STUDY ON AGRO-ECONOMIC PERFORMANCE OF MANGO BASED AGROFORESTRY SYSTEM AT SHIBGONJ UPAZILA UNDER CHAPAI NAWABGONJ DISTRICT

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CERTIFICATE

*This is to certify that the thesis entitle "**STUDY ON AGRO-ECONOMIC PERFORMANCE OF MANGO BASED AGROFORESTRY SYSTEM AT SHIBGONJ UPAZILA UNDER CHAPAI NAWABGONJ DISTRICT**" submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science (MS) in Agroforestry and Environmental Science,** embodies the result of a piece of bonafide research work carried out by **MST. ATIA KHATUN,** Registration No.**09-03393**, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that any help or sources of information, as has been availed of during the course of investigation have been duly acknowledged.

Dated: June, 2015
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Dedicated to
My
Beloved Parents

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ABSTRACT

A survey was carried out at Shibgonj Upazila under Chapai Nawabgonj District to identify the mango based agroforestry systems, their production technologies, economic returns and problems faced by the respondents. To achieve the objectives, a simple random sampling technique was adopted to collect the necessary information through a structured questionnaire during January to March 2015. SPSS Computer package program 16.0 was used to analyze the data. Results revealed that the existing mango based agroforestry system is profitable and has a great opportunity to increase national production to feed the growing population. There is a scope of adopting improved management practices and it may increase the total production. Based on crop condition with mango forest, a total of 12 mango based agroforestry systems were identified. The most frequent observed mango based agroforestry systems were Mango + Turmeric (85.00%) and Mango + Ginger (78.75%). Maximum respondents (72.50%) commented that 10 - 12 year aged mango tree performed best yield. Some problems were identified in respect of mango based agroforestry systems. About 40% respondents faced medium level of problems for marketing of mango. The discounted benefit cost ratio (2.006), and the internal rate of return (29%) clearly indicated that mango based agroforestry system was productive and economical system.

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LIST OF ABBREVIATIONS

AEZ	=	Agro Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCR	=	Benefit Cost Ratio
CF	=	Cash Flow
CV	=	Cultivar
cm	=	Centimeter
DBCR	=	Discounted Benefit Cost Ratio
DR	=	Discounted Ratio
et. al.	=	et allii (and others)
g	=	Gram
HYV	=	High Yielding Variety
Ha	=	Hectare
ICRAF	=	International Council for Research in Agroforestry
IRR	=	Internal Rate of Return
Kg	=	Kilogram
Km	=	Kilometer
LER	=	Land Equivalent Ratio
m	=	Meter
MP	=	Murate of Potash
NPV	=	Net Present Value
PV	=	Present Value
TSP	=	Triple Super Phosphate
TSS	=	Total Solid Substance
t/ha	=	Ton per Hectare
SD	=	Standard Daviation
%	=	Percent

CHAPTER 1

INTRODUCTION

Agroforestry is the collective name for all land use systems and technologies where woody perennials are deliberately grown on the same land management units as agricultural crops and/or animals in some form of spatial arrangement or temporal sequence. There must be significant ecological and economical interactions between the woody and non-woody components (Lundgren and Raintree, 1982). Through agroforestry, important forest products and desirable forest environment may be obtained almost everywhere in the country (Manandhar 1986). Bangladesh is one of the most densely populated countries in the world bearing about 149.77 million people and the density of population is about 1015 per square kilometer (BBS 2011). The forestry situation in Bangladesh is also reveals a dismal picture. Bangladesh has about 17% forest (BBS 2011) but the effective tree covered area is estimated at around 10%. This remaining forest is also shrinking gradually due to encroachment for human habitation and agricultural expansion.

To maximize the crop production to feed the increasing population various types of practices such as mixed cropping, alley cropping, multistoried cropping system are adopted in Bangladesh. Like other district Chapai Nawabgonj is also a highly populated district in Bangladesh. Rapid population growth has created severe pressure on the agricultural land. In this situation mango based Agroforestry can play an important role to improve the production level in this district as well as in the whole country by producing different types of vegetables and spices along with mango fruit.

Mango (*Mangifera indica*) is the favorite fruit in Bangladesh and has been repeatedly acclaimed as the king of fruits (Ahmed, 1994). Mango belongs to the family Anacardiaceae is a tropical to sub-tropical fruit. It is the most

important economic and delicious fruit. The plant starts bearing 3 to 5 years after planting and reaches their maximum bearing capacity within 12-15 years.

In Bangladesh, mango ranks first in terms of area and third in production (BBS 2008). So, combined production of vegetables and mango play important role in human nutrition as sources of vitamins and minerals which are not in adequate qualities in other food items such as wheat, rice etc. Barind ecosystem (Rajshahi Region) is unfavourable for field crop production but suitable for production of fruits like mango, litchi and jujube etc (Sarker *et al*. 2014). Cultivating various vegetables and spices such as Chilli, Brinjal, okra, sweet gourd, yam, aroid, Indian spinach, turmeric, ginger etc. especially in the early developing stage of mango tree (generally 1 to 10 years) under the mango tree, there is a great scope for increasing the production of vegetables throughout. A mango based cropping was conducted with ginger, turmeric, tomato, cowpea, French bean, ragi, niger and upland paddy (Swain, 2014). The average annual net returns of the traditional agrisilvicultural practices were found much higher than the agriculture (Abedin and Quddus, 1991). Mango is the principal fruit in Chapai Nawabgonj. But the farmers are loosing their interest in such kind of agroforestry system due to some problems. Agroforestry system especially Mango based agroforestry may be popular among the farmers if effective measures are taken for increasing production and different management practices.

On the above considerations, the following objectives are considered regarding "Agro-Economic Performance of Mango Based Agroforestry in Shibgonj Upazilla under Chapai Nawabgonj District".

1. To identify the mango-based Agroforestry systems,
2. To assess the contribution of this practice to economic condition of the society, and
3. To identify the problems and constraints faced by the farmers in practicing this systems.

CHAPTER 2

REVIEW OF LITERATURE

This chapter is a review of past studies having relevance to the research problem. However, the reviews are presented in different sections as follows:

2.1 Concept of Agroforestry and importance

Agroforestry has been promoted as a sustainable and ecologically sound alternative approach to manage upland landscapes. It involves the integration of annual and perennial food crops as well as livestock, which renders social, economic and environmental benefits (Leakey, 1996). However, the question is whether it is financially attractive for farmers to adopt.

A number of studies have been undertaken to determine the financial viability of agroforestry systems. Many of these studies have sought to examine the financial cost of establishing, managing and producing various combinations of agricultural and timber crops as well as the potential gross revenues and profitability (Grado and Husak, 2004). The adoption of agroforestry systems has proven a financially viable and an attractive land use alternative in various settings throughout the world (Garrett 1994, as cited in Grado and Husak, 2004). The increased financial benefits from practicing agroforestry may stem from increased biophysical productivity or reduction in input costs (Franzel, 2004).

Franzel (2004) observed that analyzing the economics of agroforestry practices is more complicated than of annual crops because of the complexity of agroforestry systems and the time lag between tree establishment and harvest. Also, the analysis should include the valuation of all components of the ecological systems, including the agriculture, forestry, wildlife, livestock and other activities to (Grado and Husak, 2004).

Agroforestry is being practiced from the time immemorial in different countries in different forms. John Bene of Canada gave first widely accepted definition. According to Bene *et al.* (1977) 'Agroforestry is a sustainable management system for land that increases overall production, combines agricultural crops, tree crops and forest plants and/or animal simultaneously or sequentially and applies management practices that are compatible with the cultural patterns of a local population'.

Lundgren and Raintree (1982) stated that agroforestry is the collective name for all land use systems and technologies where woody perennials are deliberately grown on the same land management units as agricultural crops and/or animals in some form of spatial arrangement or temporal sequence. There must be significant ecological and economical interactions between the woody and non-woody components.

Nair (1983) defined agroforestry as a collective name for all land use systems and practices where woody perennials are deliberately grown on the same land management unit as agricultural crops or animals in some form of spatial arrangement or temporal sequence.

From a business point of view, agroforestry is an economic enterprise which aim to produce a combination of agricultural and forest crops simultaneously on the same land area (Duldulao, 1983).

Agroforestry is a land-use system that involves socially and ecologically acceptable integration of trees with agricultural crops and/or animals, simultaneously or sequentially, so as to get increased total productivity of plant and animal in a sustainable manner from a unit of farmland, especially under conditions of low levels of technology inputs and marginal lands (Nair, 1989).

Jackson (1987) stated that agroforestry systems that incorporate a range of tree and crop species offer much more scope for useful management of light interception and distribution than monoculture forest and agricultural crops. The potential benefits as a result of combining field crops with trees are so

obvious from consideration of the waste nutrient resources experienced in orchards and tree crop combination.

Agroforestry system offers a great scope for efficient nutrient use because of their distinct root system. Trees is known to be deep rooted and are desired as "Nutrient pump" which use nutrients from below the crop rooting zone and recycled them to the crop in litter fall and in the green pruning (Beer, 1988).

Akhter *et al.* (1989) mentioned that farmers also consider tree as savings and insurance against risk of crop failure and low yield, as well as assets for their children. Some farmers stated that tree would contribute toward expenses for marriage of their daughters.

Agroforestry is practiced on homegarden (Millat-e-Mustafa, 1997), cropland (Roy, 1996), forestlands etc. However, the sustainability of these practices, a major concerns in Bangladesh. Agroforestry is considered an efficient and sustainable land use option specially suited for resources poor farmers (Stocking *et al.*, 1990).

Agroforestry can provide a sound ecological basis for increased crops and animal productivity more dependable economic returns and greater diversity in social benefits on a sustainable basis (Saka *et al.*, 1990).

Abedin *et al.* (1990) mentioned that agroforestry is considered as one of the strategies for augmenting tree production for a country like Bangladesh where there is a little scope of developing pure forest due to obvious priority for food crop production.

