pallob Kumar Das.

ABSTRACT

The present study describes about farmers' preferences to Plant *Mangifera indica* & *Ziziphus mauritiana* in agroforestry practice in Jessore District. The study was conducted over a period of three month from May 2014 to July 2014 to know which species is best preferable to plant between *Mangifera indica* & *Ziziphus mauritiana* and to identify silvicultural operation and opportunities of *Mangifera indica* & *Ziziphus mauritiana* based agroforestry practice in Jessore district. It was found that majority of the respondents (61%) are directly involved in agriculture and only 39% respondents were involved in other profession. In the study area highest number of the male (48%) and female (42%) are middle aged (21-40 years) and about 100% respondents are male because male are dominant persons and have a good knowledge about their land and cultivation techniques. Otherwise, in agroforestry, directly women participation is zero because they think women are appropriate for household and post harvesting activities. Most of the people both respondents(41%) and respondents family(43%) are completed secondary level of education. The income level was categorised into three types and it was found that 44% respondent have moderately high income (3 lakh - 10 lakh) and about 19% respondents income was about 10 lakh to above taka per year. Among the respondent about 48% use their own land. Because of land scarcity they lease land and have to pay a certain amount of money according to the productivity of land, 33% use leased land with own land to increase farm size and only 19% done only in leased land. The respondents practice Alu, Ada, Lal Sak, Holud, Cucumber, Brinjal, Karolla, Olkochu etc with *Mangifera indica* & *Ziziphus mauritiana*. About 91% of the respondents collect planting materials from their nearby markets and very few are collect from their sed bed. Maximum respondents (93%) are continuing some types of ground operation like weeding, vacancy filling, other types of soil workings. The respondents (100%) practiced agroforestry with *Mangifera indica* & *Ziziphus mauritiana* mainly for cash generation. According to likert scale it was found that at present the respondent prefer *Mangifera indica* more rather than *Ziziphus mauritiana* because *Ziziphus mauritiana* plantation created low production in last two years for insect attack and high rate of mortality.

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CHAPTER - ONE

INTRODUCTION

1.1. Background & Justifications Of The Study:

Agroforestry is the art and science of growing woody and non-woody together on the same unit of land for range of benefits. Agroforestry is one of the important sustainable land management techniques, involving a combination of different agricultural, horticultural, forestry and livestock practices. Sometimes it is closely related to community forestry and homestead forestry (Hasanuzzaman, 2009). It is a form of multiple cropping which satisfies three basic conditions: 1) there exists at least two plant species that interact biologically, 2) at least one of the plant species is a woody perennial and 3) at least one of the plant species is managed for forage, annual or perennial crop production (Somarriba, 1992). This practice is considered as one of the major strategies for sustainable forest management as well as poverty reduction in Bangladesh, where there is obvious priority for food crop production. It may not only be an optimal solution for afforestation, species diversity conservation and the sustainability of environment but also quite good economic rates of return (Alam, M, K, et.al. 1996).

The agroforestry not only helps to increase food and fodder but also create employment opportunity where unemployed and poor people rush to earn their livelihoods. Agroforestry helps to lift rural poor from poverty through market driven, locally led tree cultivation systems with annual crops that generate income and build assets. The practice is appropriate for poor farmers because they can get immediate returns from agricultural crops and accrue long term benefits from trees (Ali and Ahmed, 1993). The poor people have very limited scope of alternative production system or other income generating sources to recover the failure of one system. But agroforestry is an easy approach from that point of view and hence it is a sustainable poverty alleviation tool. Besides women's involvement in agroforestry practices also facilitate the economic development of Bangladesh.

In Bangladesh there are many types of agroforestry practices and one of them is fruit based Agroforestry which practiced in many part in our country. In this type of practice farmers faced a problem that is preference of best fruit tree. Because it may be happened that the crown diameter of the selected tree is extra large and as a result the sun light cannot reached on the annual crops. Sometimes the volume of roots can be too large which hampered nutrition uptake of annual crops from soil. It is also important to know the nutrients contents of leaves of the selective tree

because of the fallen leaves can increase soil fertility that can improve production of annual crops. In this sense *Mangifera indica* & *Ziziphus mauritiana* can be a good suitable species for fruit based agroforestry practices. They have a good position in respect of nutritional quality, taste, consumer's preference etc., among the fifty kinds of fruits which are usually grown in Bangladesh (Ahmad, 1985).

Mango trees (*Mangifera indica* L.) belong to the plant family Anacardiaceae and originated in South-East Asia. Mangos have been cultivated in India for more than 4000 years, mainly for the tasteful and nutritious fruit (Bally et al. 2009). Mango trees have a relatively high growth rate; they may grow 2 m in height the first year. Once the trees start to produce fruits (after 2-4 years) their growth rate slows (Bally, 2006). Wild trees can reach 30 m, and have a crown width of 30-38 m in favourable forest conditions. Cultivated trees usually reach 3-10 m in height at maturity.

Ziziphus mauritiana is a medium sized tree that grows vigorously and has a rapidly developing taproot, a necessary adaptation to drought conditions. The species varies widely in height, from a bushy shrub 1.5 to 2 m tall, to a tree 10 to 12 m tall with a trunk diameter of about 30 cm. *Z. mauritiana* may be erect or wide-spreading, with gracefully drooping thorny branches, zigzag branchlets, thornless or set with short, sharp straight or hooked spines. The leaves are alternate, ovate or oblong elliptic with rounded apex, with 3 depressed longitudinal veins at the base. The leaves are about 2.5 to 3.2 cm long and 1.8 to 3.8 cm wide having fine tooth at margin. It is dark-green and glossy on the upper side and pubescent and pale-green to grey-green on the lower side. (ISSG, 2009).

These two species are grow in all parts of Bangladesh. At present people cultivated *Mangifera indica* & *Ziziphus mauritiana* with combination of annual crops. So in these situation, it has become imperative to institute a study to know farmer's best preference between *Mangifera indica* & *Ziziphus mauritiana*.

1.2. Objectives Of The Study:

The objectives of the study are given below-

- To know the suitability to plant *Mangifera indica* & *Ziziphus mauritiana* with agricultural crops according to farmer's perception in Jessore district.
- To identify benefits and opportunities of *Mangifera indica* & *Ziziphus mauritiana* based agroforestry practice in Jessore district.

CHAPTER -TWO

LITERATURE REVIEW

2.1 History Of Agroforestry:

Agroforestry combines agriculture and forestry techniques to create more integrated, diverse, productive, profitable, healthy and sustainable land-use systems with the direct integration of trees into the cropping system (Ahmed and Rahman, 2004). Agroforestry has been practiced by the farmer for a very long time by applying low level of technology where monocropping system is not profitable. The term "agroforestry" is not familiar with farmers and was primarily developed for the tropical regions where existing climatic conditions are mostly harsh and be inclined not to support conventional cropping systems (Gordon *et al*, 1997).

Cultivating trees and agricultural crops in intimate combination with one another is an ancient practice that farmers have used throughout the world. This "farming system" is no longer popular in Europe, but was widely practiced in Finland up to the end of the last century, and was being practiced in a few areas in Germany as late as the 1920s. In tropical America many societies have simulated forest conditions to obtain the beneficial effects of the forest ecosystem. In Asia, the Hanunoo of the Philippines practiced a complex and somewhat sophisticated type of "shifting" cultivation. In clearing the forest for agricultural use, they deliberately spared certain trees which, by the end of the rice-growing season, provided a partial canopy of new foliage to prevent excessive exposure of the soil to the sun. Similar farming systems have also been common in many other parts of the humid lowland tropics of Asia. The situation was little different in Africa. In southern Nigeria, yams, maize, pumpkins and beans were typically grown together under a cover of scattered trees. However agroforestry the integration of trees with annual crop cultivation, livestock production and other farm activities – is a series of land management approaches practiced by more than 1.2 billion people worldwide. Integration increases farm productivity when the various components occupy complementary niches and their associations are managed effectively (Steffan-Dewenter *et al.*, 2007).

In Bangladesh the climate, soil quality, topography, socio-economic condition of the people etc. are very much favourable for the agroforestry practices. Moreover agroforestry provides intermediate returns for the people, retain fertility of soil, allows both short and long rotation crops on the same piece of land and improves quality of the crops. Increases production, avoid losses, changes the product form etc. Besides the creation of new job opportunities, better

Chapter - Two: Literature Review

nutrition facilities, environmental benefits etc. intangible benefits influence the adaptation of agroforestry in the country. Moreover, the following factors influence the adaptation of agroforestry in Bangladesh (Huque,1993):

- The forest cover in the country is being depleted at the rate of about 10-15 thousand hectares per year.
- The scope of allocating more Government land for forestry is extremely limited.
- Per capita land in the country is very small and this is being reduced with the growth of population.
- More and more land is being diverted to non-agricultural and non-forestry activities.
- Agroforestry can stop further degradation of the forest by maximizing the production and income.
- It can meet the multidimensional of the rural people for food, fuel, timber, construction materials, agricultural implements etc.
- Agroforestry can improve the economic condition and the social status of the rural people.
- It can help the rural poor into self-sustained life style.

2.2 Definitions And Concept Of Agroforestry:

Agroforestry is the art and science of growing woody and non-woody together on the same unit of land for range of benefits. Agroforestry is the use of land for a combination of agriculture and forestry. In other word, the practice of growing tree crops or some other fast growing trees along with the main crops. Agroforestry is one of the important sustainable land management techniques, involving a combination of different agricultural, horticultural, forestry and livestock practices. Sometimes it is closely related to community forestry and homestead forestry (Hasanuzzaman, 2009).

According to Nair (1990), agroforestry is a land-use system that involves socially and ecologically acceptable integration of trees with agricultural crops and/or animals, simultaneously or sequentially, to get increased total productivity of plant and animal in a sustainable manner from a unit of farmland, especially under conditions of low level of technological inputs and marginal lands.

Chapter - Two: Literature Review

Agroforestry is a form of multiple cropping which satisfies three basic conditions: 1) there exists at least two plant species that interact biologically, 2) at least one of the plant species is a woody perennial and 3) at least one of the plant species is managed for forage, annual or perennial crop production (Somarriba, 1992).

Agroforestry is a collective name for land use systems involving trees combined with crops and/or animals on the same unit of land, Further, it:

- Combines production of multiple outputs with protection of resource base;
- Places emphasis on the use of multiple indigenous trees and shrubs;
- Involves the interplay of socio- cultural values more than in most other land use systems; and
- Is structurally and functionally more complex than monoculture. (Kenneth and Napoleon, 1990).

2.3 Characteristics Of Agroforestry:

- Various plant components, at least one of which must be perennial. Components of the system either economical/ ecological.
- A great interaction (economic and bio physical) between the woody and non woody components.
- Provide products, often of different categories(i.e. food, fuel, fodder)
- The cycle of an agroforestry system is always more than one year.
- The most simple agroforestry system is more complex, ecological, and economically than a monoculture system. (Hasanuzzaman, 2009).

2.4 Components Of Agroforestry:

Depending on the nature and type of components involved, agro forestry system can be classified as agrisilvicultural (tree + crops), silvopastoral (tree + pasture and /or livestock) and agrosilvopastoral (all three types of components).

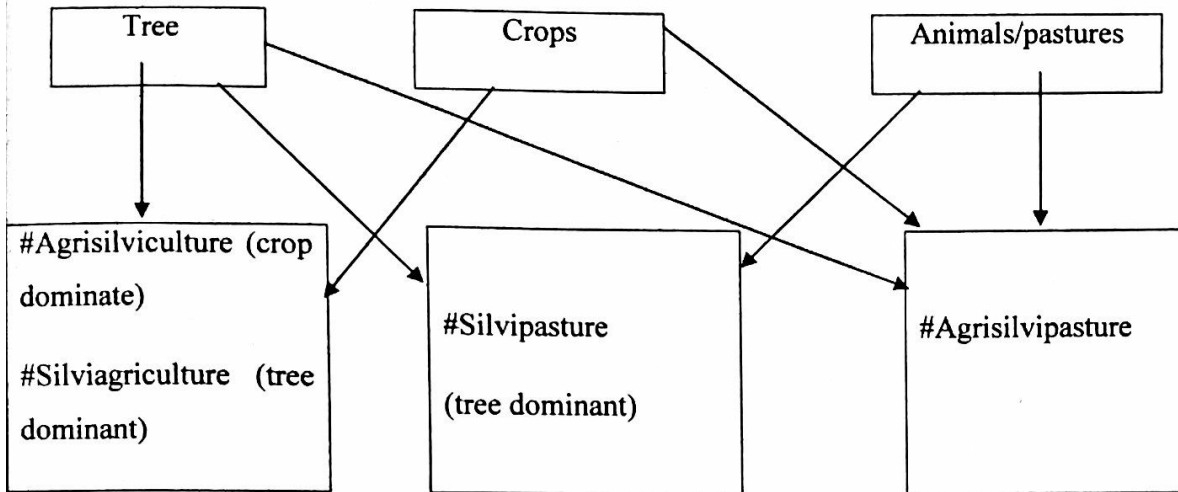


Fig. 2.1: Components of Agroforestry.

2.5 Classification Of Agroforestry:

Arrangements of different types of crops, e.g. animals' perennials, trees etc. and the level of interaction between different components are distinct for individual agroforestry system. One system differs from others in respect of structure, composition, age, intensity technology, inputs etc. (Dwivedi, 1992). It is difficult to work out anyone system of classification of agroforestry systems capable of meeting most of the requirements. The system can be grouped, based on anyone factor or function of the farming system.

Nair classified the agroforestry system based on structure, function, socio-economic and ecological status. The agroforestry system can be classified based on the following factors:

- i. Structure
- ii. Function
- iii. Socio-economic factors
- iv. Utility of land (Haque,1996).

The classification of agroforestry is described below:

2.5.1 Structural Classification:

Structure refers to composition, stratification and dimension of crops. On the basis of composition the agroforestry systems are classified as:

Chapter - Two: Literature Review

- i. Agrosilvocultural system
- ii. Agrosilvopastur
- iii. Silvopastural system
- iv. Multipurpose tree plantation system.

2.5.2 Functional Classification:

From agriculture practice we get employment opportunity, livelihood, food, nutritional and ecological securities. Today our economy is based on mainly in the field of agriculture, for achieving rapid progress in rural area, our strategy must focus on; conserving natural resources, enhancing efficient of resource use, increasing productivity and profitability and improving quality and competitiveness through reduced unit cost of production. Integrated plant nutrients and protection systems of crop, livestock and aquaculture production are being updated for various agro-ecologies. Based on various functions the agroforestry system is classified into following systems-

- Productive agroforestry system
- Protective agroforestry system
- Multipurpose agroforestry system (Haque, 1996)

2.5.3 Socio-economic Classification:

Based on socio-economic considerations, the agroforestry system is grouped into:

- i. Subsistence agroforestry system
- ii. Commercial agroforestry system
- iii. Intermediate agroforestry system (Haque, 1996).