Abedin and Quddus (1990) reported that successful introduction of fast growing exotic tree species and increasing awareness of the multipurpose use of indigenous tree species, the potential of agroforestry for environments improvement and in sustaining increased output of food and forest produce needs to be exploited.

According to Fernandes and Nair (1990), the term agroforestry is refer to land-use practices involving deliberate management of multipurpose trees and invariably livestock within the compounds of individual houses, the whole crop-tree- animal units being intensively managed by family labour. It can therefore, be seen that home gardens display many agroforestry features: the intimate mixture of diversified agricultural crops and multipurpose trees fulfils most of the fundamental needs of the local populations, and their multistoried configuration and high species diversity avoid the environmental deterioration commonly associated with monoculture production systems.

Khandaker (1991) reported that agroforestry system is traditional in the homesteads of moist tropical world including rural areas of Bangladesh since the establishment of houses. This system could be considered as potential technology for rural poverty alleviation because of its diversified functions.

Lawrence and Hardostry (1992) mentioned that the landowners cited potential advantages to practicing agroforestry were land use diversity (25 percent), enhanced productivity (18 percent), aesthetics (13 percent), income diversity (13 percent) and the most frequently identified potential obstacles to practicing agroforestry were: lack of information (28 percent), lack of technical assistance (18 percent), establishment cost (14 percent) and the fact that it is not an established practice (14 percent). They also found that the responses suggested there is great potential for application of agroforestry throughout the state, and non-industrial private forestland owners were selected for future study of this potential.

Anoja and Wickramasinghe (1992) reported that village agroforcstry systems in Sri Lanka associated with age-old tree-use practices that have evolved through farmers' experience to meet survival needs. The benefits of village agroforestry systems were diverse, but food products were of outstanding importance among them.

Agroforestry system that incorporate a range of tree and crop species offer much more scope for useful management of light interception and distribution than do monoculture forests and agricultural crops (Miah, 1993).

Agroforestry is a dynamic, ecologically based, natural resource management system that, through the integration of trees in farm and rangeland, diversifies and/or sustains agricultural production for increased social, economic and/or environmental benefits (Leakey, 1996).

Wickramasinghe (1997) illustrated that agroforestry is important for income, nutrition and health, for reducing economic reducing economic risk and for improving food security at health, for reducing economic risk and for improving food security at household level. Home gardens were seen as having potential role to play in maintaining biological diversity at both his species and sub species level.

Solanki (1998) reported that agroforestry can significantly contribute in increasing demand of fuel wood, fodder and lack of cash and infrastructure in many developing countries. He also stated that agroforestry has high potential with simultaneously 3 important objectives: (i) protecting and stabilizing the ecosystems, (ii) producing a high level of output of economic goods (fuel, fodder, small timber, organic fertilizer etc.) and (iii) providing stable employment, improved income and basic material to rural populations.

Despite the apparent simplicity and productivity of monoculture agriculture, there are numerous advantages to be gained from the inclusion of tree species. Trees provide food, feed, fiber, fuel, medicines, timber, pole and other products and, in providing additional outputs, can increase the value of an agricultural system. The multiple outputs of tree systems can reduce the risk associated with agriculture. If the one species fails to produce, either because of insect attack or adverse weather, there is the possibility of production from a second species. With two outputs, some market risk is alleviated, if the selling price of one output is low, it may not be so with the second output (Wojtkowski, 1998).

Nasaruddin *et al.* (2000) carried out a study in Malaysia to analyze the current agroforestry practices adopted there and reported that agrosilvicultural is the main system being practiced, which is reflected in the major tree/crop components in a given site.

Basavaraju and Gururaja (2000) concluded that selection of suitable tree species for agroforestry is important. However, it is not always possible to select tree species having all the desirable characteristics for agroforestry, because of different production and protection goals. It is stated that in such cases, agroforestry systems have to be managed through planting optimum tree density of trees, proper special arrangement and pruning and thinning of tree crown and roots to reduce the negative effects of trees.

Scherr and Franzel (2000) stated that successful diffusion and adoption of new agroforestry practices depends not only upon the technical performance of those practices and their fit with farming systems, but also on the broader policy management. Key policy factors relate to: tree germplasm supply, agricultural input supply, markets for agroforestry products, land and forest tenure systems and strategies and institutional arrangements for extension and research support. On-farm research during the technology development process provides a strategic opportunity to begin evaluating policy constraints and ways to address them.

Neupane and Thapa (2001) cited that the practices which minimize the rate of soil degradation, increase crop yields and raise farm income are key to sustaining agricultural productivity in the hills of Nepal. They also stated that agroforestry has great potential for enhancing food production and farmers' economic conditions in a sustainable manner through its positive contributions to household income.

2.2 Agroforestry in Bangladesh context

Agroforestry is comparatively a new concept in Bangladesh, but some of its systems such as homestead agroforestry, have been existing in this country for long unknown periods.

According to Hossain and Shailo (1987), the present annual demand of fuelwood in the country stands in 2.04 million m^3 and the timber at 0.92 million m^3 where as the supply is presently 0.61 million m^3 and 0.76 million m^3, resulting in a deficit of 1.42 million m^3 of fuel wood and 0.16 million m^3 of timber. There is possibility of meeting this deficit through the practice of Agroforestry system.

Nair (1989) reported that Agroforestry is not a new enterprise since it has been practiced under different conditions and in diverse locations at least a century. The taungya system is the most popular and very ancient Agroforestry system originated with the Burmese (Myanmar) hill-farming experience using teak as the forest crop and was later adapted in Bangladesh at Kaptai in Chittagong district in the early 1870s.

Abedin *et al.* (1990) mentioned that Agroforestry is considered as one of the strategies for augmenting tree production for a country like Bangladesh where there is a little scope of developing pure forest due to obvious priority for food crop production.

According to Haque (1996), at least 20 percent of the total land area of the country out side of the forest coverage may be brought under the coverage of trees if afforestation is applied properly and extensively. Through agroforestry, the people of Bangladesh can get more food, enough timber as well as better environment to live in.

2.3 Traditional Agroforcstry in Bangladesh

Agroforestry is a century old livelihood production systems in most of the ecosystems particularly floodplain, hill and terrace ecosystems of Bangladesh.

According to Miah, *et al.* (2002), the major traditional Agroforestry systems, which have been playing significant role in livelihoods, income generation and environmental management of the country are briefly highlighted below:

2.3.1 Homestead Agroforestry: In homestead system, trees, shrubs and herbs arc grown in close association with the different strata (Mustafa, 1995) depending on household's needs and preferences as well as ecosystem determinants. Species combination varies from place to place but dominated by fruit trees particularly *Mangiferu imlica. Artocarpus heterophyllus, Areca catechu, Cocos nucifera, Psidium guajava* and *Musa spp.* The density of trees per unit area varies from homestead to homestead. Usually smaller farms tend to plant more trees per unit area.

2.3.2 Cropland Agroforestry: Floodplain and terrace are the major ecosystems of Bangladesh in terms of traditional farmland agroforcstry systems. Some most important traditional systems, on the basis of tree species dominance with reference to ecosystems are described below:

2.3.3 *Phoenix sylvestris* based system (Date palm)

Phoenix sylvestris (Date palm) system is dominant in the rain fed and irrigated highland ecosystem of High Ganges River floodplain in the south and southwest region of Bangladesh. Date palm is also used as minor species in *Artocurpus heterophyllus* based system in the floodplain and in the terrace ecosystem of the central region of the country.

2.3.4 *Borassus flahellifer* based system (Palmyra palm)

Borassus flabellifer (Palmyra palm) based system is predominantly distributed in the Lower Ganges Floodplain area in the central-south region, southwest coastal region and in the terrace ecosystem of central and northwest regions.

2.3.5 *Artocarpus heterophyllus* based system (Jackfruit)

Artocarpus heterophyllus (Jackfruit) based system in predominantly distributed in the central terrace ecosystem in the central region and sporadically in almost all over the country except the saline coastal region. The lateritic highland soils of Bhawal and Madhupur tract are ideal for jackfruit, which is planted systematically as orchard as well as along boundaries and within fields randomly.

2.3.6 *Acacia nilotica* based system (Babla)

Acacia nilotica (Babla) is adapted in flood free and drier areas of High Ganges River floodplain and terrace ecosystem of high Barind tract covering parts of Rajshahi, Pabna, Natore, Kushtia and Jessore districts.

2.3.7 Shifting Cultivation: The hill ecosystem represents 10-12 percent of the total land of the country covering the Chittagong Hill tracts, Sylhet and Mymensingh districts. The hill ecosystem represents the oldest agroforestry practices in the country known as Jhum or shifting cultivation. This shifting cultivation is the center of livelihood activities of the tribal peoples living in these hill tracts.

2.3.8 Taungya System: In the hills, the Taungya system, which was introduced to Bangladesh in 1971 by the then British government. Under this system, teak plantations were established in the Chittagong hill tracts. Though introduced for leak plantations, the Taungya system was subsequently extended to all types of forest plantations provided the forest soil was fertile enough to sustain a good agricultural crop. Tea gardens present a unique feature of Agroforestry systems in Sylhet region where tea is cultivated under the shade of big trees.

Another sonic minor systems such as *Dalbergia sissoo* based system, tree-betel leaf peeper association. Lac culture, sericulture and apiculture arc also traditionally practiced.

Hocking (1986) stated that some 15 million household of the country occupy about 0.3 million hectare under traditional Agroforestry practice in homestead.

According to FAO (1986), home garden is one of the most elaborate systems of indigenous Agroforestry found most often in tropical and sub tropical areas where subsistence land use systems predominate.

In traditional Agroforestry systems of Bangladesh, farmers consider trees as savings and insurance against risk of crop failure or compensate low yields of crops (Akhtar *et al.*, 1989).