2.5.4 Classification Based on Utilization of Land:

Based on utilization of land, the agroforestry production systems are sometimes classed into the following categories:

- i). Homestead agroforestry
- ii). Forestland agroforestry
- iii). Crop-farm forestry
- iv). Fish-farm forestry/Gherland Agroforestry
- v). Animal-farm forestry
- vi). Integrated farm forestry
- vii). Road side agroforestry
- viii). public place forestation/agroforestry (Haque, 1996).

Whichever classification scheme is most appropriate in a given moment depends upon the purpose of the user.

2.6. Agroforestry Practice With *Mangifera indica*:

Mangifera indica based agroforestry is a very popular practice in many part of Bangladesh. *Mangifera indica* L. is one of the most common, important and popular fruits in Bangladesh. It is considered as the "king of fruits". Besides, having delicious taste, captivating flavor with multifarious color, it is an excellent source of nutritive values.

2.6.1. Scientific Classifications:

Kingdom: Plantae
Division: Tracheophyta
Class: Magnoliopsida
SubClass: Rosidae
Order: Sapindales
Family: Anacardiaceae
Genus: *Mangifera*
Species: *Mangifera indica* L.



Pic-2.1: *Mangifera indica* species in the study area.

2.6.2. Botanic Description:

Mango trees have different types of canopies, according to the propagation type, density, type of variety and eco-geographical conditions. Some varieties, such as "Latra", are considered to have a creeper-growth habit because of its spreading nature. The biggest mango tree in the world is found in India and has a spreading crown of 36.6 x 45.7 m. When trees are propagated by seed they develop a sympodially branched appearance according to the Scarron's model, while grafted trees tend to be shorter. The tree height can reach 8-35 m, depending on cultivar, climate, soil type and rootstock (Human, 2008).

The root system of mango trees is composed of a taproot about 6-8 m deep, superficial feeder-roots and fibrous anchor roots. Sometimes feeder-roots can develop above the water table and fibrous roots may extend away from the drip line. This effective root system can reach 7.5 m to the lateral side and 1.2 m depth in 18 years or older plants in well drained soil (Anonymous, 2008). The volume of feeder roots of mango varies during the annual cycle, with the majority of

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root development occurring during the wet periods of the year and declining during the dry periods. Root growth is periodical, slowing or stopping throughout major canopy growth periods (Bally, 2006).

Characteristic leaf shapes include entire, leathery, short, pointed and oblong to lanceolate leaves. The length is about 450 mm. Differences are due to varietal variation, climate, cultural practises and growth stages. Young leaves from different varieties can present different colours. This can vary from copper-red to purplish in colour. At maturity the leaf colour changes to dark green and usually smells like turpentine (Fivaz, 2008).

The mango inflorescence is primarily terminal on a panicle (Bally, 2006). Inflorescence colour ranges from yellow to light green with crimson patches or with crimson flushes on branches. The number of panicles per plant ranges from 600-6000 and the number of flowers per panicle varies from 200-4 000. The majority of flowers open between 9-11 am and the receptivity of the stigma occur about 72 h after anthesis (Genu and Pinto, 2002). The greenish-white or pinkish flowers are borne in inflorescences usually located on current or previous year's growth. Male flowers usually outnumber the bisexual or perfect flowers. The hermaphroditic flowers have a shiny, green, globous, superior ovary with an anatropic ovule and a style with a single lobe (Griesbach, 2003).

Mango fruit of the different cultivars varies in shape, size, appearance and internal characteristics. The fruit is a fleshy drupe, varying in size from 2.5-30 cm long, may be kidney-shaped, ovate or round and weigh from approximately 200 g to over 2 000 g. The leathery skin is waxy and smooth and when ripe entirely pale green or yellow marked with red, depending on the cultivar (Griesbach, 2003).



Pic-2.2: Mango fruit.

2.6.3. Ecology and distribution:

2.6.3.1. History of Cultivation:

The cultivated mango probably originated in Indo-Burma, notably the Assam-Chittagong Hills, where many mango wild relatives still grow, but its progenitors are not known. The mango has been cultivated in India for several millennia; it spread to other parts of Southeast Asia about 1500 years ago, and to the east coast of Africa about 1000 years ago. Further spread to Australia, East Africa and the Americas has been within the last few hundred years. Today the production areas for mango fruits can be grouped into different groups viz. Florida (USA), Mexico, Central America, West Indies (Caribbean islands), South America, Africa/Arabian Peninsula, Indian subcontinent and Indochina (China/Indonesia/Pacific) (Anonymous, 2008).

2.6.3.2. Mango Production Area in Bangladesh:

The main mango growing regions are around Rajshahi, Chapainawabganj, Nawabganj, and Dinajpur. The better varieties of mangoes have exotic names like Fazlee, Langda, Gopalbogh, Himsagar, Khirsapat, Ashhwina, Khisanbogh, Kuapahadi, Lata Bombai, Foria, Bombai, Kohitoor, Laksmambhog, Mohanbhog, Misribhog etc. Each has its distinctive flavor and arguments about the superiority of one over the other can get very serious. Though these are table varieties, meant to be relished as cut fruit, there are others that are used for making jam, jelly, squash, chutney, and pickle. The raw green mango is even added to a dal or curry to enhance the flavor.

Once only Chapainawabganj was famous for growing mangoes, but huge mangoes are also produced in Rajshahi district. There are over 270 varieties of sweet edible mangoes in the Rajshahi region alone. Newer groves are being set up and high-quality fruit trees have been planted along the boundaries of the paddy fields.

December to February is when the mango trees blossom. These grafted mango plants quickly start bearing blossoms only a year or two after the planting. Mango growers try hard to nurture and support their young trees during this period. If all goes well at this time of the year the growers can expect a bumper crop of mangoes.

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Mango is the leading seasonal cash crop of the northwestern region of Bangladesh and dominates the economy in Rajshahi and Chapainawabganj districts. There is no large industry here. Most of the people are employed for different jobs on the orchards such as nursing, harvesting and packing mangoes for transportation during the season every year.

2.6.4. Reproductive Biology:

Individual trees often flower irregularly; some trees do not flower for periods of 10-20 years, sometimes even longer. Flowering starts at the beginning of the rainy season and fruits ripen at the end of the rainy season. Bisexual and male flowers appear on the same cluster, in proportions that vary from 1:4 to 2:1. Evidence from various countries shows that some cultivars develop fruit without fertilization but that others need cross-pollination; the determining factors are not yet well understood. Pollinators are nectarivorous bats and insects such as flies, ants and possibly thrips, but bees are the most effective. Rain and high humidity at blossoming reduce pollination and fruit setting. Usually only small proportions of the flowers develop into fruit. Hermaphrodite flowers are predominantly outcrossing and exhibit protogynous dichogamy, but trees are generally self-compatible, and self-fertilization by pollen from the same flower is possible. It has been shown that 65-85% of hermaphrodite flowers remain unpollinated and that only 0.1-0.25% of them reach the harvesting stage, with fruit drop occurring at all stages. The time of development after fertilization to maturity of fruit is 2-5 months, depending on the cultivar and temperature. Fruiting is often biennial; some cultivars, in addition to the main fruiting seasons, set a few fruits throughout the year. The fruits are eaten and dispersed by bats, hornbills, porcupines, monkeys, elephants and humans (Griesbach, 2003).

2.6.5. Management and Propagation:

2.6.5.1. Climate:

The climate of a place is dependent on its latitudes, altitude, temperature and rainfall. Mangoes are grown commercially within an area roughly 30 degree north to 30 degree south latitude. Bangladesh is situated between 20.5 degree to 26.5 degree north latitude. The mango is in general a tropical fruit that grows in the sub-tropical zone too and grows up to an altitude of 4600 feet (1400m) provided there is no high humidity, rain or frost during the flowering period . So,

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the range of latitude and altitude in Bangladesh is basically good for mango. It does well within a temperature range from 24 to 27 degree centigrade. Bangladesh's overall mean annual temperature of 18 to 30 degree centigrade, which is quite good for mango production. The amount of rainfall is not so important factor as its intensity and distribution. It can do well in areas having an average rainfall as low as 25 cm to as high as 250 cm. The period of preceding flowering needs to be dry in order to induce flowering in the absence of chilling temperature.

2.6.5.2. Soil:

Mangoes can be grown on a wide range of soil type, but well drainage deep, fertile loamy soil of high to medium high land is best. pH 5.5-7.5 and water table below 180 cm around the year.

2.6.5.3. Land preparation:

Mango plantation are made on the selected site after cleaning the land of all wild growth, weeds etc. The seedling/sapling are planted generally during the rains in pit made well-leveled areas.

2.6.5.4. Planting system:

Square or rectangular for plain land and contour system for hilly areas. One year old seedling obtained through vegetative propagation that are strong, stout, and free from any diseases should be planted.



Pic-2.3: Plantation of *Mangifera indica* in the study area.

2.6.5.5. Variety:

The mangoes of Bangladesh belong mainly to two groups viz: 1. The elite mango varieties propagated through grafting and other vegetative means. Locally known as "Kalam Aam" and 2. Fruits are born by seedling trees locally known as "Guti Aam". Some of the common varieties grown in Bangladesh are listed below:

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➤ **Early variety**

The varieties which can be harvested within mid May to mid June. E.g, Gopalbhog, Himsagor, Khirsapat, Brindabani.

➤ **Mid-season varieties:**

The varieties which can be harvested within mid- June to late-June, e g. Lengra, Misribhog, Krisanbhog, Kohitoor, Lakhanbhog, Daseri.

➤ **Late varieties:**

The varieties which can be harvested within July to mid-August , e.g. Fazli, Ashawina, Kuapahari, Mohanbhog, Chausa.

➤ **Regular bearing varieties:**

Neelum, Mollika(Neelum*Daseri)Amropali.

2.6.5.6. Propagation:

Mango can be raised from seed or vegetatively propagated. Seed propagation is now restricted to raising rootstocks, which are not true to type. To raise rootstock , freshly extracted stones from mature and ripe fruits are sown in beds in lines. These seedlings remain there for a year. When they attain a suitable thickness and height they are propagated asexually by side or veneer either in beds or shifted to a suitable sized earthen or polythene bags and grafted by inarching.

2.6.5.7. Time of planting:

Mid May to mid-July is the best period for planting and mid-August to mid-October is also good.

2.6.5.8. Distance:

Planting distance depends upon soil, variety, climate and system of orchard management. However under good management the planting distance for tall varieties 10-12 meters and the dwarf varieties require only 2.5 to 3 meters between the plants and rows 8-10 meters. Size of pit should be 1.0 mX1.0 mX1.0 m.

2.6.5.10. Seedlings planting:

Seedlings should be planted with the soil ball intact at middle of the pit straightly after 10-15 days of filling the pit. After planting, the seedling should be provided with proper fencing, sticks etc.

2.6.5.11. Fertilizer application:

Table-2.1: Yearly recommended fertilizers for mature and fruiting trees are:

Manures/Fertilizers	Amount per plant
Organic manure	50.0 kg
Urea	2.0 kg
TSP	1.0 kg
MP	500 g
Gypsum	500 g
Zinc sulphate	25 g

The fertilizers should be applied into two equal split: one in mid-May to mid-July and other in mid-September to mid-October.

2.6.5.12. Irrigation:

Frequent irrigation is needed for fast growth of seedlings. The need for irrigation will arise during the drier part of the year from November to April and lesser in summer (May-June). In the bearing trees, once irrigation at the later part of flowering and once irrigation at fruit setting stage (when the fruits are in a pea stage) will be needed. Basin system is best for irrigation.

2.6.5.13. Pruning:

Mango has no specific pruning schedule, except when trees are young to give them a good shape. All side shoots should be pruned upto a height of 1.0-1.5 m of the main stem. All the inflorescences should also be pruned upto 4 years of the seedlings age.

2.6.5.14. Intercultural operation:

Intercultural operation of the mango orchard is necessary not only to remove the weeds which compete for water and nutrients but also to ensure aeration which is essential for the proper development root and shoot. Intercultural operation may help in reducing the pest population by killing them physically.

2.6.5.15. Maturity indices:

Appearances of wax coating, dots on the fruits, relative size of the fruits are some of the external appearances of the fruits which indicate maturity. However some ripened fruits when start dropping, it is said that maturity of that particular variety is reached.

2.6.5.16. Harvesting:

Mango fruits are rarely allowed to ripen on trees. Fruits may be harvested at the time when they show a slight yellowish color around the fruit stalk or when the specific gravity reaches 1.01 to 1.02 or when naturally one or two ripe fruits start dropping from the plant. Mango should be harvested without any injury. Generally fruits with stalk intact are harvested by hand or with the help of a bag affixed on along pole from the tall trees.

2.6.5.17. Yield:

The yield of mango varies with the variety, productivity of flowering, growing condition influencing the size of the plants etc. The young trees, in the beginning, bear 15 to 20 fruits per year which increases to an average of 400 to 600 fruits in the 10th year and to 2500-5000 fruits per tree after 20th year. The average fruit production in Bangladesh is 4.76 t/ha which is quite low compared to India (8-10 t/ha) as well as to the world production of 14-16 t/ha.

2.6.6. Functional uses:

2.6.6.1. Products:

- **Food:** Mango is cultivated for the fruit, which can be eaten in 3 distinct ways, depending largely on the cultivar: unripe (mature green, very popular in Thailand and the Philippines), ripe (the common way to enjoy mango throughout the world), and processed (at various stages of maturity, in the form of pickles or chutneys, dried slices, canned slices in syrup, juice and puree or paste). The fruit is surrounded by golden, juicy flesh, rich in vitamins A and C Nanjundaswamy (1991).
- **Fodder:** Mango leaves are occasionally fed to cattle, but large quantities can cause death. Seed kernels are a byproduct of processing; they can be used as feed for cattle and poultry.
- **Apiculture:** *M. indica* is an important honey plant, secreting large quantities of nectar.