Abedin and Quddus (1991) described in detail of the traditional cropland agroforcstry systems in the Ganges floodplain region of Bangladesh A few trees of *Phoenix sylvestris*, *Borassus flabellifer*, *Bombax malaharicum* and other are also often found on the higher parts, particularly on plot boundaries in the districts of Chuadanga, Meherpur and Kushtia, recently there has been a growing trend, particularly along the richer farmers, to plant *Dalbergia sissoo* trees on agricultural lands, with regular spacing and with primary emphasis on the timber crop.

2.4 Climate and soil for Mango forestry

According to Singh (1969) mango grows up to an altitude of 4,000 feet but the fruiting is poor above 2,000 feet. Chacko and Randhawa (1971) attributed the delay of the latter to the low temperatures that prevail in northern India. Singh (1969) stated that mango can grow in almost all types of soil. But a well drained, deep loamy soil is generally conducive to successful mango culture. The pH range of soil from 5.5 to 7.5 is desirable. Bondad (1989) stated that many of the mango growing areas have well drained loamy soil with pH 5.0-7.0. Hossain (1994) stated that although Bangladesh is basically good for mango cultivation yet the more favoured areas are the North-West and

relatively lesser favoured are in the extreme South-East and North-East considering the climate (altitude, latitude, temperature, rainfall, relative humidity) and soil. North-Western region have high temperature, low rainfall and humidity than Eastern side which favours the production of good quality mango.

In Philippines, the Mango Committee (1978) recommends the growing of the crop in a well-drained deep loamy soil with an elevation below 600 m and pH of 6 to 8. Ahmad (1989) stated that the optimum soil for mango is about in two meter in depth. The tolerable pH range being as wide as 4.0 to 8.5, though optimum is said to be 5.5 to 7.5. The soil should be provided with organic matter, phosphorus and sulphur, besides usual nitrogen and potassium. According to Singh (1969) mango is damaged by frost at temperatures below 1.1 °C to 2.2 °C. Grafted plants are more susceptible than seedlings, especially during the first three years. Ideal growth takes place at 23.9 °C to 26.7 °C. Singh (1969) stated that mango grows successfully in areas with an annual rainfall of 771 mm to 642.5 mm with little or no irrigation.

Bondad and Valmayor (1979) stated that mango requires relatively higher temperatures but there are variations in cultivar responses. They observed that in wet areas where Pico and Carabao did not perform well, but Kachamitha flowered profusely and fruited abundantly. Ahmad (1989) narrated that setting of fruits is adversely affected by fog, rain or cloudy weather in January to March when the trees flower. Mild showers at the time of development and enlargement of fruits are good, but storms affect them adversely, often resulting in immature fruit- drops. Webster (1920) stated that mango will flourish under abundant rain throughout the year but for fruit production the tree can not be grown where much rain falls from December to May. Hartless (1914) reported that a number of climatological factors such as temperature, at the time of bloom, affect the setting of the fruits adversely. Singh (1960) observed that there appears to be no well- established effect of temperature on the date of the start or- extent of bud break.

2.5 Mango based Agroforestry system

Mango base Agroforestry have got a number of desirable attributes as a good agroforestry combination, particularly in the context of Bangladesh.

Abedin and Quddus (1990) recorded 28 different tree species in the homestead of the Barind Tract in Rajshahi district. *Mangifera indica* and *Phoenix sylvestris* were the most dominant species, whereas *Artocarpus heterophyllus* was only of minor occurrence. They also mentioned that the average tree density was higher in Potuakhali and Rangpur (1.5 and 1.4 trees/10 m^2 respectively) than in Rajshahi (0.7) where the annual rainfall is the lowest in Bangladesh. Miah *et al.* (1990) found that farmers generally prefer fruit trees over fuel/timber species in their homestead.

The purpose of the study was to determine the diversity and distribution of fruit species in the homestead and to explore the relationship between farmers' characteristics and fruit diversity in their homestead. In the study, 28 fruit species were identified. Among 28 fruit species. Banana, Mango and Jujube were found in the 100% homestead surveyed. The Relative Prevalence of most common species like Banana, Betel nut. Coconut, Date, Mango, Papaya, Guava, Jujube were very high while that of less common species like Kaow, Pineapple, Litchi, Star apple etc. were found very low. Black berry and Jujube were found highly diverse (0.986) fruit species followed by Mango (0.984), Jackfruit (0.984). The traditional homestead fruit production system and fruit diversity in the study area was found very poor due to management practices. Fruit diversity should be increased to fulfill the nutritional needs as well as to conserve the genetic resources and environmental balance (Rahman and Hasanuzzaman, 2009).

Mannan (2000) in a study of 3 agro-ecological region found higher fruit diversity than that of vegetable and timber. Sellathurai (1997) also found higher diversity in his study. Mannan (2000) found higher fruit diversity in Gazipur than that of Bandarban and Naogaon. He also found fruit diversity ranged from

0.000 to 0.920 over the region. Mango was found highly diverse fruit species in the fruit group. Mannan *et al.* (2004) found fifty seven different mango local varieties at 150 household.

The Relative Prevalence of most common species like Banana, Betel nut, Coconut, Date, Mango, Papaya, Guava were very high while that of less common species like Kaow, Pineapple, litchi were found very low. Alam et al. (1990) found mango as the most prevalent among the horticultural species followed by guava, jackfruit, coconut and jujube. Chowdhury and Sattar (1992) found coconut as the most prevalent among the fruit species followed by jackfruit, date palm, banana and mango. Mannan (2000) observed Mango as the most prevalent among the fruit species followed by Jackfruit, guava, jujube, coconut etc.

Singh *et al*. (2013) conducted a field experiments to investigate the suitability and profitably with different intercrops of cowpea, frenchbean, arhar, soyabean, lentil, blackgram and chickpea in mango orchard (cv. Himsagar). The age of the plant is 7 years old with a spacing of 10x10m which provide the utilization of land space between the plants as an intercrop. Pooled data reveals that the maximum number of fruits 192.41 / tree and yield 46.09 kg / tree were found in Mango + Cowpea whereas maximum fruit weight (254.16 g) in Mango + Lentil. Most of the physical parameters such as fruit length and breadth maximum were recorded (8.20 cm and 7.21 cm respectively) in Mango + Cowpea. But, in case of peel weight (35.67 g) was highest in Mango + Soyabean whereas the higher stone weight (35.79 g) was in sole crop (Mango) only. Again, pulp weight and pulp: stone ratio (193.53 g and 5.80) were observed in Mango + Frenchbean respectively. The quality parameters such as TSS, reducing sugar, vitamin c, acidity and shelf-life showed non-significant variation among the different treatments.

From an experiment, the results demonstrate the potential of leguminous crops to improve the ecological stability in traditional fruit orchards. *Cajanus cajan*

achieved the highest yield of dry biomass (11.04 t/ha) and the treatment with *Phaseolus vulgaris* produced 0.73 t/ha. The soil cover integrating leguminous crops increases soil fertility and benefits insect populations. Mango yield was highest in combination with *Phaseolus acutifolius* (9.13 t/ha) and *Cajanus cajan* (7.42 t/ha). Additionally, more abundance and diversity of insect population was observed when intercropping leguminous crops between the mango trees Agreda *et al*. (2006).

A mango based cropping study was conducted with ginger, turmeric, tomato, cowpea, French bean, ragi, niger and upland paddy by Swain (2014). The results of the study revealed that the mango + guava + cowpea combination exhibited better performance which has been reflected in the form of plant height, girth, canopy area, fruit weight and fruit yield of mango closely followed by mango + guava + French bean system. The mango plants, under study, however, did not exhibit any kind of variation in quality parameters in fruits. The leguminous intercrops, cowpea and French bean, were the most effective crop because of their desirable impact on improvement of nutrient status of soil and plant of mango orchard. Highest LER was obtained with mango + guava +cowpea combination (4.17) followed by mango + guava + French bean. The highest benefit, cost ratio (2.02) was recorded in the mango + guava + cowpea combination, which was almost similar to that of mango + guava + turmeric, mango + guava + French bean and mango + guava + tomato.

The mango plants when planted at a spacing of 10 × 10m provide an ample scope for growing of short duration crops as intercrops during initial years. The inter row space in mango remains underutilized in the early growing period and during which short duration, location specific and market driven crops may be grown as intercrops and filler crops thus, allowing one to grow more than one crop and also to efficiently utilize the space and other natural resources. The intercrops under mango base Agroforestry not only generate an extra income but the practice also helps to check the soil erosion through ground coverage and improves the physico-chemical properties of the soil. Different crops

cultivation base on fruit garden is one of the techniques of land utilization for optimum production (Bhattanagar *et al*. 2007). Experimental evidences have also proved that yield stability is grater with intercropping than sole cropping. Different other crops based on fruit forest can provide substantial yield advantages compared with sole cropping.

Behera *et al*. (2014) stated that demand of food can probably be met through more intensive crop production with increase in productivity per unit area and time. Mango trees provide enough space even if they are fully grown as they do not cover much area. It is possible to grow a mixed fruit orchard, such as mango intercropped with other fruit crops, vegetables and spices during initial years of establishment. Intercropping in mango with suitable crops bring good income and improves the fertility of the soil. During the first few years, intercropping can be practiced with no shortage of irrigation. Intercropping of some vegetables and spices in plantation can be practiced if sufficient irrigation and manuring facilities are available.

Behera *et al*. (2014) also studied on development of mango based intercropping and observed that it is the need of hour to increase production along with increasing income of mango growers. Keeping the above facts in to consideration different intercrops like pineapple, turmeric and ginger were tried in mango orchard with and without application of biofertilizers. Growing of intercrops like ginger, turmeric and pineapple with biofertilizers and inorganic fertilizers in mango orchard revealed that maximum mango yield was recorded intercropping with turmeric with application of biofertilizers (36.87 quintal per hectare) followed by intercropping with ginger with application of biofertilizers (34.47 quintal per hectare) and minimum was recorded in control (22.07 quintal per hectare) where no intercrop was grown over the two years of investigation. The percentage increase of yield over control is 40 per cent. The application of biofertilizers also increased the yield over control and inorganic fertilizers to the ton of 48 per cent and 20 per cent, respectively.