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- Fuel: With a calorific value of 4200 kcal/kg, the wood makes excellent charcoal and firewood.
- Timber: Heartwood is pale yellowish-brown to reddish-brown, darkening on exposure, not clearly demarcated from the pale yellowish-brown sapwood. Grain somewhat wavy, texture moderately coarse; freshly cut wood is scentless. The wood is used for many purposes, including indoor construction, meat-chopping blocks, furniture, carpentry, flooring, boxes, crates and boat building (canoes and dugouts).
- Tannin or dyestuff: Bark is the source of a yellowish-brown dye used for silk. Poison: In sensitive individuals, ingestion of the fruit or skin contact with the juice may cause a rash like that of poison ivy.
- Medicine: Charred and pulverized leaves make a plaster to remove warts and also act as a styptic. Seeds are used to treat stubborn colds and coughs, obstinate diarrhoea and bleeding piles. The bark is astringent, homeostatic and antirheumatic.

2.6.6.2. Services:

- Shade or shelter: Its umbrella-shaped crown makes the mango tree a suitable shade for people and their livestock; it also acts as a firebreak.
- Soil improver: Mango leaves improve soil fertility when used as mulch for crops.
- Intercropping: Young mango is often interplanted with other fruits and vegetables, and the tree is a valued component of the traditional homegarden agroforestry

2.6.7. Pest and Diseases:

Mango trees may be infested with several pests and diseases caused by fungi and bacteria. Reports indicate that there are 492 species of harmful insects, including grasshoppers, mealy bug, inflorescence midge, fruit fly, scale insect, shoot borer, leaf webber and stone weevil. Apart from these pests there are 17 species of mites and 26 species of nematodes that can attack mango trees. Some of these pests cause injuries during flowering and fruiting, resulting in high production losses. Other pests like aphids and termites not mentioned here, are considered to be minor pests on mango (Anonymous, 2008).

Anthraxnose (*Glomerella cingulata*, conidial stage *Colletotrichum gloeosporioides*) distorts and turns developing leaves black and disfigures developing fruit. The fungal infection may spread to

fresh young growth. It can be controlled with bimonthly applications of copper spray or captan as a growth flush begins and until the flowers open; spraying is resumed when the fruit begins to form. The flower panicles, young fruit and leaves are subject to powdery mildew (*Oidium mangiferae*), especially in rainy weather or frequent fog. A spray of powdered kelp at bud break will often control it. Sodium bicarbonate and fungicide sprays are also effective. Other diseases include the flower malformation caused by *Fusarium moniliforme* and spread by mites, and bacterial canker, which is becoming a pressing disease problem. A mealybug, *Rastrococcus invadens*, has recently invaded Africa, where it causes serious damage to mango and other crops. In the greenhouse, thrips often turn leaves rusty brown. Malathion is the conventional spray for insect pests; sulphur works on mites. A long-horn beetle (*Rhytidodera simulans*) bores into the trunk and thick branches; branches may be killed but the whole tree retains its viability. The larvae of the mango weevil (*Cryptorhynchus mangiferae*) feed on the pulp and damage the fruit. Control of this pest through field sanitation is required but is labour-intensive. Chemical control can be done through some insecticides such as organophosphate or fenthion that reduce infestation to $\leq 17\%$ (Pena and Mohyuddin, 1997).

2.7. Agroforestry Practice With *Ziziphus mauritiana*:

Ziziphus mauritiana based agroforestry is a more common practice in many part of Bangladesh. *Ziziphus mauritiana*, (Bengali name- Kul or Boroi,) also known as Ber, Chinee Apple, Jujube, Indian plum and Masau is a tropical fruit tree species belonging to the family Rhamnaceae (Ibrahim *et al*, 2009).

2.7.1. Classifications:

Kingdom:	Plantae
Division:	Eudicots
Class:	Rosids
Order:	Rosales
Family:	Rhamnaceae
Genus:	<i>Ziziphus</i>
Species:	<i>Z.mauritiana</i>



Pic-2.4: *Ziziphus mauritiana* species in Jessore District.

2.7.2. History of Cultivation:

Z. mauritiana is a spiny, evergreen shrub or small tree up to 15 m high, with trunk 40 cm or more in diameter; spreading crown; stipular spines and many drooping branches. The fruit is of variable shape and size. It can be oval, obovate, oblong or round, and that can be 1-2.5 in (2.5-6.25 cm) long, depending on the variety. species is believed to have originated in Indo-Malaysian region of South-East Asia. This species is indigenous to North Africa, from Afghanistan through north India to southern China, Malaysia, and Queensland in Australia. The use of *Z. mauritiana* in India can be traced back as early as 1000 BC. However, It is now widely naturalised throughout the Old World tropics from Southern Africa through the Middle East to the Indian Subcontinent and China, Indomalaya, and into Australasia and the Pacific Islands (Pareek 2001).

2.7.3. Botanic description:

Z. mauritiana is a medium sized tree that grows vigorously and has a rapidly developing taproot, a necessary adaptation to drought conditions. The species varies widely in height, from a bushy shrub 1.5 to 2 m tall, to a tree 10 to 12 m tall with a trunk diameter of about 30 cm. *Z. mauritiana* may be erect or wide-spreading, with gracefully drooping thorny branches, zigzag branchlets, thornless or set with short, sharp straight or hooked spines. The leaves are alternate, ovate or oblong elliptic with rounded apex, with 3 depressed longitudinal veins at the base. The leaves are about 2.5 to 3.2 cm long and 1.8 to 3.8 cm wide having fine tooth at margin. It is dark-green and glossy on the upper side and pubescent and pale-green to grey-green on the lower side. Depending on the climate, the foliage of the *Z. mauritiana* may be evergreen or deciduous. The flowers are tiny, yellow, 5-petalled and are usually in twos and threes in the leaf axils. Flowers are white or greenish white and the fruits are orange to brown, 2-3 cm long, with edible white pulp surrounding a 2-locular pyrene (Pareek 2001).

This quick growing tree starts producing fruits within three years. The fruit is a soft, juicy, drupe that is 2.5 cm diameter though with sophisticated cultivation the fruit has of size 6.25 cm long and 4.5 cm wide. The form may be oval, obovate, round or oblong; the skin smooth or rough, glossy, thin but tough. The fruit ripen at different times even on a single tree. Fruits are first green, turning yellow as they ripen. The fully mature fruit is entirely red, soft, juicy with

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wrinkled skin and has pleasant aroma. The ripe fruit is sweet and sour in taste. Both flesh texture and taste are reminiscent of apples. When under ripe the flesh is white and crispy, acid to subacid to sweet in taste. Fully ripe fruits are less crisp and somewhat mealy; overripe fruits are wrinkled, the flesh buff-coloured, soft, spongy and musky. At first the aroma is apple like and pleasant but it becomes peculiarly musky when overripe. There is a single, hard, oval or oblate, rough central stone which contains 2 elliptic, brown seeds, 1/4 in (6mm) long (Awasthi, 2009).

2.7.4. Ecology:

Z. mauritiana is hardy tree that copes with extreme temperatures and thrives under rather dry conditions with an annual rainfall of 6 to 88.5 in (15–225 cm). In Fiji, sometimes naturalised Ber trees grow along roadsides and in agricultural land, usually near sea level but occasionally up to an elevation of about 600 m. It also grows well on laterite, medium black soils with good drainage, or sandy, gravelly, alluvial soil of dry river-beds where it is vigorously spontaneous. In Australia, this species grows on a wide variety of soil types, including cracking clays, solodic soils and deep alluvials, in the tropics and sub-tropics where the average annual rainfall is in the range 470-1200mm. In the drier parts of this range, it grows best in riparian zones. Commercial cultivation usually extends up to 1000 m. Beyond this elevation trees do not perform well, and cultivation becomes less economical.

The tree has a high tolerance to both water-logging and drought and can grow where annual rainfall ranges from 125 to 2,225 mm, but is more widespread in areas with an annual rainfall of 300 to 500 mm. In China and India, wild trees are found up to an elevation of 5,400 ft (1,650 m). In India, the minimum shade temperature for survival is 7–13° and the maximum temperature is 50 °C. Studies report that this species flourishes in alkaline soils with a pH as high as 9.2. However, deep sandy loam to loamy soils with neutral or slightly alkaline pH are considered optimum for growth (Awasthi, 2009).

2.7.5. Reproductive biology:

Some cultivars attain anthesis early in the morning, others do so later in the day. The flowers are protandrous. Hence, fruit set depends on cross-pollination by insects attracted by the fragrance and nectar. Pollen of the Indian jujube is thick and heavy. It is not airborne but is transferred

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from flower to flower by honeybees. The flowers are pollinated by ants and other insects, and in the wild state the trees do not set fruits by self-pollination. Ber propagates by seeds, seedlings, direct sowing, root suckers as well as by cuttings. Ber seeds are spread by birds, native animals, stock, feral pigs and humans who eat the fruit and expel the seeds. Seeds may remain viable for 2½ years but the rate of germination declines with age. Cross-incompatibility occurs, and cultivars have to be matched for good fruit set; some cultivars produce good crops parthenocarpically. In Bangladesh improved varieties are multiplied by vegetative propagation and are mostly cultivated in Satkhira, Rajshahi and Comilla (Rahman *et al*, 2003).

2.7.6. Propagation and Management:

2.7.6.1. Propagation methods:

Pretreatment is beneficial. Storage of the seed for 4 months to let it after-ripen improves germination. If facilities are available, stratification in sand for 60-90 days at 5 deg. C is recommended. Scarification, extracting the seed from the stone, and treating it with sulphuric acid has also been recommended. To germinate, seeds need full sunlight. Germination is epigeal and takes 3-4 weeks with seed left in stone, quicker if it is cracked, and 1 week if carefully extracted. Seed should be sown in trays or beds, and the seedlings pricked out when 2 pairs of true leaves have developed. The seedlings should also be given full light. It is likely that seedlings will need about 15 months in the nursery. Stumps may be used. When propagating selected varieties for fruit, budding or ring-grafting is used. Inarching and root-suckers are also possible methods of vegetative propagation (Rahman *et al*, 2003).

2.7.6.2. Germplasm Management:

Orthodox storage behaviour, viability maintained for 2 years in hermetic air-dry storage at 5 deg. C. The germination rate increases during the 1st year of storage. The cleaned stones can be kept for 5 years in sealed containers, although during this period the viability drops from 95% to 30%. *Z. mauritiana* has 3300 pyrenes/kg.

2.7.6.3. Season and harvesting:

Plants are capable of seed production once they reach a height of about 1 metre. Wild-growing plants in northern Australia may take 8 years to reach this size. In Australia, plants growing under natural conditions are capable of producing seeds once they reach a height of about 1m.

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Plants between 1 and 2m high produce, on average, less than five fruits per season. Large plants (>5m high) can produce 5000 or more fruits in a single season.

In India, some types ripen as early as October, others from mid-February to mid-March, others in March, or mid-March, to the end of April. In the Assiut Governorate, there are 2 crops a year, the main in early spring, the second in the fall. In India the trees flower in July to October and fruits are formed soon after. In February–March the fruits are mature and in some places a second crop is produced in the fall. Pickings are done by hand from ladders and about 110 lbs (50 kg) is harvested per day. The fruits remaining on the tree are shaken down. Only fully mature fruits are picked directly from the tree. They are transported in open bags to avoid fermentation. Seedling trees bear 5,000 to 10,000 small fruits per year. Superior grafted trees may yield as many as 30,000 fruits. The best cultivar in India, with fruits normally averaging 30 to the lb (66 to the kg), yields 175 lbs (77 kg) annually. Special cultural treatment increases both fruit size and yield.

In Bangladesh *Z. mauritiana* tree species is gaining popularity with the growers because of its higher yield, good return and suitability for the arid and semi-arid regions where as most of the other fruit crops can not be grown either due to lack of proper irrigation facilities or adverse climatic and soil condition (Bose et al, 1990).



Pic-2.5: Plantation of *Z. mauritiana* species in Jessore District.

2.7.7. Uses:

- The fruit is eaten raw, pickled or used in beverages. It is quite nutritious and rich in vitamin C. It is second only to guava and much higher than citrus or apples.
- The leaves are readily eaten by camels, cattle and goats and are considered nutritious.

- In India and Queensland, the flowers are rated as a minor source of nectar for honeybees. The honey is light and of fair flavor.
- Erosion control: A suitable species to aid in fixation of coastal dune sand.
- Shade or shelter: The tree has been planted for shade and windbreaks.
- Reclamation: Can withstand severe heat, frost and drought; hence it is planted in dry areas and on sites unfit for other crops.
- Ornamental: *Z. mauritiana* is well suited for homegardens.
- Boundary or barrier or support: Tree useful as a living fence; its spiny stems and branches deter livestock.
- Ber timber is hard, strong, fine-grained, fine-textured, tough, durable, and reddish in colour. It has been used to line wells, to make legs for bedsteads, boat ribs, agricultural implements, tool handles, and other lathe-turned items. The branches are used as framework in house construction and the wood makes good charcoal with a heat content of almost 4,900 kcal per kg.
- It contains 20 to 30% sugar, up to 2.5% protein and 12.8% carbohydrates. Fruits are also eaten in other forms, such as dried, candied, pickled, as juice, or as ber butter (Ibrahim *et al*, 2009).

2.7.8. Pests and diseases

The greatest enemies of the jujube are fruit flies. Some cultivars are more susceptible than others, the flies preferring the largest, sweetest fruits, 100% of which may be attacked while on a neighbouring tree, bearing a smaller, less-sweet type, only 2% of the crop may be damaged. The larvae pupate in the soil and it has been found that treatment of the ground beneath the tree helps reduce the problem. Control is possible with regular and effective spraying of insecticide.

A leaf-eating caterpillar and the green slug caterpillar attack the foliage. Mites forms scale-like galls on twigs retarding growth and reducing the fruit crop. Lesser pests include a small caterpillar, *Meridarches scyroides*, that bores into the fruit. The tree is subject to shrouding by a parasitic vine . Powdery mildew causes defoliation and fruit-drop, but it can be adequately controlled. In storage, the fruits may be spotted by the fungi. Fruit rots are caused by *Fusarium* spp., *Nigrospora oryzae*, *Epicoccum nigrum*, and *Glomerella cingulata* (Islam *et al*, 2004)

2.8. Scope Of Agroforestry Practice with *Mangifera indica* & *Ziziphus mauritiana* Species:

Mangifera indica & *Ziziphus mauritiana* based Agroforestry is the most effective land use system from sustainable view point and as recognized the best productive system from which the rural people can meet their requirement of food fodder, fuel and other necessities. This has long been practiced by the farmers of Bangladesh in haphazard manner. The homestead of rural people is a unique feature of combination of *Mangifera indica* & *Ziziphus mauritiana*, shrubs, vegetables, live-stock animals, duck, and poultry birds.



Pic-2.6: *Mangifera indica* & *Ziziphus mauritiana* based agroforestry in Jessore District.

There is a great scope to manage and develop our homestead with sound sustainable technologies. Because the *Mangifera indica* & *Ziziphus mauritiana* based Agroforestry are providing of bio-fuel requirement as well as fruit fodder, timber, shelter, for rural people.

The Scope of *Mangifera indica* & *Ziziphus mauritiana* based Agroforestry in Bangladesh are:

- Increase in food supply.
- Increased variety of farm products.
- Conserves and improves farmland.

- Utilizes sustainable resource.
- Minimize risk of crop failure.
- Increase participation of local population.

2.9. Constraints in Developing of Agroforestry Practice with *Mangifera indica* & *Ziziphus mauritiana* Species:

Lack of farmer's knowledge about improved management of trees and agricultural crops (training) is a common constraint for agroforestry system.

- ❖ Scarcity of quality planting materials was reported as the most important constraint for improving the economic productivity of the tradition homestead agroforestry system in Bangladesh.
- ❖ Damage by animals is a major problem for agroforestry plantation. In homesteads, goats and cattle often damage seedlings. Protection problems are also common in strip-side agroforestry.
- ❖ Knowledge gap in agroforestry standard module and species selection is one of the important constraints for improving agroforestry in Bangladesh. Sometimes forestry professionals are lacking of agronomic and sociological knowledge to agroforestry production system.
- ❖ Irrigation facility is the prime limiting factor for all season cultivation (Bhuiyan, 1994).
- ❖ Scarcity of land, lack of forestry professionals with shortage of other staff, lack of marketing facility, etc are also vital constraints in developing agroforestry.
- ❖ People's negative attitude toward NGOs also hinders the system's mobility.

CHAPTER - THREE

PROFILE OF THE STUDY AREA

Chapter - Three: Profile of the Study Area

3.1. Location:

Jessore is the Division of Khulna in Bangladesh. It is bounded by Jhenaidah and Magura districts on the north, Satkhira and Khulna districts on the south, Narail and Khulna districts on the east, West Bengal state of India on the west.

3.2. Geography:

Jessore District encompasses 2606.98 km². It is located in between 22°48' and 23°22' north latitudes and in between 88°51' and 89°34' east longitudes. Major rivers that flow through this region are the Bhairab, Chitra, Betna, Kobadak, and the Mukteshwari (Banglapedia 2012).

3.3. Physiography:

Most of Bangladesh's land was formed by the alluvial deposits of the Ganges, Brahmaputra, Meghna, and Tista rivers and estuaries. This region includes the high Ganges River Floodplain which is predominantly high land and medium highland (Zainul Abedin et.al.1987). Most areas have a complex relief of broad and narrow ridges and inter-ridge depressions, separated by areas with smooth, broad ridges and basins. These lands are arranged in a catenary sequence and are mainly level to gently undulating with ridges and basins (Joshua and Rahman 1983).

3.4. Geology And Soil Condition:

The landscape of Jessore District is nearly level to gently undulating with broad highland inter ridge depressions and some small concave basins and unfilled channels. Soil texture varies from sandy loam to heavy clay. Light textured soils occur in the highlands and ridges. The texture gradually becomes heavier in the basin. There is an overall pattern of olive-brown silt loams and silty clay loams on the upper parts of floodplain ridges and dark grey mottled brown, mainly clay soils on ridge sites and in basins. Most ridge soils are calcareous throughout. General soil types predominantly include calcareous dark grey floodplain soils and calcareous brown floodplain soils (BARC, 2005). Organic matter content in the brown ridge soils is low but higher in the dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low although CEC is medium and K-bearing minerals are medium to high but the Zn and B status is low to medium. The older soils are decalcified up to a depth of 25-60 cm. Soil pH ranges from 7.0 to

Chapter - Three: Profile of the Study Area

8.5(SRDI,1977).The homesteads are situated on high lands which are above normal flood level and well drained, but the lower part of the medium highland is shallowly flooded during the rainy season.

3. 5. Climatic Condition:

The area enjoys a tropical monsoon climate with the lowest and least reliable rainfall in Bangladesh. The monsoons usually start in May and end in late September. The annual rainfall within the tract varies from 1,400-1,800 mm. About 90% of the total annual rainfall occurs during June- September. The mean annual rainfall increases from west to east and from north to south. The average daily temperature ranges from 12° C during December-January to about 31° C during May-August. The annual average temperature is 24° C, with the extreme lowest 8.1° C in January and the highest 40° C in May. Annual average temperature is maximum 37.1° C and minimum 11.2° C. Four main seasons namely the dry or winter season (December to February), the pre-monsoon hot season (March -May), the monsoon or rainy season (June-September) and the post monsoon or autumn season (October -November) are recognized.

3. 6. Administration:

Jessore district was established in 1781. It consists of 4 municipalities, 36 wards, 8 upazilas, 92 unions, 1329 mouzas, 1434 villages and 120 mahallas. Upazilas are Abhaynagar Upazila, Bagherpara Upazila, Chaugachha Upazila, Jessore Sadar Upazila, Jhikargachha Upazila, Keshabpur Upazila, Manirampur Upazila, and Sharsha Upazila. Of the eight upazilas of the district manirampur is the largest (444.72 sq km) and abhaynagar is the smallest (247.19 sq km).

Chapter - Three: Profile of the Study Area

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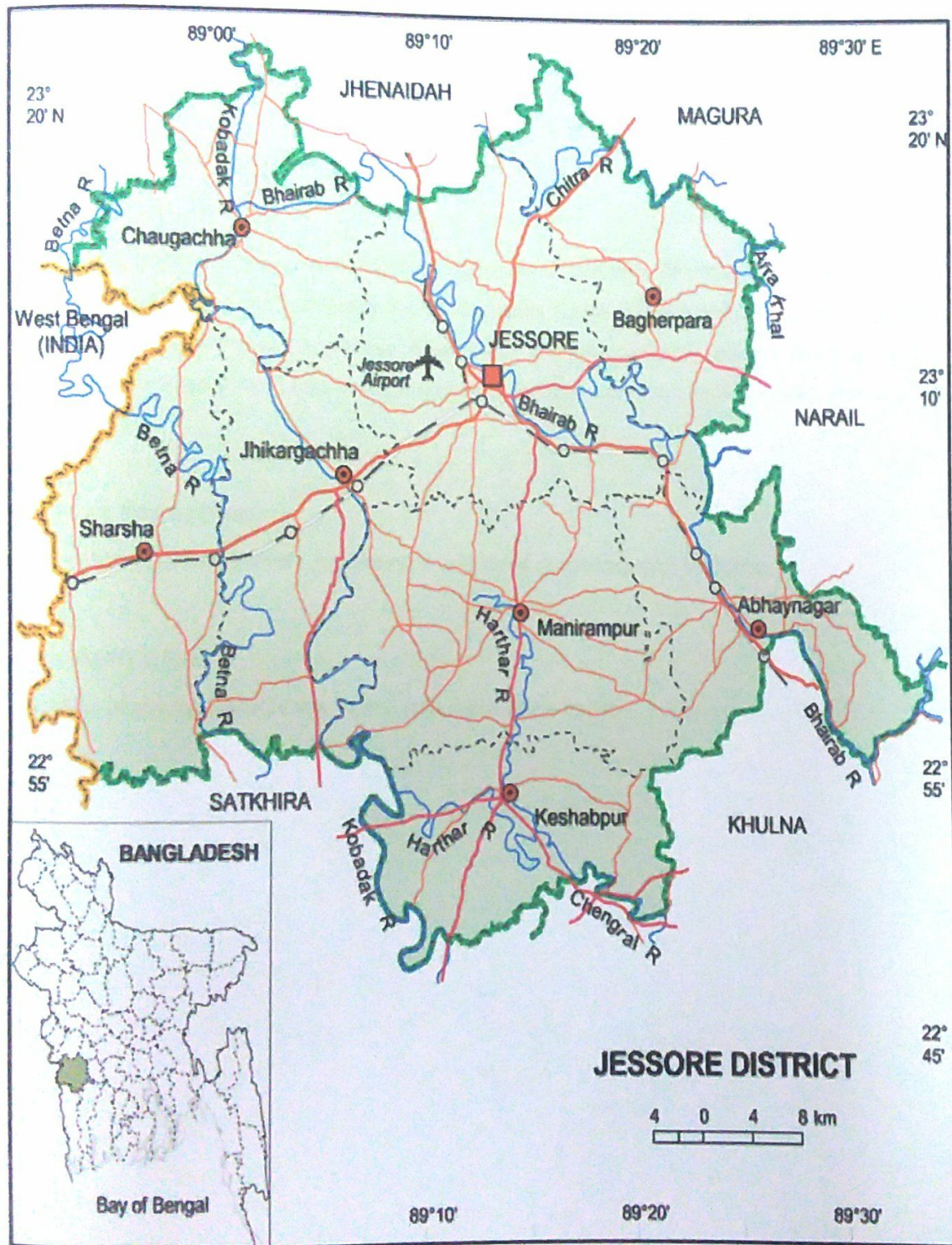
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Chapter - Three: Profile of the Study Area



Pic-3.1: Map of Jessore District.

CHAPTER - FOUR

RESEARCH DESIGN & METHODOLOGY

Chapter - Four: Research Design & Methodology

This chapter includes detail design & methods used to conduct this study. Research design mainly describes the way of sampling where the agroforestry plot was selected for primary data collection. The methodology section mainly contains the detail of primary data collection & analysis procedure.

4.1. Sample Size & Sampling Design:

4.1.1 Selection of the Study Area:

The study was conducted in Jessore district of Bangladesh through three month from May 2014 to July 2014. An exploratory survey was conducted to explore information regarding the Demographic profile (age, sexual pattern, educational status, land status, land pattern) of farmers who practiced *Mangifera indica* & *Ziziphus mauritiana* based agroforestry practice. The survey was also conducted to know annual income of farmers, reason for choosing *Mangifera indica* or *Ziziphus mauritiana* based agroforestry and by using Likert scale to determine which type is the best suitable for practice in Jessore District.

4.1.2 Selection of the Sample Size & Respondents:

The sampling design for the survey was purposive sampling because of the uneven and discrete distribution of agroforestry land in the region. The agroforestry practice of the region is not old but in young stage. In my field survey, the sampling units were selected by some stages (purposive multistage sampling). During the reconnaissance survey the area selected where agroforestry type of land-use are dominant through snow-ball methods. This had been done by the information collected from personnel of GO's and NGO's at district levels and upazilla levels who are involved in agriculture and forestry extension. Besides public representative such as Upazills chairmen and locals were consulted. Based on this secondary information a physical verification of the secondary information about *Mangifera indica* & *Ziziphus mauritiana* based agroforestry land-uses were done by travelling into the agroforestry fields of the District.

In this way five Upazillas from the District were indentified for sampling. Form these five Upazillas two Unions were selected from each Upazilla and then two Villages were selected under each Unions. Here, in addition to GO's and NGO's personnel, union council members, local farmers and key personnel of the area were consulted for information on *Mangifera indica*

& *Ziziphus mauritiana* based agroforestry land uses about the respective Upazillas. From 20 villages 160 farmers/respondents were selected purposively.

4.1.3 Reconnaissance Survey:

Reconnaissance survey carried out to know the existing information of the study area to prepare a set of questionnaire for fulfilling the purpose of the study.

4.1.4 Questionnaire survey:

In order to obtain relevant information, the interview schedule was carefully designed keeping in mind the objective of the study. The formal survey of each upazilla was carried out by using the semi structured questionnaire by the author. The questions were asked in Traditional language but written in English language.

4.1.5 Data collection process:

In order to fulfill the objectives of the study, relevant information and literature were collected from primary sources and secondary sources.

4.1.5.1 Primary data collection:

The primary data has been collected by conducting a survey work with a well-prepared semi structured questionnaire. For this reason, interviewers were selected randomly. It is also done by physical visit to the study area and then interviewing the respondent. I collected data from the respondent according to likert Scale.

4.1.5.1.1 Likert scale:

A Likert scale (Wuensch, Karl L. 2005)) is a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scaling responses in survey research, such that the term is often used interchangeably with *rating scale*. The scale is named after its inventor, psychologist Rensis Likert (Likert. R, 1932)..

4.1.5.1.2. Likert scales and items:

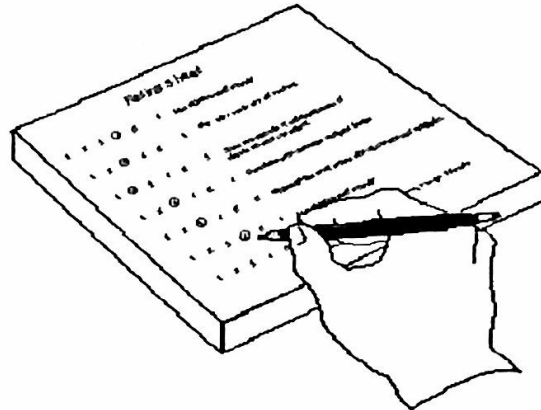
A Likert item is simply a statement which the respondent is asked to evaluate according to any kind of subjective or objective criteria; generally the level of agreement or disagreement is measured. It is considered symmetric or "balanced" because there are equal numbers of positive

Chapter - Four: Research Design & Methodology

and negative positions (Burns *et al*, 2008). Often five ordered response levels are used, although many psychometricians advocate using seven or nine levels

The format that I used was five-level Likert item, which are given below-

1. Strongly like
2. like
3. Neither like nor dislike
4. dislike
5. Strongly dislike



Pic-4.1: Data collection according to Likert

scale

4.1.5.2. Secondary Data:

Some information and literature of the study are collected from the following sources:

- Seminar library, Forestry & Wood Technology Discipline, Khulna University
- Khulna university library.
- Published and Unpublished reports, journals, books.
- Internet browsing.
- Newspapers.
- Regional center, BBS, Jessore.
- Agriculture Information Services, Jessore.

4.1.6 Data processing and analysis:

The surveyed data were converted into frequencies and percentage forms. After collecting information from primary and secondary sources, data are processed and analyzed by following steps:

- i. Reviewed of collected data and information
- ii. Discarded of unnecessary parts of the information and data
- iii. Sorted of revised data and information

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- iv. Analyzed for easy explanation

4.1.7 Report writing:

After successful completion of primary data analysis and arrangement all primary and secondary information, then a draft final report was prepared and it was finalized after some necessary correction.