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

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

Sarker *et al*. (2014) conducted a comparative study with a total of 85 mango growing farmers by interviewing. They observed that Barind ecosystem (Rajshahi Region) is unfavourable for field crop production but suitable for production of fruits like mango, litchi and jujube etc.

CHAPTER 3

MATERIALS AND METHODS

This Chapter included the detailed procedures that were used in conducting the study. This Chapter also included brief description of the study area and characteristics of the sample farmers. The geographical location, agro-ecological region, topography, climate, land use and socio-economic characteristics of the sample farmers are described in the following sections:

3.1 Selection of the study area

The study was conducted at Shibgonj Upazilla under Chapai Nawabgonj district during January to March 2015. This Upazila was selected purposively for data collection on mango based agroforestry practices, because this Upazila is very much famous for mango production in Bangladesh. After short visit and discussion with local people of Shibgonj Upazilla under Chapai Nawabgonj district was selected for this study. Out of eighteen (18) unions of Shibgonj Upazilla, eight (8) unions were selected purposively as the locale of the study. Among other things, the following considerations were kept in mind during selection of the study area:

i) Concentration of Mango gardens
ii) No systematic study on this aspect had yet been conducted
iii) Easy accessibility to collect required information and
iv) Good co-operations from the respondents in view of getting reliable and valuable information

3.2 Geographical location and area

The study was conducted at Shibgonj Upazila of Chapai Nawabgonj District under Rajshahi Division. The study area is located in the north-east region of Rajshahi. It was about 36 km away from Rajshahi City and about 10 km away from Chapai Nawabgonj District head quarter (Figure 1 and 2 showing Map of Shibgonj Upazila and Chapai Nawabgonj district).

3.3 Agro-ecological region

The study area belonged to the different Agro-ecological Zone (AEZ). Chapai Nawabgonj district is under the AEZ-6: Lower Punarbhaba Floodplain, AEZ-10: Active Ganges Floodplain, AEZ-11: High Ganges River Floodplain and AEZ-26: High Barind Tract (BBS 2010).

3.4 Crops and cropping pattern

In upland soils (i.e. Chala) brinjal, turmeric, ginger, chili, sponge gourd, snake gourd, country bean, teasle gourd, ladys finger, bitter gourd, bottle gourd, cucumber, amaranth, jackfruit, lotkon, mango, banana, olive, lemon, papaya, guava etc. are mainly cultivated. In medium high land and medium low land and low land, local and high yielding variety of transplanted Aman and Boro rice, are grown under irrigated condition.

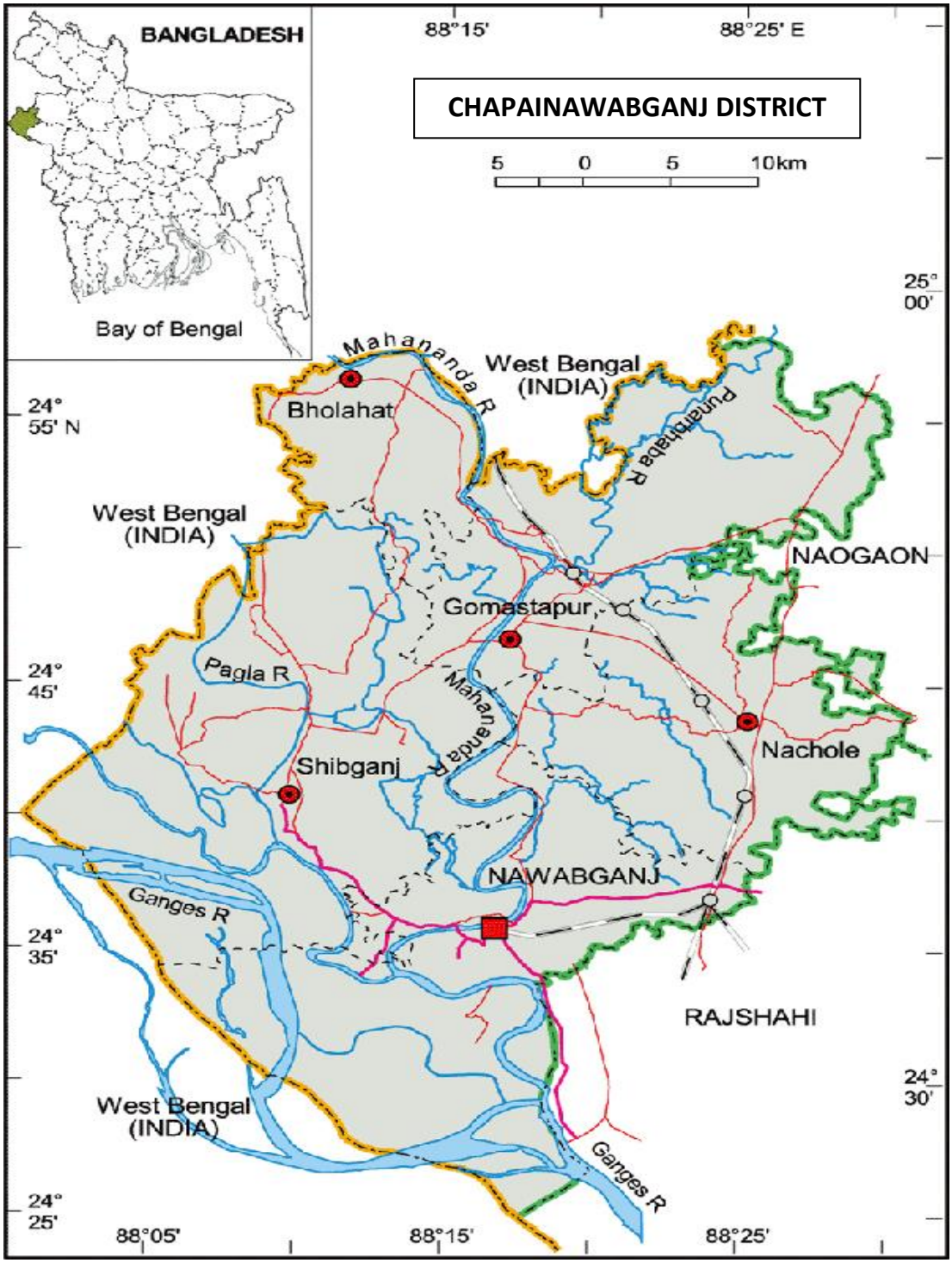


Figure 1. Map showing locale of the study area at Chapai Nawabgonj district.

Figure 2. Map showing locale of the study area at Shibgonj Upazila under Chapai Nawabgonj district.

3.5 Period of the study

The study was conducted during the period from January to March 2015 through field testing of interview schedule, direct interviewing of the respondents, field visit and observations, and discussion with the concerned experienced farmers.

3.6 Sampling procedure

At the first phase of the study, it is concerned that it is generally not possible to make survey covering all the respondents. For the convenience of time and money, a simple random sampling technique was followed.

All Mango growers of eight (8) unions of Shibgonj Upazila constitute the population of the study. There are about 1005 mango farmers in these 8 unions Ten (10%) percent of the population were proportionately randomly selected as the sample of the study by using random number table. Thus, Sample sizes of the study were 100 farmers and among them eighty (80) respondents were selected randomly from the selected areas. A structured questionnaire was used to collect information on mango based agroforestry practiced from the selected respondents.

3.7 Preparation of interview schedule

Based on the field observation and objectives of the study, an interview schedule was prepared. The draft interview schedule was validated in the field and then necessary modifications were done incorporating the information recorded during the testing of the interview schedule. After pretesting and necessary adjustment, a final schedule was prepared to collect data from the selected respondents. The interview schedule of the present study is presented in Appendix 1.

3.8 Methods of data collection

Before going to make an actual interview, a brief introduction of the aims and objectives of the study were explained to each respondent. When they were assured that the study was purely academic and had no other purpose, they provided their cooperation to the researcher. The necessary information was collected by the researcher herself during the period of the study. After completion of each interview, the schedule was checked and verified to be sure that the answers were correct. In order to minimize errors, data were collected in the local units. The local units were later converted into standard units.

3.9 Data analysis

Collected data of the present study were summarized and scrutinized carefully for statistical analysis using SPSS 16.0, computer software for analyzing Social Science data. In order to achieve meaningful conclusions, tabular technique of analysis was intensively used because its simplicity. Finally, relevant Tables were prepared according to the requirements of data presentation to meet objectives of the study. In order to evaluate the mango based agroforestry system, investment analyses were carried out considering the timing of benefit and costs throughout the rotation period of mango and mango based Agroforestry systems. Three discounted measures as suggested by Guittinger (1982) and followed by Hasan *et al.* (1991) and Uddin and Hasan (2003) for the present investigation.

3.9.1 Discounted Benefit cost ratio (DBCR)

Benefit-cost ratio is the ratio of discounted benefit divided by discounted cost. It implies the benefit derived from one unit of cost.

$$\text{Benefit-Cost Ratio (BCR)} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}$$

Where, B_t = Gross benefit in i^{th} year

C_t = Total cost in i^{th} year

t = Number of years (1, 2, 3, ... n)

i = Interest rate

3.9.2 Net present value (NPV)

This is the present value of the cash flow stream. It can be computed by subtracting the total present value of cost from the total present value of benefit.

$$\text{Net present value (NPV)} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}$$

3.9.3 Internal rate of return (IRR)

It is the discount rate, which just makes the net present value of cash flow equal to zero. It represents the highest possible rate of return from an investment over the project life. Internal rate of return is that discount rate 'i' such that,

$$\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0$$

The operating formula of calculating IRR is,

$$\text{IRR} = \text{Lower discount rate} + \text{Difference between the two discount rates} \left(\frac{\text{Present value of cash flow at lower discount rate}}{\text{Absolute difference between the present values of cash flow at the two discount rates}} \right)$$

3.10 Procedure for computation of cost and return

To determine the profitability, it is necessary to compute all the cost items and deduct them from the gross value of outputs, which the farmer produces.