CHAPTER - FIVE
RESULTS AND DISCUSSION

5.1. Demographic And Socio-Economic Profile Of The Households In Jessore District:

5.1.1 Gender And Age Distribution Of The Respondent's Family:

Among the respondents family it was found that highest number of the male (48%) and female (42%) are middle aged (21-40 years), only 18% male and 15% female are <20 years old, 29% male and 25% female are 41-60 years (fig.5.1). Otherwise, above 60 years male and female members are only 5% and 18%. Here male and female age distribution in all ages almost same except very old aged male and female age distribution. By surveying it was also found that 100% respondents are male in the study area. Because male are dominant persons and have a good knowledge about their land and cultivation techniques. Otherwise, in agroforestry, directly women participation is zero because they think women are appropriate for household and post harvesting activities. They also said social, religious and traditional barriers retard them to join such activities.

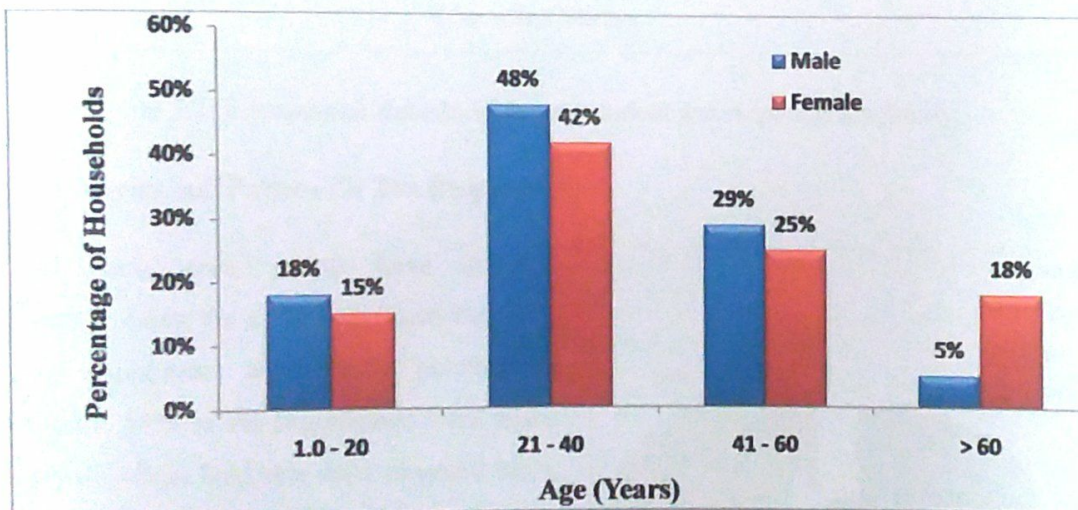


Figure 5.1: Age distribution with sex(male and female).

5.1.2. Literate Members in The Respondent's Family:

Educational status of the population depends on the socio-economic condition, environment, institutional support and government policy making. Educational attainments help develop conceptual skill and also facilitate the acquisition of technical knowledge about their profession. The educational status of the survey area (only respondent's family) is categorized as primary,

Chapter – Five: Results and Discussion

secondary, higher and illiterate. The highest numbers of the people both respondents(41%) and respondents family(43%) are secondary level Otherwise, 31% of respondents and 14% of the respondents family members are illiterate (see fig.5.2). They said they did not get enough facilities and scope of education at that time. About 16% of the respondents' family and 13% of respondents has completed their higher education level.

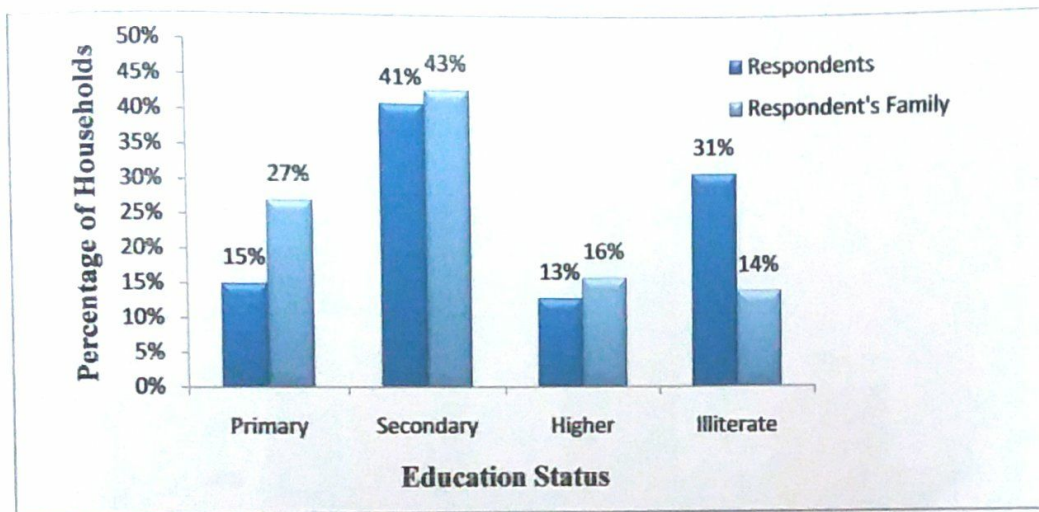


Figure 5.2: Educational statuses of the respondent and respondent's family.

5.1.3. Occupational Pattern Of The Respondent:

In the study area, people have different occupation. From the survey, it found that 61% of the respondents are directly involved in agriculture, 14% of the respondents were labor. They work others land at a daily payment basis. Beside that 19% of the respondents' occupations were business and rest 6% were service holder (see fig.5.5). These findings indicate that most of the respondents depend on agriculture as their primary source of income.

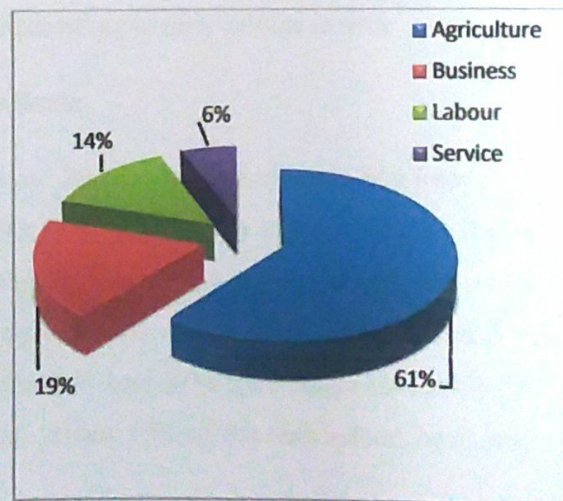


Figure 5.3: Occupational patterns of the respondents.

5.1.4. Income Of The Respondents:

Mangifera indica and *Ziziphus mauritiana* based agroforestry practice is not very new in Jessore District. By this practicing farmers can achieve their livelihood security as well as conserve the biodiversity. In Jessore District, most of the farmers practice *Mangifera indica* and *Ziziphus mauritiana* based agroforestry for their livelihood. The annual income of the respondents are categorized into three types. About 37% respondents practiced whose income is less than 3 lakh taka and about 44 % is 3 lakh - 10 lakh taka and 19% respondents income is about 10 lakh to above taka per year.

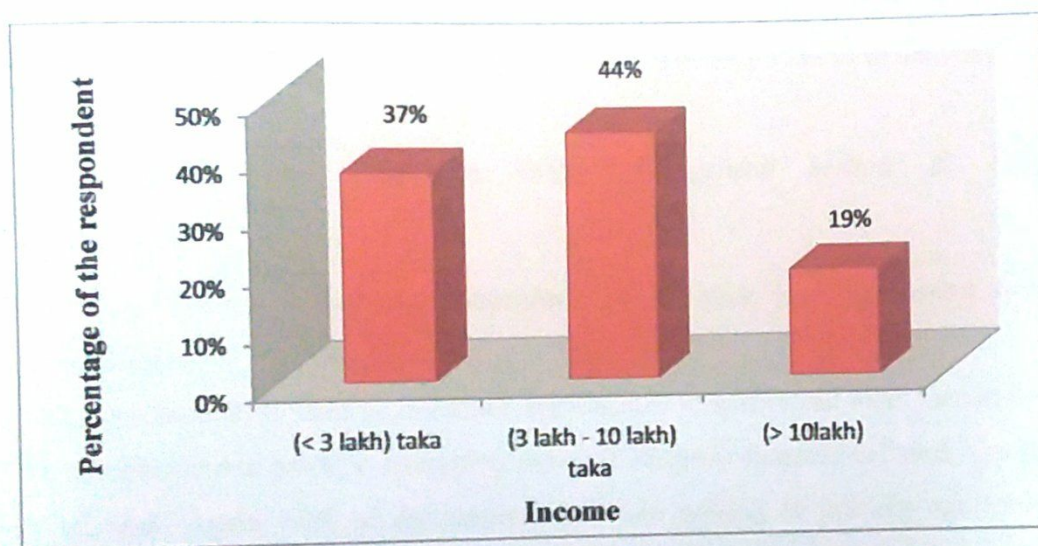
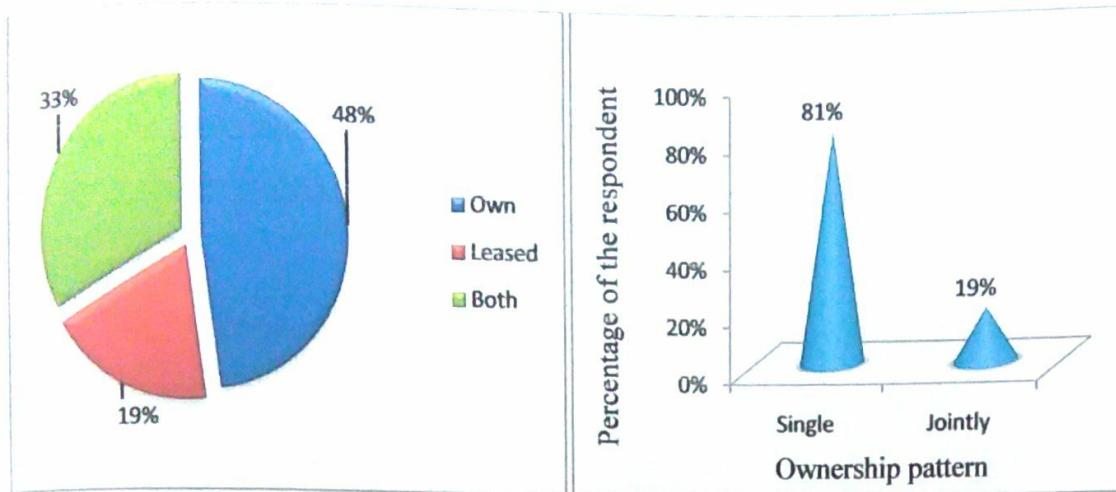


Fig- 5.4: The percentage of respondents according to their income in taka.

5.1.5. Ownership Status & Pattern of the Respondents:

Among the respondent about 48% use their own land. Because of land scarcity they lease land and have to pay a certain amount of money according to the productivity of land, 33% use leased land with own land to increase farm size and only 19% done only in leased land. Generally farmer has to maintain a positive relation with adjacent land owner to avoid conflict and to secure their farm stability. From the respondents most of them 81% have single ownership for capital formation and to secure safety of their farm. About 19% of the respondents have joint ownership.



5.2. About Agroforestry Practice With *Mangifera indica* & *Ziziphus mauritiana*:

5.2.1 Preference of land to introduce Agroforestry Practice with *Mangifera indica* & *Ziziphus mauritiana*:

Among the respondents 21% likes to introduce agroforestry in homestead land. Generally small land holder farmers want to practice *Mangifera indica* & *Ziziphus mauritiana* based agroforestry in homestead land. Again 61% of the respondents were willing to practice agroforestry in agricultural land and rest 18% of the respondents who were willing to practice aquaculture wants to introduce in water body.

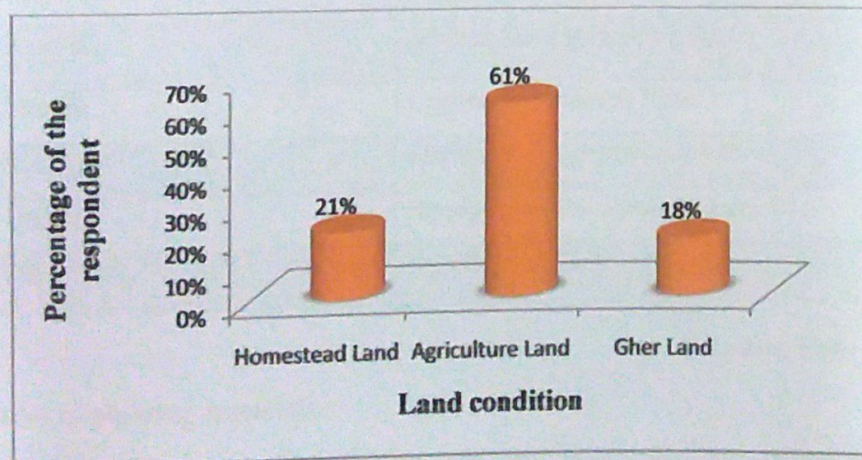


Fig- 5.7: The percentage of the respondents to prefer land for raising agroforestry.

Chapter – Five: Results and Discussion

5.2.2. Preference of Agricultural Species:

In Jessore District various agricultural species are practiced in *Mangifera indica* & *Ziziphus mauritiana* based agroforestry. The main purpose of such integration is to increase total productivity of smaller pices of land and make a cash beside meeting need for family consumption.

Table-5.1: Local and Scientific names of annual crops that practiced in Jessore District.

Local name	Scientific name
Alu	<i>Solanum tuberosum</i>
Ada	<i>Zingiber officinale</i> Rosc.
Brinjal	<i>Solanum melongena</i> L.
Sim	<i>Lablab purpureus</i>
Cucumber	<i>Cucumis sativus</i> Linn.
Dharosh	<i>Hibiscus esculentus</i> (L.) Moench.
Lal sak	<i>Amaranthus beitung</i>
Holud	<i>Curcuma longa</i> Linn.
Kochu	<i>Calocasia esculenta</i> (L.) Schott
Data	<i>Amaranthus gangeticus</i>
Kumra	<i>Cucumbrita maxima</i> Duch.
Lau	<i>Lagenaria vulgaris</i>
Karolla	<i>Momordica charantea</i> Linn.
Morich	<i>Capsicum frutescens</i> Linn.
Kakrol	<i>Momordica cochinchinensis</i>
Olkochu	<i>Amorphophallus campanulatus</i> Bl.
Pui	<i>Baselle alba</i> Linn.

(Source: Field survey 2014)

5.2.3. Source of planting material:

About 9% of the respondents collect planting materials (seeds, seedlings, vegetative propagules or tree) from seed bed in their land. They also collect seeds from available trees and around their

locality. Other 91% of the respondents collect planting materials from their nearby markets. When they purchase seedlings from market they consider the size, physical and morphological condition of the seedlings.

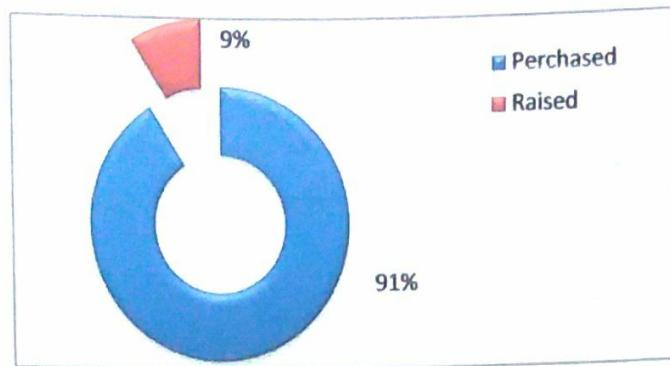


Fig-5.8: The percentage of the respondents of the source of planting material.

5.2.4. Types of practices with *Mangifera indica* & *Ziziphus mauritiana*:

The subsequent section describes different existing integrated practices that were developed by farmers from their own experience. The numerous type of existing integrated systems are distinguished from each other by the choice of species and design. The main purpose of such integration is to increase total productivity of smaller pieces of land and make a cash beside meeting need for family consumption. The different types are as follows-

5.2.4.1. *Mangifera indica* + Annual crops:

In this type of system *Mangifera indica* practiced with various annual crops such as Alu, Ada, Brinjal, Holud, Morich etc. It is common and very popular practice in the study area. Farmers practiced *Mangifera indica* mainly for cash generation and with annual crops for meet the basic need of their family. It found that about 39% respondent done this type of practice.



Pic-5.1: *Mangifera indica* plantation with annual crops.

5.2.4.2. *Ziziphus mauritiana* + Annual crops:

This system is the combination of *Ziziphus mauritiana* and various agricultural crops such as Brinjal, Holud, Lal sak, Pui, Lau etc. It is a popular practice in the study area. Farmers main target is to cash generation. They also practice for family consumption. About 32% respondent practiced this type of system.



Pic-5.2: *Ziziphus mauritiana* plantation with annual crops.

5.2.4.3. *Mangifera indica* + *Ziziphus mauritiana* + Annual crops:

In this type of system farmers used both *Mangifera indica* and *Ziziphus mauritiana* species for practiced with vegetables or annual crops. Many small landholders practiced this system to get more products at the same time from the same land. They usually practiced this system mainly for their family consumption and they usually sell products to the local market. About 21% respondent practiced this type of system.



Pic-5.3: *Mangifera indica* & *Ziziphus mauritiana* plantation with annual crops.

5.2.4.4. *Mangifera indica* + *Ziziphus mauritiana* + Rice:

In the study area it was found that many small landholders who practiced *Mangifera indica* and *Ziziphus mauritiana* species used the surface of the land as the seed bed of rice. Many of farmers are more interested in this type of practiced but in the study area it found that about 8% respondents are done this practiced at present time.



Pic-5.4: *Mangifera indica* & *Ziziphus mauritiana* plantation with rice.

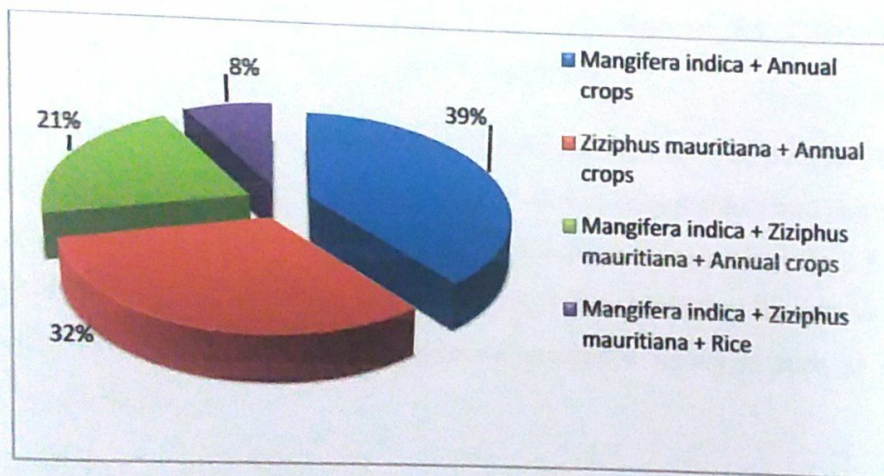


Fig-5.9: Various agroforestry practices with *Mangifera indica* & *Ziziphus mauritiana*.

5.3. Silvicultural Operation of Agroforestry Practice with *Mangifera Indica* & *Ziziphus Mauritiana*:

By the survey the author found that the farmers of the study area continue some types of silvicultural operation such as thinning, pruning, using pesticide, fungicide, fertilizer, some types of ground operation such as weeding, cleaning, vacancy felling etc.

Chapter – Five: Results and Discussion

In the study area almost 63% respondents practicing both are thinning and pruning operation, 31% of the respondents done only pruning and very few 6% respondents are done only thinning operation. Maximum respondents (93%) are continuing some types of ground operation like weeding, vacancy filling, other types of soil working etc.

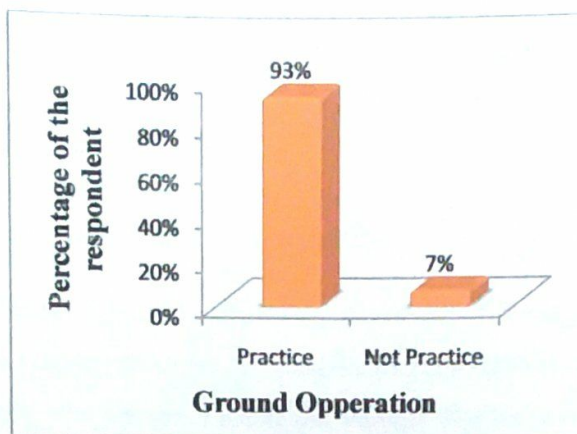
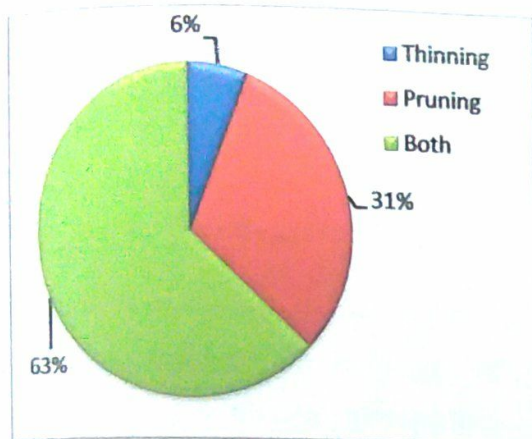


Fig -5.10: Types of silviculture operation.

Fig -5.11: Percentage of the respondent for Ground operation.

Almost 85% respondents are using various types of fertilizers such as uria, potash, TSP, and other types of organic fertilizers. Outer fertilizer is urgent need as crop residues and animal dung are not kept in the field; this are collected for by poor people for making cooking fuel. Fertilizer is normally applied twice per cropping season; they increase dosages if they think land is tired. All the respondents (100%) are using various types of protection technique such as fencing, using pesticide, fungicide etc.

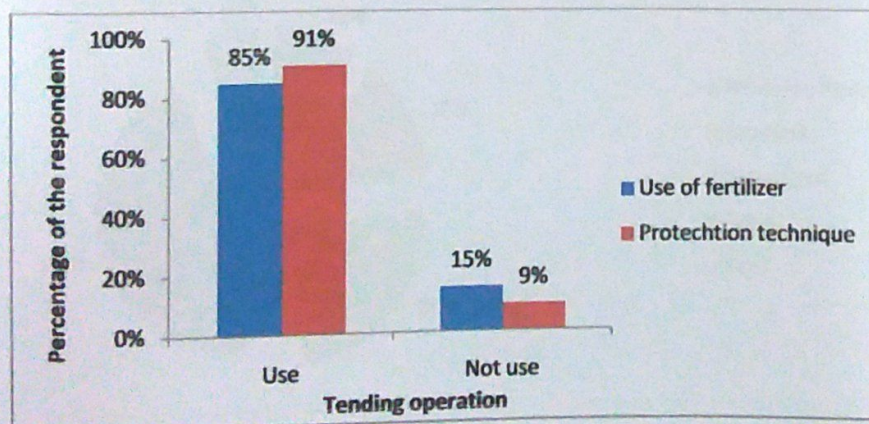


Fig -5.12: Percentage of the respondents for tending operation.

5.4. Opportunities of Agroforestry Practice with *Mangifera Indica* & *Ziziphus Mauritiana*:

Mangifera indica & *Ziziphus mauritiana* based agroforestry are mainly practiced for fruit production. The main target of the respondents is to generate cash by selling fruit in the market. They also produce vegetable crops to fulfill the basic needs of the family and also for generating cash. Otherwise they get fuelwood, fodder and other benefits from these type of practiced.

5.4.1. Market Opportunities of Agroforestry Practice with *Mangifera Indica*:

A market opportunity denotes the overall market condition, facilities, demands of certain products, market types etc. In Jessore district the market facilities are good for *Mangifera Indica* products. About 10% of the respondent specially who are small landholder thought that there is more excellent market facilities, 15% of the respondent thought that there is a excellent market facilities, about 25% of the respondent thought that the market facilities is more good, 47% respondents specially who are are large lanholder thought that the market facilities is good and only 7% respondents thought that the market facilities is poor for the products of *Mangifera Indica* and *Mangifera Indica* based agroforestry products.

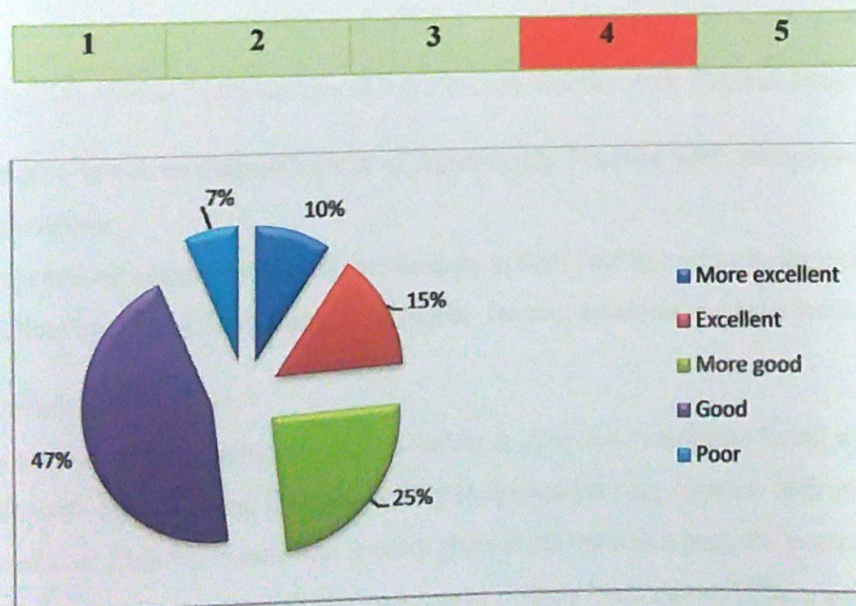


Fig-5.13: Market Opportunities of Agroforestry Practice with *Mangifera Indica*.

5.4.2. Market Opportunities of Agroforestry Practice with *Ziziphus Mauritiana*:

In the study area author found that about 8% of the respondent specially who are small landholder thought that there is more excellent market facilities, 16% of the respondent thought that there is a excellent market facilities, about 30% of the respondent thought that the market facilities is more good, 42% respondents specially who are are large lanholder thought that the market facilities is good and only 4% respondents thought that the market facilities is poor for the products of *Ziziphus Mauritiana* and *Ziziphus Mauritiana* based annual products.

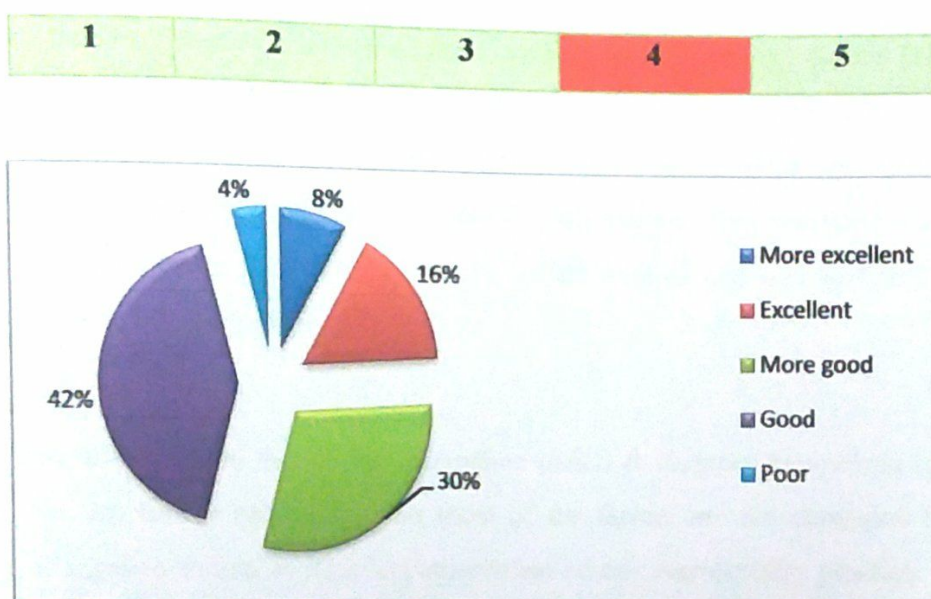


Fig-5.14: Market Opportunities of Agroforestry Practice with *Ziziphus Mauritiana*.

5.4.3. Productive resource diversification of Agoforestry Practice with *Mangifera indica* & *Ziziphus mauritiana*:

Respondents practiced various system of agroforestry in their land according to their choices and become benefited by getting food, fruits, fuel, timber, fencing materials and cash money.

5.4.3.1. Generate cash:

The primary purpose for practising *Mangifera indica* & *Ziziphus mauritiana* based agroforestry is to generate cash. By collecting fruit and selling in the market they increase their income. But *Mangifera indica* & *Ziziphus mauritiana* species gives fruits once in a year. So to generate more cash they practice variety of crops all the year round in their land. About 95% respondent said that cash generating is the main cause for practising such type of practice.