3.10.1 Estimation of cost

The farmers practicing mango based agroforestry system had to incur costs for different inputs, which are used in the production process. The input items were valued at the prevailing market price and something government price. In calculating the production cost, the cost of various components like human labor, seedling, cowdung, fertilizer, irrigation, interest on operating capital, land use, pruning, thinning etc. were considered.

(a) Cost of human labor

Human labor cost for different operations such as land preparation, sapling/seedling transplantation, application of fertilizer and irrigation, pruning, harvesting, marketing etc. were calculated by the actual wages (with/without meal). The farmers were paid for these operations. The labor has been measured in a man-day unit, which usually, consisted of 8 hours in a day. In this study, labor wages was considered at Tk. 200 per man-day in 15 years ago on the basis of farmer's assumption.

(b) Cost of seedlings

For cost of seedlings, prevailing market price during transplantation. At that time, the price of mango seedlings was considered at Tk. 150.00 per seedling

(c) Cost of manures and fertilizer

Farmers use different types of manures and fertilizers such as cowdung, vermicompost, urea, TSP, MP, oil cake etc. for growing mango and associated crops. Cost of fertilizer was estimated on the basis of actual market price. The price of cowdung/vermicompost, urea, Triple Super Phosphate (TSP), Murate of Potash (MP), oil cake was 1.50, 16.00, 24.00, 16.00, 20.00 respectively in the present year and 2.00, 12.00, 15.00, 10.00, 16.00 respectively in the 15 years ago.

(d) Cost of irrigation, drainage, pruning/thinning and pesticide application

Farmers need to apply irrigation in the mango garden during and/or before/after cultivation with or without other associated crops and also need to apply for drainage, pruning/thinning and pesticide application on the same condition. Cost was calculated regarding operational item for one or two or more operations.

(e) Cost of interest on operating capital

Interest on operating capital was calculated taking into account of non-material inputs like human labor for land preparation, transplantation, application of fertilizer and pesticides, weeding, harvesting etc. and material inputs like seedlings, fertilizers etc. used in mango production. Hence, interest was charged as per prevailing bank rate of 12% per annum interest rate of opportunity capital for mango production. It was assumed that if the farmers would deposit the money in a bank, he would have received some interest at that rate. It was computed by using the following formula –

Interest of operating capital = Operating cost × Rate of interest × Time

(f) Land use cost

The cost of land use was estimated by the cash rental value of land. In calculating the land use cost, the average rental value of land per hectare for a particular year was used. Rental value of land use cost was calculated according to farmers' statement.

(g) Yield and return

In case of grafted plants of mango, the effective return was considered from the age of 3. A feature of other crops in mango garden like turmeric, ginger etc. production is also done continuously during the year round. In the study area, price of mango varied from Tk. 50 to 60 per kg.

CHAPTER 4

RESULTS AND DISCUSSION

The present investigation was conducted with a survey from sample farmers of Shibgonj Upazila under Chapai Nawabgonj District in respect of mango based agroforestry system regarding different production technologies, existing situations on problems and advantages, productivity and profitability and management practices against adverse situation. Obtained results, different suggestions and future plan from the selected respondents have been discussed by the following headings:

4.1 Characteristics of the sample farmers

4.1.1 Age

Age of the farmers were categorized into three groups as young age (<30 years), middle age (31 - 50 years) and old age (> 50 years) (Table 1). The observed ranges among the respondents were (23 – 62) years with mean values of 47.43 and standard deviation of 10.54. The results showed that maximum farmers were in old aged (47.5%) where the lowest was in young aged (7.5%) and 45% was as middle aged farmers. Under the present study, results revealed that relatively aged farmers were exclusively involved with mango based agroforestry system.Similar findings were reported by Ahmed (2008).

Table1. Distribution of respondents according to their age

Age level	Age range (year)	Respondent		Mean	SD
		Number	Percent		
Young age	< 30	6	7.5	47.43	10.54
Middle age	31 – 50	36	45		
Old age	> 50	38	47.5		
Total	23 - 62	80	100		

4.1.2 Education

Education of the farmers was categorized into five groups as no education/can sign only (0 -0.5), primary education (1 - 5), secondary education (6 -10), HSC education (11 - 12) and above HSC education (> 12). The observed score range among the respondents was (0-16) with mean values of 4.50 and standard deviation of 2.17 (Table 2). It can be said that an educated person is able to proper use of his land and other resources by adopting modern technologies. The results showed that the maximum farmers had primary education (40%) followed by secondary education (23.75%) and HSC education (12.50%) respectively. It was also observed that only (3.75%) farmers had above HSC level education which was the lowest in number among the respondents.These findings were supported by Biswas (2003) and Asaduzzaman (2003).

Table 2. Distribution of respondents according to their education level

Educational level	Score range	Respondent		Observed score	Mean	SD
		Number	Percent			
No education/can sign only	0 -0.5	16	20.00	3	4.50	2.17
Primary education	1 – 5	32	40.00	68		
Secondary education	6 – 10	19	23.75	133		
HSC education	11 – 12	10	12.50	114		
Above HSC education	> 12	3	3.75	42		
Total	0 – 16	80	100	360		

4.1.3 Occupation

Various occupations were observed among the respondents. The main occupations of the respondent farmers are presented in (Table 3). In the present investigation it was observed that there were four categories of occupation as agriculture, business, poultry farming and day labor. The 4 main occupations were scored as 4, 3, 2 and 1 respectively. The observed score range among the respondents was (1-4) with mean value 3.18 and standard deviation of 1.34. The results showed that among the respondents, agriculture was the primary occupation and more than half of the respondents (52.5%) were under this category followed by business (22.5%), Poultry farming (15%) andday labor (10%).

Table 3. Distribution of respondents according to their occupation status

Occupation	Score	Respondent		Observed score	Mean	SD
		Number	Percent			
Agriculture	4	42	52.5	168	3.18	1.34
Business	3	18	22.5	54		
Poultry farming	2	12	15	24		
Day labor	1	8	10	8		
Total	1 - 4	80	100	254		

4.1.4 Family size

Family size (number of family members) of the farmers was categorized according to their age group. Total family members of 80 respondents were 274 with mean values of 3.43 and SD of 1.07 (Table 4). It was found that the highest family members (140 out of 274) were under > 50 years age group where 31 – 50 and < 30 years age group restrained 116 and 18 family members respectively.

Table 4. Distribution of respondents according to their family size

Category of family size according to age	Number of respondents	Number of family members			Mean	SD
		Male	Female	Total		
< 30	6	10	8	18	3.43	1.07
31 – 50	36	64	52	116		
> 50	38	72	68	140		
Total	80	146	128	274		

4.1.5 Land ownership

The land ownership of the respondent farmers is presented in (Table 5). Five categories of land ownership was under the present study as landless (0-49 decimal), marginal (50-149 decimal), small (150-249 decimal), medium (250-749 decimal) and large (above 750 decimal). Average land ownership was 207.88 decimal with the standard deviation of 9.74. Halves of the respondent farmers (50.0%) was marginal farmers (50%) whereas 3.75%, 30%, 10% and 6.25% farmers were landless, small, medium and large farmers, respectively.

Table 5. Distribution of respondents according to their land ownership

Categories of the farmers	Number of respondents	Percent	Total land (decimal)	Percent of total land	Average farm size (decimal)	SD
Landless (0-49 decimal)	3	3.75	127.50	0.77	207.88	9.74
Marginal (50-149 decimal)	40	50.00	4900.00	29.46		
Small (150-249 decimal)	24	30.00	5395.50	32.44		
Medium (250-749 decimal)	8	10.00	3568.00	21.45		
Large (above 750 decimal)	5	6.25	2640.00	15.87		
Total (23 – 864 decimal)	80	100.00	16631.00	100		

4.1.6 Size of homestead and mango garden

Two categories as homestead (2068 decimal) and mango garden (14563 decimal) with standard deviation of 3.65 and 8.83 respectively was revised under the present study (Table 6). Majority land of the investigation area was cultivated under mango garden (87.57%) where homestead garden was under (12.43%). The present findings showed that the maximum respondent farmers wereinhabited to production mango because of their mango garden area was more than homestead area under mango based agroforstry system in the study area.Sarker *et al. (*2014) found similar findings in their studies.

Table 6. Distribution of respondents according to homestead size and mango garden

Category	Land size (decimal)/Person	Percent	Average (decimal)	SD
Homestead	2068	12.43	25.85	3.65
Mango garden	14563	87.57	182.04	8.83
Total	16631	100.00	--	--

4.2 Existing agroforestry system

Diversification was found regarding existed mango based agroforestry system atShibgonjUpazilla under ChapaiNawabgonj District. Farmers of the studied area were found to cultivate different vegetables in associated with mango trees. However, a total of 12 different mango based agroforestry systems were identified in the investigated area (Table 7). The most frequently mango based agroforestry systems were mango + turmeric (85.00%), mango + ginger (78.75%), mango + chilli (75.00%), mango + eggplant (55.00%), mango + snake gourd (40%), mango + ridge gourd (28.00%), mango + bottle gourd (22.50%), mango + cucumber (15.00%), mango + hyacinth bean (10.00%), mango + sweet pumpkin (8.75%) and mango + bitter gourd (17.50%). The most frequently observed mango based agro forestry systems showed that the

maximum land of the studied area was cultivated by mango with turmeric (85.00%) followed by mango with ginger, chilli and eggplant where the lower area was mango with sweet pumpkin (8.75%) followed by hyacinth bean, cucumber and bitter gourd. Finally it revealed that turmeric is the best associated crop with mango tree under mango based Agroforestry system.