5.4.3.2. Improve food consumption:

Farmers' food preference depended on income. When income increases his/her food preferences also improved. Due to *Mangifera indica* & *Ziziphus mauritiana* based Agroforestry practice the income level of respondents increased. About 90% respondents said that they got benefit from these practice.. Because they produced fruits, annual crops and vegetables and so they had no need to spend money for these.

5.4.3.3. Improve consumption of fuel wood/ firewood:

Generally the peoples of the study area used wood, cow dung, jute sticks, straw, dry leaves etc. as for their fuel purpose. Most of the respondents (75%) said that when they did not practice any agroforestry system, they met their fuel demand from nearby market or used other like cow dung, jute sticks, straw etc. But after *Mangifera indica* & *Ziziphus mauritiana* based Agroforestry practice, they could not buy fuel wood from market. They collected it from their agroforestry land. Sometimes they used fallen dry leaves for fuel and also sold the extra fuel wood and leaves for cash generation.

5.4.3.4. Timber:

In the study area author found that as the *Mangifera indica* & *Ziziphus mauritiana* species are not so large tree for timber production. So most of the farmer are not depended for timber production on *Mangifera indica* & *Ziziphus mauritiana* based Agroforestry practice. Very few respondent (17%) specially who are small land holder sometimes practiced agroforestry with large mango tree for timber production.

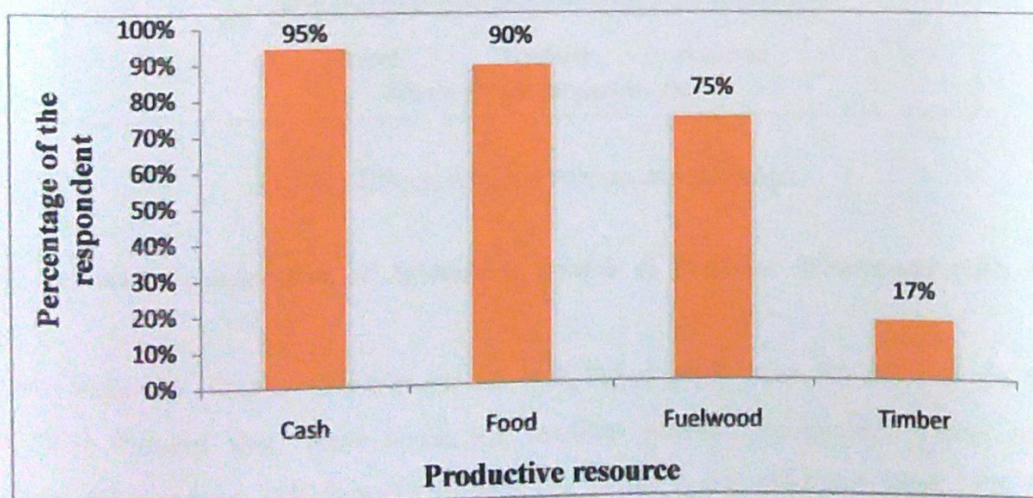


Fig -5.15: Percentage of the respondents for productive resource.

5.5. Suitability to Plant *Mangifera Indica* & *Ziziphus Mauritiana* with agricultural crops:

5.5.1. Effects of *Mangifera Indica* & *Ziziphus Mauritiana* on annual crops:

The adverse effect of *Mangifera Indica* & *Ziziphus Mauritiana* on agricultural crops according to the farmer's perception is given below by considering some key effects.

5.5.1.1. Root competition between trees and annual crops:

In the study area about 15% farmers thought that the root system of *Mangifera Indica* & *Ziziphus Mauritiana* severely damages their agricultural crops. But most of the farmers (about 47%) thought that as the root system of *Mangifera Indica* & *Ziziphus Mauritiana* species are not too large as comparative to many large species (such as babla, sissoo, rain tree, ipil-ipil). About 28% farmers thought that there is no effect of the root system of *Mangifera Indica* & *Ziziphus Mauritiana* on agricultural crops.

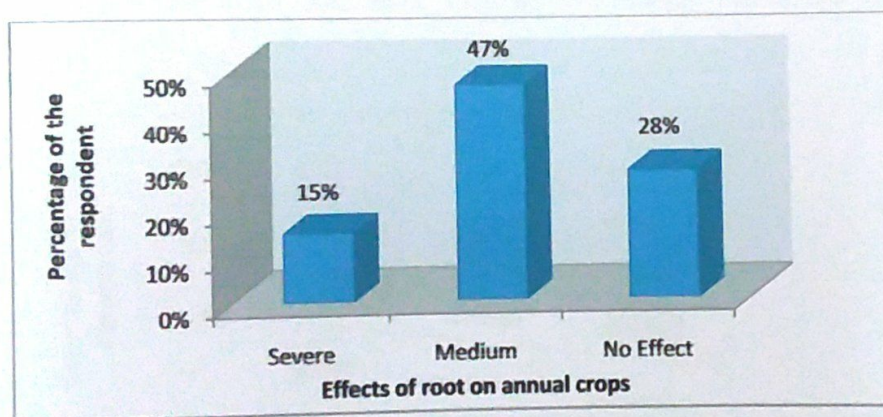


Fig-16: Effects of trees root on annual-crops

5.5.1.2. Nutrient Competition of *Mangifera Indica* & *Ziziphus Mauritiana* with annual crops:

Mangifera Indica & *Ziziphus Mauritiana* are fruit based small trees. So most of the farmers (about 59%) thought that, these trees has medium nutrient competition effect on their agricultural crops. About 23% farmers thought that it has severe effect and about 18% farmers thought that it has no effect on agricultural crops.

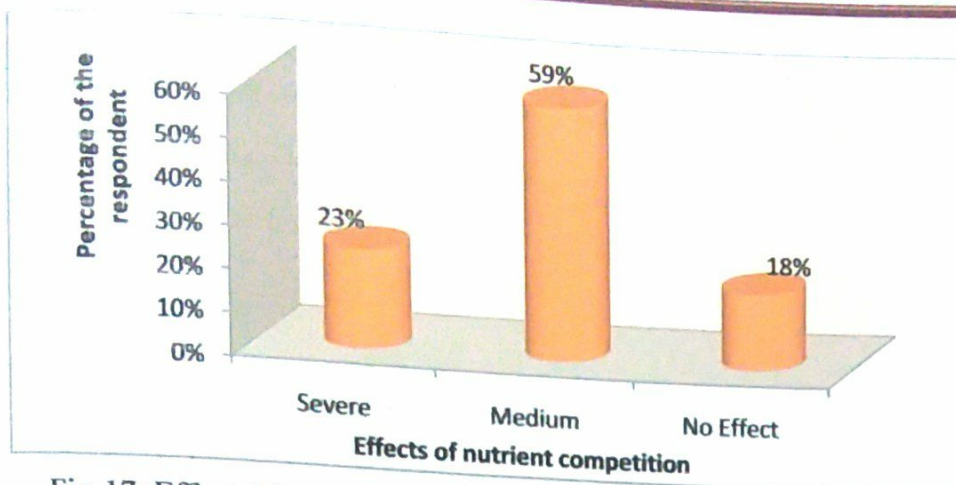


Fig-17: Effects Nutrient Competition between trees and annual crops

5.5.1.3. Light competition between *Mangifera Indica* & *Ziziphus Mauritiana* species and agro-crops:

Mangifera Indica & *Ziziphus Mauritiana* species has medium crown density as comparative to large trees. So most of the farmers (about 63%) thought that, the trees which is grown in their farm land has medium light competition effect on their agricultural crops. About 21% farmers thought that it has severe effect and about 16% farmers thought that it has no effect on agricultural crops.

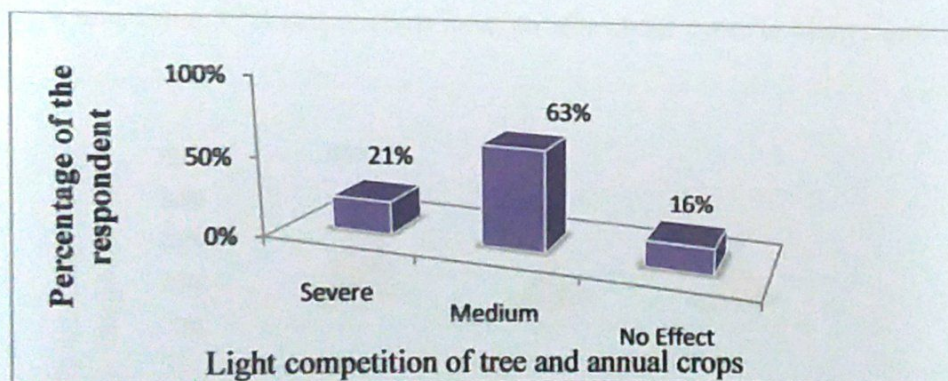


Fig-18: Effects of Light competition between trees and annual-crops.

5.5.1.4. Role of litter fall and green manure:

The farmer's response positively in case of litter fall and green manuring role of trees on their farm land. About 71% of the respondents thought that the trees can play an important role to make their land fertile by discharging the leaves i.e. green manuring. About 16% farmers specially who mainly dependent on agricultural crops rather than fruit products thought that

Mangifera Indica & *Ziziphus Mauritiana* has a little negative impact on annual crops. It is more interesting that about 13% farmers have no idea about litter fall and green manure. They inspired by seeing others.

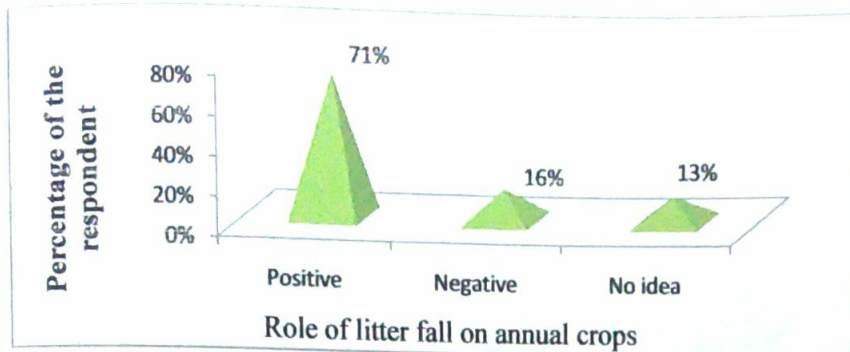


Fig-19: Role of litter fall and green manure on annual crops

5.5.1.5. Role of water holding capacity:

According to the farmers of the study area there is an important role of trees to increase the water holding capacity of the soil. About 60% of the respondent thought that trees can play an important role (positive role) to increase the water holding capacity. So that in the summer season, there is no serious water scarcity for agricultural crops. But 21% of the respondents thought negative and about 19% respondents have no idea about water holding capacity.

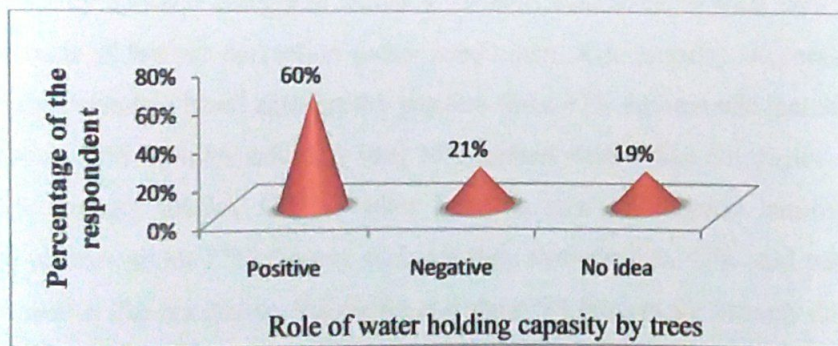


Fig-20: Role of soil water holding capacity by trees

5.5.1.6. Role of soil erosion control:

According to the farmers of the study area there is an important role of trees to reduce soil erosion control. About 75 % of the respondent thought that trees can play an important role (positive role) to reduce soil erosion control. So that in the rainy season, there is no serious soil

erosion in this locality due to trees and crops. Only about 9% respondents thought that in rainy season trees play important role to increase soil erosion and about 16% thought that trees has no effect on soil erosion.

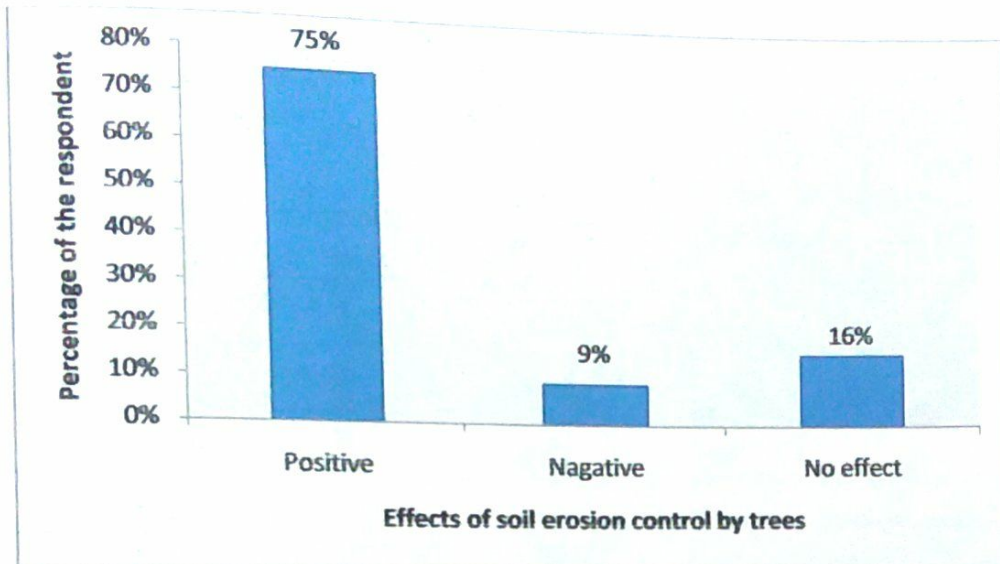
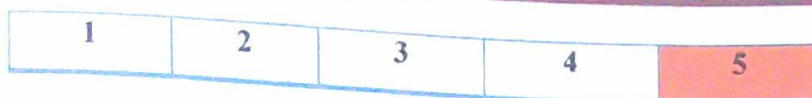


Fig-21: Role of soil erosion control by trees and annual crops.