Table 7. Distribution of respondents according to mango based agroforestry system

Agroforestry system	Number of respondents	Percent respondents	Total land (decimal)	Average land (decimal)	SD
Mango + Turmeric	68	85.00	4255	62.57	4.36
Mango + Ginger	63	78.75	3038	48.22	3.88
Mango + Chilli	60	75.00	912	15.20	2.64
Mango + Eggplant	44	55.00	708	16.09	3.48
Mango + Snake gourd	32	40.00	630	19.69	1.73
Mango + Ridge gourd	23	28.75	388	16.87	2.18
Mango + Bottle gourd	18	22.50	320	17.78	3.66
Mango + Cucumber	12	15.00	321	26.75	2.47
Mango + Hyacinth bean	8	10.00	110	13.75	1.14
Mango + Sweet pumpkin	7	8.75	305	43.57	3.47
Mango + Bitter gourd	14	17.50	672	48.00	3.18
Mango + Sweet potato	13	16.25	312	24.00	2.37

4.3 Vegetable production season

In the study area the vegetables growing season was presented as winter and summer and both in winter and summer season (Table 8). The investigation revealed that the maximum farmers cultivated vegetables in winter season (45.00%) and the minimum number of farmers (26.25%) cultivated vegetables in summer season and only 28.75% farmers were involved for vegetable cultivation both in winter and summer season. In the study area it was

observed that all around the year mango based vegetable cultivation was continued. Singh *et al*. (2013) also found the similar result.

Table 8. Distribution of respondents according to vegetable growing season

Season	Number of respondents	Percent	Average land size (decimal)	SD
Winter	36	45	146.06	6.54
Summer	21	26.25	132.95	5.39
Both in summer and winter	23	28.75	170.48	6.88
Total	80	100	--	--

4.4 Farmers experience in mango production

Experience with mango gardening means how long the farmers are related with mango production. Farmers' experience in mango cultivation in the study area was long and it varied from 3 to 35 years with the mean value of (11.19) and standard deviation of (5.56). Farmer's experiences under mango cultivation were categorized into four levels as 3 - 7 years, 8 - 12 years, 13 - 17 years and 18 to above. Investigation showed that most of the respondents (45.00%) were experienced with mango cultivation for 8-12 years. On the other hand the minimum number of respondents (11.25%) were experienced with 18 and above years followed by (17.50%) and (26.25%) respondents with 3-7 years and 13-17 years experience respectively.

Table 9. Distribution of respondents according to their experience with mango gardening

Experience (year)	Farmers opinions			
	Number of respondents	Percent	Mean	SD
3 - 7 years	14	17.50	18.64	9.56
8 - 12 years	36	45.00		
13 - 17 years	21	26.25		
18 to above	9	11.25		
Total	80	100		

4.5 Land type for mango gardening

In the study area the land type is categorized into four levels as high, medium high, low and medium low (Table 10).In the invested area it was observed that the half of the total respondents (50%) practiced mango base agroforestry in medium high land and the minimum number of respondents (12.50%) was under high land followed by medium low and low land (17.50% and 20% respectively). The result showed that medium high land is appropriate for practice of mango based agroforestry system.

Table 10. Distribution of respondents according to land type for mango based agroforestry system

Land type	Number of respondents	Percent
High	10	12.50
Medium high	40	50.00
Low	14	17.50
Medium low	16	20.00
Total	80	100

4.6 Types of planting materials

In the studied area farmers were found to use two types of planting materials viz. vegetative propagation materials and true seedling from seed for establishing mango garden (Table 11). The investigation showed that most of the respondents (90%) used vegetative propagation materials for mango gardening where only 10%of the total respondents used seedling from seed. Use of vegetative propagation materials for mango garden was popular might be due to cause of quality fruits and return of output within short duration.

Table 11. Distribution of respondents according to use of planting materials for mango gardening

Types of planting materials	Number of respondents	Percent
Vegetative propagation	72	90
Sapling from seed	8	10
Total	80	100

4.7 Source of planting materials

In the study area respondent farmers were found to collect planting materials from nursery, local marker and both nursery and local market (Table 12). Above two third of the respondent farmers (71.25%) collected seedling from nursery and only 10% respondent farmers collected seedling from both nursery and local market and only (13%) of the total respondent farmers collected seedling from local market. The investigation showed that nursery is the chief source than the others might be due to cause of quality seedling with cheaper rate and good transportation from here.

Table 12. Distribution of respondents according to source of planting materials

Source of seedling	Number of respondents	Percent
Nursery	57	71.25
Local market	13	16.25
Both nursery and local market	10	12.5
Total	80	100

4.8 Age of seedling

Age of seedling is a major factor for better growth of fruit plantand sustainable production of mango. Mainly age of seedling usually depends on availability and supply of seedling. The study area is well-known for seedling production in nursery. The investigation showed that there were three types of aged seedling were planted in the mango garden (Table 13). The results revealed that maximum respondent farmers (56.25%) used 6 months to 1 year aged seedling and the minimum number of respondent farmers (11.25%) used 1.5 year to 2 years aged seedling in their mango garden where (32.50%) respondent farmers used 1 year to 1.5 year agedseedling. Here, it can be mentioned that 6 month to1 year aged seedling is more suitable for proper productionand was proved by the studied respondents.

Table 13. Distribution of respondents according to seedling age use for mango gardening

Age of seedling	Number of respondents	Percent
6 months - 1year	45	56.25
1 year - 1.5 year	26	32.50
1.5 year - 2 year	9	11.25
Total	80	100

4.9 Planting time of seedling

Farmers in the studied area start to plant mango seedling in March and continue up to October (Table 14). The result revealed that most of the respondent farmers (55%) planted mango seedling in June-July. On the other hand the minimum number of respondent farmers (7.50%) planted mango seedling in September- October where (37.5%) of the respondent farmers planted mango seedling in March- April. In the investigation it was found that June-July is the optimum planting time for mango seedling atShibgonjUpazila under ChapaiNawabgonjDistrict regarding mango based agroforstry system.

Table 14. Distribution of respondents according to perception of planting time of mango seedling

Planting time	Number of respondents	Percent
March – April	30	37.5
June – July	44	55
September - October	6	7.5
Total	80	100

4.10 Amount of fertilizer use

Farmers in the study area were found to use different types of fertilizers at different doses for different aged mango tree (Table 15). The investigation showed that farmer used 345, 250 and 200 gm of urea, TSP and MP respectively for 2- 5 years old mango tree; 750, 375 and 300 gm urea, TSP and MP respectively for 6 – 10 years old tree; 1000, 500 and 400 gm of urea, TSP and MP respectively for 11 – 15 years old and 1500, 750 and 500 gm of urea, TSP and MP respectively for above 15 years old mango tree with every single tree/year (Table 15). Present investigation showed that fertilizer doseis increased with the advancement of age of mango tree.

Table 15. Amount of fertilizer used at different aged mango tree per year (g/tree/year)

Age category (in year)	Amount of fertilizer (g/tree/year)		
	Urea	TSP	MP
2 - 5 year	375 (350 - 400)	250 (200 - 300)	200 (150 - 250)
6 - 10 year	750 (700 - 800)	375 (350 - 400)	300 (250 - 350)
11 - 15 year	1000 (900 - 1100)	500 (450 - 550)	400 (350 - 450)
Above 15	1500 (1400 - 1600)	750 (700 - 800)	500 (450 - 550)

4.11 Irrigation schedule

The frequency of irrigation in mango tree was presented in (Table 16). The investigations showed that for proper growth and development of mango tree farmers apply three types of irrigation. Actually three times were selected for irrigation according to the respondent's practices as only before flowering, only prematurity stage and both before flowering and pre maturity stage. The result revealed that majority of the respondent farmers (75%) applied irrigation twice in a season that in before flowering and pre maturity stages. Only (8%) and (12%) respondent farmers applied irrigation into mango garden in pre maturity stage and before flowering respectively.

Table 16. Distribution of respondents according to application of irrigation in mango orchard

Time of irrigation	Responses of farmers	
	Number of respondents	Percent
Only before flowering	12	15
Only pre maturity stage	8	10
Both before flowering and pre maturity stage	60	75
Total	80	100

4.12 Pruning

Pruning is a great factor for successful mango production due to reduce insect and disease infestation, balanced growth and development of fruit and tree. Farmers in the study area pruned mango tree twice in a year (Table 17). Once it was done before flowering and another after harvesting. Investigation showed that majority respondent farmers (60.00%) pruned mango tree after harvesting where 40% respondent farmers pruned mango tree before flowering.

Table 17. Distribution of respondents according to their opinion regarding pruning practices

Time of pruning	Responses of farmers	
	Number of respondents	Percent
Before flowering	32	40
After harvest	48	60
Total	80	100

4.13 Disease infestation

Disease infestation is a great threat for mango production. The investigations showed that diseases attack in mango tree was very harmful for desired mango production. In the study area the identified diseases were die-Back, sooty molds, scab, powdery mildew, pink disease, anthracnose, fruit rot, black banded disease, black mildew and twig blight (Table 18). The results revealed that most of the respondents (50.00%) opinioned that powdery mildew was the most harmful diseases followed by sooty molds (45.00%), dieback (35.00%) and scab (30.00%) respectively. Another way almost the minimum number of respondents (6.25%) opinioned that black banded diseases attacked mango garden followed by pink diseases and black mildew (7.50%), Anthracnose (12.50%), Fruit rot (20%) and Twig blight (15%).

Table 18. Distribution of respondents according to disease infestation in mango orchard

Name of the diseases	Responses of farmers	
	Number of respondents	Percent
Dieback	28	35.00
Sooty molds	36	45.00
Scab	24	30.00
Powdery mildew	40	50.00
Pink disease	6	7.50
Anthracnose	10	12.50
Fruit rot	16	20.00
Black banded disease	5	6.25
Black mildew	6	7.50
Twig blight	12	15.00

4.14 Insect infestation

The area of investigation the identified insects were fruit piercing moths, mango seed weevil, mango shoot caterpillar, mango leafhopper, mango stem miner, queensland fruit fly, red-banded thrips, spiralling whitefly, fruit-spotting bug and mango tipborer (Table 19). The result revealed that (40.00%) respondents estimated that mango leafhopper attacked mango tree serioslyfollowed by mango shoot caterpillar (32.50%) and spiralling whitefly (30.00%), mango stem miner (22.50%), mango tip borer (20.00%), mango seed weevil (18.75%) and queensland fruit fly (17.50%) where the minimum number of respondents (6.25%) expressed their opinion against fruit piercing moths followed by fruit-spotting bug.

Table 19: Distribution of respondents according to insects' infestation in mango orchard

Insect infestation	Responses of farmers	
	Number of respondents	Percent
Fruit piercing moths	5	6.25
Mango seed weevil	15	18.75
Mango shoot caterpillar	26	32.50
Mango leafhopper	32	40.00
Mango stem miner	18	22.50
Queensland fruit fly	14	17.50
Red-banded thrips	12	15.00
Spiralling whitefly	24	30.00
Fruit-spotting bug	8	10.00
Mango tipborer	16	20.00

4.15 Control measures

Farmers in the study area were found to adopt different control measures against insect and diseases. Scoring was done on yes for 1 and no for 0. The responses among the respondents as yes or no was with mean values of 0.324 and standard deviation of 0.90 (Table 20). Investigation showed that (90.00%) of the respondents applied control measures against diseases and pest and 10.00% of them did not apply any control measures.

Table 20. Distribution of respondents according to control measure against pest and diseases

Responses of farmers	Number of respondents	Percent	Mean
Yes	72	90	0.324
No	8	10	
Total	80	100	

Scoring: Yes = 1 and No = 0

4.16 Age of mango plant for higher production

Mango plants start comparatively higher fruiting from 4 years and continue up to 50 years (Table 21). Scoring was given as 1 for each year of plant age. Observed score range based on age of mango tree for higher production, mean values were 11.58 years with standard deviation of 6.42. All the respondent farmers stated that 4 - 6 year aged mango tree was not suitable for commercial production of mango. Maximum respondents (72.50%) argued for 10 - 12 year aged mango tree for highest production followed by 13 - 15 year aged mango tree and gradually increased aged tree gave gradually decreased mango yield.

Table 21. Distribution of respondents according to age of mango tree for maximum production

Age category (year)	Responses of farmers			
	Number of respondents	Percent	Mean	SD
4 - 6 year	0	0.00	12.48	6.42
7 - 9 year	6	7.50		
10 - 12 year	58	72.50		
13 - 15 year	12	15.00		
Above 15 year	4	5.00		
Total	80	100		

4.17 Marketing of mango

In the investigated area there were four types of marketing systems of mango were identified as middle man, retailer, lease (contract basis) and self marketing (Table 22). Different marketing systems were developed as middle man, retailer, lease or contract basis and self marketing and scoring was given by 4, 3, 2 and 1 respectively for measuring more active existing situation for marketing of mango. Total obtained score was 211 with mean values of 2.64 and standard deviation of 1.12. Investigation showed that the highest number of respondent farmers (50%) sold their products by the contract basis or lease system where 16.25%, 18.75% and 15% respondents were dependent on middle man, retailer and self marketing respectively.

Table 22. Distribution of respondents according to marketing of mango

Marketing system	Observed/obtained score	Responses of farmers		Mean
		Number	Percent	
Middle man	13	13	16.25	2.64
Retailer	30	15	18.75	
Lease (contract basis)	120	40	50	
Self marketing	48	12	15	
Total	211	80	100	

Scoring: 4 = Self marketing, 3 = Lease (contract basis), 2 = Retailer and 1 = Middle man

4.18 Marketing of vegetables

Three types of marketing systems of vegetables were identified in the study area as wholesaler, retailer and self system which was scored as 3, 2 and 1 respectively to measure strong existing marketing system. The obtained scored was 112 with mean value of 1.40 and standard deviation of 0.64 (Table 23). The results indicated that the maximum respondent farmers (70.00%) depends

on wholesaler for selling their vegetables where 8.00% respondents sold their vegetables by self marketing system and 16.00% of the total respondent farmers sold their products to retailer. The result revealed that in the studied area maximum farmers contracted with vegetables marketing by wholesaler.

Table 23. Distribution of respondents according to marketing of vegetables

Marketing system	Observed/obtained score	Responses of farmers		Mean	SD
		Number	Percent		
Wholesaler	56	56	70.00	1.40	0.64
Retailer	32	16	20.00		
Self system	24	8	10.00		
Total	112	80	100		

Scoring: 3 = Self marketing, 2 = Retailer and 1 = Middle man

4.19 Marketing problems of mango

Three categories of marketing problems were identified as low, medium and high on the basis of information on lack of communication facilities, middle man interference, lack of storage facilities, lack of marketing infrastructure and lack of processing industries given by the respondents and scoring was done by 5, 4, 3, 2 and 1 respectively. The total obtained score was 711 with mean value of 8.89 and standard deviation of 5.87 (Table 24). Investigations showed that 40.00% of the total respondent farmers faced medium problems where 22.50% respondents faced low problems and 37.50%respondent faced high marketing problems of mango. In the studied area, results revealed that every respondent's farmers had to face some marketing problems.

Table 24. Problems of mango marketing faced by the farmers

Marketing problems	Score range	Obtained score	Responses of farmers		Mean	SD
			Number	Percent		
Low	0 - 5	56	18	22.50	8.89	5.87
Medium	5 - 10	262	32	40.00		
High	11 - 15	393	30	37.50		
Total	0 - 15	711	80	100.00		

Scoring: Lack of communication facilities = 5, Middle man interference = 4, Lack of storage facilities = 3, Lack of marketing infrastructure = 2 and Lack of processing industries = 1

4.20 Farmers' suggestion for improving mango based Agroforestry system

A number of suggestions were made by the respondent farmers to make mango based agroforestry practice for more productive. The suggestions given by the respondents were communication facilities, market infrastructure, pest and disease control, use of optimum fertilizer, management practices, planting materials, technical support, product quality, maintenance system, HYV and mechanization (Table 25). The investigation showed that the maximum respondent farmers (80.00%) suggested for improving marketing infrastructure and it was ranked 1st. Suggestions on improving management practices, communication facilities, planting materials, pest and disease control practices, Product quality, Use of optimum fertilizer, Technical facilities, Maintenance system, Mechanization and improved HYV were ranked as 2nd, 3rd, 4thand 5th, 6th, 7th, 8th, 9th, 10th and 11th respectively. The result explained that the market infrastructures of the identified area were not more developed and sophisticated for good practices of mango based agroforestry system.

Table 25. Farmers suggestions to improve production in mango based agroforestry system

Suggestions to improve	Number of respondents	Percent	Rank
Communication facilities	56	70.00	3
Market infrastructure	64	80.00	1
Pest and disease control	44	55.00	5
Use of optimum fertilizer	32	40.00	7
Management practices	60	75.00	2
Planting materials	48	60.00	4
Technical support	28	35.00	8
Product quality	40	50.00	6
Maintenance system	25	31.25	9
HYV	16	20.00	11
Mechanization	22	27.50	10

4.21 Responses of the respondents on the term of 'Production is increasing day by day'

Three categories of respondents were identified as Yes, No and No comments based on the comments on 'Production is increasing day by day' (Table 26). The maximum respondent farmers (85.00%) agreed with the term. Only (6.25%) of respondent farmers did not agree with the comment on **'**Production is increasing day by day' where (8.75%) of respondent farmers were neutral on this term.

Table 26. Responses of the respondents on the term of 'Production is increasing day by day'

Comments	Number of respondents	Percent
Yes	68	85.00
No	5	6.25
No comments	7	8.75
Total	80	100

4.22 Productivity performances on different mango based agroforestry systems

In the studied area there were 12 different types of mango based agroforestry systems were identified (Table 27). The investigation showed that the cost of mango production and land use cost were similar for all the systems which was Tk. 85630.00 and 50000.00/ha respectively. The highest total cost of production (Tk. 128378) was estimated from Mango + Ginger agroforestry system where the lowest (Tk. 94620) was found from Mango + Hyacinth bean. The results revealed that higher BCR was obtained from mango + ginger (3.43) followed by mango + turmeric (3.17), mango+ ridge gourd (3.00), mango + bottle gourd (2.88), mango + bitter gourd (2.73) and mango + cucumber (2.72). Lower BCR was found from mango + snake gourd (2.55) followed by mango + eggplant (2.60) and mango + chilli (2.68). The investigation also showed that all the existing mango based agroforestry system was promising considering benefit cost ratio (BCR). The investigation from studied area showed that the more profitable cultivation was obtained by mango with ginger, turmeric and bottle gourd together in mango based agroforestry system performed by the farmers.

Table 27. Productivity performances on different mango based agroforestry system

Mango baed Agroforestry system	Cost of production				Return			BCR
	Production cost of mango	Land use cost	Vegetable production cost	Total cost (Mango + other crops)	Mango	Vegetables	Total	
Mango + Turmeric	85630	50000	36540	122170	225000	162575	387575	3.17
Mango + Ginger			42748	128378		215760	440760	3.43
Mango + Chilli			20575	106205		60345	285345	2.68
Mango + Eggplant			18355	103985		45390	270390	2.60
Mango + Snake gourd			26310	111940		60750	285750	2.55
Mango + Ridge gourd			12980	86920		35990	260990	3.00
Mango + Bottle gourd			30786	116416		110640	335640	2.88
Mango + Cucumber			16385	102015		52550	277550	2.72
Mango + Hyacinth bean			8990	94620		20760	245760	2.60
Mango + Sweet pumpkin			11600	97230		25470	250470	2.58
Mango + Bitter gourd			26450	112080		80680	305680	2.73
Mango + Sweet potato			23580	109210		55800	280800	2.57
Total	85630	50000	275299	1291169	225000	926710	3626710	

4.23 Gross income and net income

Under the present study, promising effect was found in terms of gross income and net income. A considerable return was found from mango based agroforestry system (Table 28). Result proved that more income return is possible when other crops cultivation is associated with mango forest and in that case income is greater than sole mango cultivation. The gross income of Tk. 926710 and net income of Tk. 651411) were recorded from other crops where the gross income of Tk. 225000 and net income of Tk. 89370 were found from only mango which is lower than income from intercrops. Total gross income was Tk. 1151710 and net income was 740781 and it can be said that if other crops are associated with mango based agroforestry, a promising achievement is possible.