5.5.2. Suitability between *Mangifera indica* & *Ziziphus mauritiana* to Plant with Agricultural Crops:

To know suitability between *Mangifera indica* & *Ziziphus mauritiana* to plant with agricultural crops on the basis of farmers perception author used Likert scale properly. According to likert scale for *Mangifera indica* based agroforestry practice about 47% farmers said that they strongly like this practice, 30% farmers said they like, 10% farmers neither like nor dislike, 5% dislike and only 3% strongly dislike. On the other hand, in case of *Ziziphus mauritiana* based Agroforestry practice about 27% farmers said that they strongly like, 43% said that they like, 15% farmers neither like nor dislike, 9% dislike and about 6% farmers are strongly dislike.

Mangifera indica



Ziziphus mauritiana

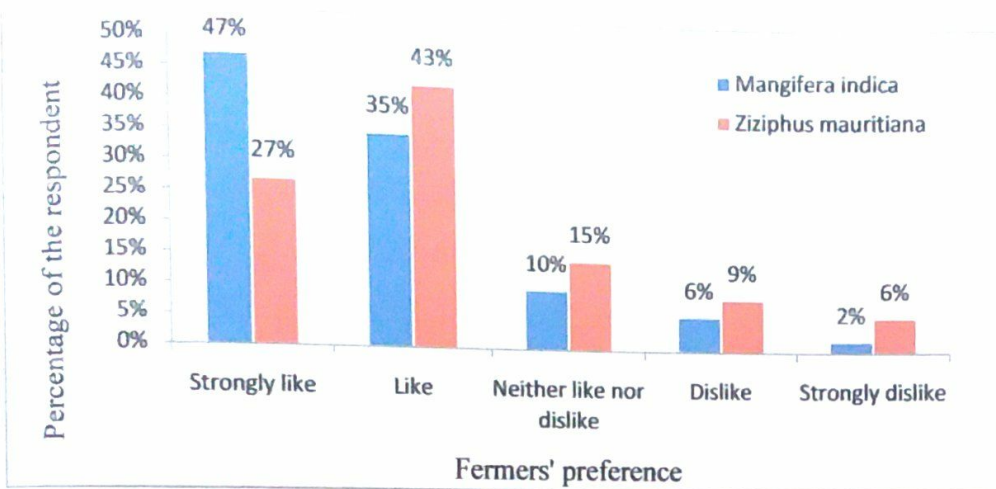
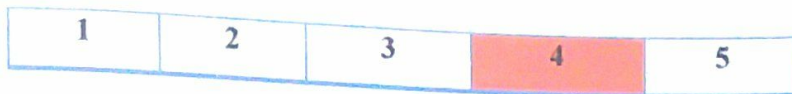


Fig -5.22: Respondents preference according to likert scale.



Pic-5.5: Field survey in the study area.

5.6. Problems of Agroforestry Practice with *Mangifera indica* & *Ziziphus mauritiana* from Respondents' Points of View:

The respondents of Meherpur district were faced various types of problem during practice of AF. Some of the problems which said by the farmers are given below:

- In the study area author found that there is a great problem which is disease and insect attack of the *Mangifera indica* & *Ziziphus mauritiana* species which decreases the productive capacity of the tree species and even causes mortality of the tree species.
- Maximum farmers practice *Mangifera indica* & *Ziziphus mauritiana* based Agroforestry in a small piece of land as their lands were fragmented and small. Consequently neighbouring farms were affected by shade and nutrients uptake.
- Good quality seedlings were not available nearby their agroforestry farm land. Most of the farmers (94%) collected seedlings from long distance and sometimes they bring seedlings from other districts at high price.
- Inadequate surface water sources during irrigation period of cultivation. Most of the farmers used ground water for irrigation in their agricultural lands which are costly and unfriendly to environment.
- Lack of capital and appropriate technology.
- Farmers had no separate grazing land for livestock. So, animals were grazing in the agroforestry farms. So damage by animals was a major problem for agroforestry practice.
- Due to planting trees in cropland, harmful birds, pests/insects etc. got suitable habitat on these trees. So these birds and pests/insects could easily damage the annual crops.
- After 5 to 6 years, when the tree species covered more area, it used to spread its root system and take more nutrients. As a result, agricultural crops used to get little food and the respondents had to give more fertilizer to increase nutrients in the field.
- Sometimes, collection of food and harvesting or pruning of trees made hamper to the under crops.

CHAPTER - SIX
CONCLUSION AND RECOMMENDATIONS

Chapter – Six: Conclusion and Recommendation

6.1. Conclusion:

Fruits have become an integral part of human diet as they supply vitamins and minerals, the important constituents essential for human health . So the demand of fruit trees are always high in the total world. Among various fruit trees *Mangifera indica* and *Zizyphus mauritiana* are very popular and common in our country. They are gaining popularity with the growers because of higher yield, good return and suitability for the arid and semi-arid regions of Bangladesh where as most of the other fruit crops can not be grown either due to lack of proper irrigation facilities or adverse climatic and soil condition.

Jessore District is very suited place for growing *Mangifera indica* and *Zizyphus mauritiana* where many people prefer to practiced agroforestry with these two types of species. They practiced *Mangifera indica* and *Zizyphus mauritiana* based agroforestry to generate income as well as to mitigate their family demand in fruits, fuelwood, timber etc. So both of *Mangifera indica* and *Zizyphus mauritiana* species are preferable to them for agroforestry practice. But last two years many farmers faced a great problem that is disease attack and high rate of mortality of *Zizyphus mauritiana* species which decreased productive capacity. For this many of them who previously practiced *Zizyphus mauritiana* based agroforestry are clear their land and introduced *Mangifera indica* based agroforestry. So it is evident from the present studies that, *Mangifera indica* is more preferable to the farmer for agroforestry practice than *Zizyphus mauritiana*.

6.2. Recommendations:

- ❖ Most of the farmers didn't know about the suitable spacing to cultivate *Mangifera indica* and *Zizyphus mauritiana* species in different agroforestry practices and they used haphazard spacing between the trees. Spacing of the trees actually depends on environment, land use practices, objectives of the land uses and socio-economic conditions of the farmers. To identify the perfect spacing between the trees in different agroforestry practices is an important issue and further study can be done on this issue.
- ❖ Socio-economic studies should be undertaken to identify the problems, potentials & needs for agroforestry research. Research should focus on: Improvement of the existing tree production systems & management practices, introduction of appropriate multipurpose nitrogen –fixing & fast growing woody perennials & suitable annual

Chapter – Six: Conclusion and Recommendation

crops species & design of site specific, multistory production systems with woody perennials.

- ❖ Part of the study area is suitable for agroforestry practice. But in this area all the farmers are not practice agroforestry. So, for increasing awareness about agroforestry, motivational program can be taken by government and NGO. Radio, TV program, Drama show also can be helpful for disseminate the awareness about agroforestry.
- ❖ Proper marketing channel should be established for the selling and buying of the products. Actual price should be ensuring for the farmer. Communication system should be developing with the study area to Dhaka city. So they get proper marketing facilities and actual price of their products.
- ❖ Research back-up should be strengthened to devise appropriate & rapidly replicable models of AF for extension to the local people by the government agencies & NGO's. Various organizations like BFRI, BARC and BARI etc. should involve in more & more research in this region to facilities the development of existing technologies.
-Financial support should be given to the farmers through NGO's, Forest department & Agriculture bank with low interest.
- ❖ To increase and to develop the agroforestry systems in the study area, some steps can be taken by the Government such as –
 - Training center for developing agroforestry practices can be established at the Upazilla level of the study area so that Local people can take training and technical advice.
 - Government should ensure the availability of fertilizer, pesticides and other necessary materials in the market with legal price.
 - Financial assistance should be given to the local people who are interested in agroforestry practices.
 - Good quality seed, seedlings and other good quality planting materials should be supplied to the poor farmers.
 - The market system of the agroforestry products should be available and free from corruption so that farmers can be encouraged to produce more products to earn cash money.

CHAPTER - SEVEN

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Fermers' Preferences To Plant *Mangifera indica* & *Ziziphus mauritiana* in Agroforestry Practice in Jessore District

FIELD SURVEY QUESTIONNAIRE

Date:

Questionnaire No:

A. Socio-Economic and Demographic information:

1. Name: Age: Sex:

2. Location: Village: Union..... Upazilla:

3. Occupation: Primary..... Secondary

General Information of the Respondent:

Name	Age	Sex		Education Level		Employment		Total no. Of family member	Total income (yr)
		Male	Female	Male	Female	Male	Female		

4.Total land area:(Bigha):;(Hectare):

- Arable:
- Homestead:
- Agroforestry land:

5. Ownership status: a) Own land b) Leased c) Both

If leased, how much many have to pay per year for per ha/bigha?

6. Ownership pattern: a) jointly b) single

If jointly, for why?

7. Previous land use system: In homestead: ; In arable land:

8. How many years practicing Agroforestry ?

B. About Agroforestry Practice with *Mangifera indica* & *Ziziphus mauritiana*:

1. Do you practice *Mangifera indica* & *Ziziphus mauritiana* based agroforestry?

a) Yes b) No

2. Why you prefer *Mangifera indica* or *Ziziphus mauritiana* for agroforestry practice?

3. Which species you prefer best between these two types of species? Why?

4. In which type of land do you like to introduce these type of practice?

Fallow land/ Homestead land/ Agricultural land/Marginal land/others:

5. What is the land condition where do you practice?

Sloppy or flat/Low or high/waterlogged or rainfed/others:

6. Which types of soil do you prefer for practice? Why?

7. When you planted *Mangifera indica* & *Ziziphus mauritiana*?

8. Source of planting material/seedling: a) Raised b) Purchased

If raised, then source of the seed:

9. Age of the seedling at the planting time:

10. Height of the seedling at the planting time:

11. What types of arrangement of the tree components?

Intercropping/Alley cropping/Strip cropping/Hedgerow or boundary plantation/Random
plantation/others:

- What is the spacing of tree species that you follow?
- Distance between trees to trees:
- Distance among alleys:
- Distance between alleys:

12. How many tree species did you plant in your AF land (per ha) area?

13. What types of products do you get from tree crops?

Cash/ Timber/ Food/ Fuel/ Fodder/Others

14. Which type of annual crop do you prefer? Why?

15. Number of annual crops usually practiced in each year? 1/2/3/4.

16. Name of the crop(s) grown here for last here:

a. b. c. d.

17. Total amount of annual crops production /ha/yr:

18. Best individual annual crop description:

a. Name of the crop:

b. Return/production/ha/year:

c. Time taken for this return:

19. What is your purpose for practicing such AF technologies?

20. Do you think these type of practice hamper your traditional agricultural practices?

a. Yes b) No

If yes, then how:

If no, then what is own perceptions about this practice?

21. Is there any contribution of this practice to your sustainable livelihoods?

Employment opportunity/Income opportunity/social status/Physical status/Human nutrition/Food security/other:

22. What are the environmental benefits of your practices?

- Water holding capacity increase

- soil erosion control/soil fertility
- biodiversity conservation
- Windbreak and other.

23. Is this practice fulfilling your satisfaction level? (From environmental and socio-cultural point of view).

Yes/ No. If yes, then how:

24. Will you continue this practice in the future?

1. Yes; why?

2. No; why?

25. Is these type of practice getting popularity in this area

1. Yes; why?

2. No; why?

26. Have you got help from any organization: Yes/ No

If yes, then

- What types of organization that is: NGO/ GO

- What is the name of that organization?

- What type of helps did/ do you get: a) Financial b) Technical c) Adversarial

Do you think that this assistance is sufficient for you?

27. Problems according to the participants in this practice?

28. What is your suggestion(s) for developing such practice in this region?

C. Management strategies:

1. Ground operation:

Soil working: a) Yes b) No

If yes, how you do soil working:

2. Tending operation:

a) Weeding: a) Yes b) No

If yes, then

- a) Time of weeding
- b) Objective of weeding

b) Thinning: a) Yes b) No

If yes, then

- i. Time of thinning
- ii. Intensity of thinning

c) Pruning: a) Yes b) No

If yes, then

- a) Types of pruning: natural/artificial
- b) Year of pruning: 1/2/3
- c) Pruning: regular/irregular
- d) Intensity of pruning.

d) Protection: a) Yes b) No

If yes, then

- a) Protection techniques
 - ◆ Fencing
 - ◆ Trench
 - ◆ Pesticides
 - ◆ Fungicides
 - ◆ Others

e) Fertilizing: a) Yes b) No

If yes, then

a) Types of fertilizer: organic/in organic

b) Time (age of trees):

c) Frequency:

d) Quantity:

D) Recommendation from Respondent:

E) Recommendation from Researcher:

Signature:

Date.....

Appendices- TWO

1. Demographic and socio-economic Profile of the Respondents in Jessore District:

Characters	Categories		Percentage (%)
Age(Year)	<20 years	Male	18
		Female	15
	21-40 years (middle aged)	Male	48
		Female	42
	41-60 years	Male	29
		Female	25
> 60 years	Male	5	
	Female	18	
Educational qualification	Primary	Respondents	15
		Respondents' family	27
	Secondary	Respondents	41
		Respondents' family	43
	Higher	Respondents	13
		Respondents' family	16
Illiterate	Respondents	31	
	Respondents' family	14	
Profession	Farmer		61
	Businessman		19
	Labor		14
	Service holder		6
Annual income	(<3 lakh) Tk.		37
	(3- 10 lakh) Tk.		44
	(>10 lakh) Tk.		19
Ownership status	Own land		48
	Leased land		19
	Both		33
Ownership pattern	Single		81
	Jointly		19

Appendices-Three

2. General informations About Agroforestry Practice With *Mangifera indica* & *Ziziphus mauritiana*:

Agroforestry Practice With <i>M. indica</i> & <i>Z. mauritiana</i>	Categories		Percentage (%)
Land Preference	Homestead land		21
	Agricultural land		61
	Gher land		18
Source of planting material	Perchased		91
	Raised		9
Silvicultural Operation	Thinning		9
	Pruning		31
	Both		63
Ground operation	Practice		93
	Not Practice		7
Tending Operation	Protection	Use	91
		Not use	9
	Fertilizing	Use	85
		Not use	15
Market facilities	Excellenent		25
	Good		56
	Poor		19
Resource diversification	Cash		95
	Food		90
	Fuelwood		75
	Timber		17
Farmers' Preference	<i>Mangifera indica</i>	Strongly like	47
		Like	35
		Neither like nor dislike	10
		Dislike	6
		Strongly dislike	2
	<i>Ziziphus mauritiana</i>	Strongly like	37
		Like	33
		Neither like nor dislike	15
		Dislike	9
		Strongly dislike	6