Table 28. Total income of the respondents in terms of gross income and net income

Name of crops	Amount (Tk.)	
	Gross income	Net income
Mango	225000	89370
Other crops	926710	651411
Total	1151710	740781

4.24 Economic performance of mango based agroforestry system

For estimation of economic performance it is necessary to calculate different types of cost and return of production. For mango based agrofoerstry system year wise cost and return are shown in Table 30.

4.24.1 Cost of mango based agroforestry system

In mango based agroforestry system cost includes all the activities from orchard establishment to production, harvesting and marketing. Different types of costs have been presented in (table 29). The cost for seedling, land

preparation during orchard establishment were Tk. 15000 and 4000/ha respectively. Other costs were fertilization, land use cost, intercultural operational cost, instrument cost, pesticide, harvesting and marketing. Among them land use cost was higher for the system. The total cost per hectare at initial, 1st, 5th, 10th and 15th year for the mango based agroforestry system were Tk. 21280, 64350, 86300, 88200, 118100 respectively (Table 29).

4.24.2 Benefit from mango based agroforestry system

Harvesting of fruit was started from third to fourth year of mango orchard establishment. But in the initial year of fruiting, the amount of fruits was very lower in quantity. So, in the first 3 to 4 years the net return was negative. From the 5th year it was gradually increased and higher production period of mango was 10 to 12 years and it started to give more production at 15 year and up to 30-40 years. The highest gross and net return in the 15th year that was Tk. 600000 and 481900 respectively.

4.24.3 Inter-temporal budgeting for mango based agroforestry system

Intertemporal budgeting for Mango based agroforestry System is presented in Table 31. For intertemporal budgeting all cost incurred and benefit accrued from the trees and vegetables have been taken into consideration.

4.24.4 Cost

Mango tree gave first fruit at the age of three. The economic life of mango based system is considered for 30-40 years. For 1st, 2nd, and 3rd year the production cost was tk. 85630, 64750, 64150 respectively (Table 30). The production cost was increased with the increase of age of mango garden.

4.24.5 Benefit

In mango based agroforestry system the benefit was started from 5th year of plantation. From six year of plantation, it was higher because at this stage mango give maximum yield and it continued up to15 years of plantation

4.24.6 Evaluation of intertemporal budget for mango based agroforestry system

Intertemporal budget for mango based agroforestry system showed that the cash flow at the 1st, 2nd, 3rd and 4th year were negative, but it became positive from the 5th year and continuing up to 15th year (Table 30). The discounted benefit cost ratio (2.006), net present value (Tk.678766) and internal rate of return (29%) clearly indicated that mango based agroforestry system was productive and economical agroforestry system. The discounted benefit cost ratio indicated that if a farmer invests Tk. 100, he would get return of Tk. 200. Again, the difference between discounted gross benefit and discounted gross cost indicated that the net present value was Tk. 678766 (Table 30). These findings were supported by Ahmed (2008).

Table 29. Year wise different cost and return per hectare (Tk./ha) of mango production of 15 years

Age of Mango	**Seedling Cost**		**Land Preparation**					**Interest on operating capital**	**Total cost**	**Gross Benefit**	**Net Return**
Initial	15000		4000					2280	21280		
	Fertilizer cost	Fertilizer application cost	Pesticide cost	Inter. Oper. Cost	Harvesting cost	Marketing cost	Land use cost				
1	5000	400	1500	1450	0	0	50000	6000	64350	0	-64350
2	5400	400	1500	1450	0	0	50000	6000	64750	0	-64750
3	6000	500	2000	1800	400	450	50000	6000	67150	10000	-57150
4	6000	500	2000	1800	400	450	50000	6000	67150	15000	-52150
5	6000	500	2000	1800	600	500	50000	6000	67400	75000	7600
6	10200	600	3000	3500	1000	800	60000	7200	86300	100000	13700
7	10200	600	3000	3500	2000	1000	60000	7200	87500	100000	12500
8	1o200	600	3000	3500	2000	1000	60000	7200	87500	200000	112500
9	10200	600	3000	3500	2000	1000	60000	7200	87500	250000	162500
10	10200	600	3000	3500	2500	1200	60000	7200	88200	500000	411800
11	12500	1000	4000	7000	2500	1400	80000	9600	118000	500000	382000
12	12500	1000	4000	7000	2500	1500	80000	9600	118100	500000	381900
13	12500	1000	4000	7000	2500	1500	80000	9600	118100	55oooo	431900
14	12500	1000	4000	7000	2500	1500	80000	9600	118100	550000	431900
15	12500	1000	4000	7000	2500	1500	80000	9600	118100	600000	481900
Total	141900	10300	44000	60800	23400	13800	950000	114000	1379480	3950000	2570520
BCR=2.863											

Table 30. Intertemporal budgeting (per ha) for mango based agroforestry for 15 years

Age of mango tree	Gross Cost	Gross Benefit	CF (Net Return)	PV of Tk. 1 at 100% DR	Discounted CF at 100% DR	PV of Tk. 1 at 110% DR	Discounted CF at 110% DR	PV of Tk. 1 at 11% DR	Discounted Gross Cost	Discounted Gross Benefit	Net PV at 11% DR
1	85630	0	-85630	1	-85630	1	-85630	1	85630	0	-85630
2	64750	0	-64750	.500	-32375	.476	-30821	.901	58340	0	-58340
3	67150	10000	-5715o	.250	-14288	.227	-12973	.812	54525	8200	-46405
4	67150	15000	-52150	.125	-6519	.108	-5632	.731	49087	10965	-38122
5	67400	75000	7600	.063	479	.051	388	.659	44417	49425	5008
6	86300	100000	13700	.031	425	.024	329	.593	51176	59300	8124
7	87500	100000	12500	.016	200	.012	150	.535	46813	53500	6688
8	87500	200000	112500	.008	900	.006	675	.482	42175	96400	54225
9	87500	250000	162500	.004	650	.003	488	.434	37975	108500	70525
10	88200	500000	411800	.002	824	.001	412	.391	34486	195500	161014
11	118000	500000	382000	.001	382	.001	382	.352	41536	176000	134464
12	118100	500000	381900	.000	0	.000	0	.317	37438	158500	121062
13	118100	550000	431900	.000	0	.000	0	.286	33777	157300	123523
14	118100	550000	431900	.000	0	.000	0	.258	30470	141900	111430
15	118100	600000	481900	.000	0	.000	0	.232	27399	139200	111800
Total					-134952		-132644		647821	1354690	678766

(Discounted Benefit Cost Ratio) DBCR=2.006 and (Internal Rate of Return) IRR=29%

DR= Discounted Rate, CF= Cash Flow and PV= Present Value

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter contains the summary of findings, conclusion and also some recommendations based on mango based agroforestry system.

5.1 Summary

The socio- economic characteristics of the farmers showed different levels and status for mango based agroforestry in the study area. The maximum farmers were old age (47.5%) where the minimum was young age (7.5%). However the maximum farmers (40%) were under primary education and the minimum numbers of respondents (12.50%) were under above HSC education. Among the respondents, agriculture was the primary occupation for more than half of the respondents (52.5%) where minimum number of respondents (10%) was involved in day labor with mango based agroforestry. Majority of the respondent farmers (50.0%) had marginal farm and minority (3.75%) was landless. The most frequently observed mango based agroforestry systems showed that the maximum land (85.00%) of the studied area was cultivated by mango with turmeric where the minimum area (8.75%) was under mango with sweet pumpkin. The investigation revealed that the maximum farmers (45.00%) cultivated vegetables in winter season and the minimum number of farmers (26.25%) cultivated vegetables in summer season. However most of the respondents (45.00%) were experienced with mango cultivation for 8-12 years and the minimum number of respondents (11.25%) was experienced with mango cultivation for 18 and above years. Where the highest number of respondent farmers (50.00%) cultivated different types of vegetables with mango garden in medium high land but the least number of respondents (12.50%) cultivated in high land.

In the investigated area farmers used two types of propagation materials where maximum respondents (90%) used vegetative propagation materials and rest of

the respondents (10%) used seedling from seed with mango based agroforestry. Above two third of the respondent farmers (71.25%) collected seedling from nursery and minority respondent farmers (10%) collected seedling from both nursery and local market to cultivate mango.

In mango based agro forestry system farmers planted different aged seedling, among these the maximum respondents (56.25%) used 6 months to 1 year aged seedling and the minimum number of respondent farmers (11.25%) used 1.5 year to 2 years aged seedling in their mango garden. All around the year mango seedling was used for gardening but most of the respondent farmers (55%) planted mango seedling in June-July and the minimum number of respondent farmers (7.50%) planted mango seedling in September- October. For fertilizers using, the minimum doses of fertilizer as 345, 250 and 200 gm of urea, TSP and MP respectively was applied for 2- 5 years old mango tree but the highest doses of fertilizer as 1500, 750 and 500 gm of urea, TSP and MP respectively was applied for above 15 years old mango tree with every single tree/year under with mango based agroforestry in the study area.

The investigation result revealed that majority of the respondent farmers (75%) applied irrigation twice in a season that in before flowering and pre maturity stages. However (8%) and (12%) of respondent farmers applied irrigation into mango garden in pre maturity stage and before flowering respectively. There were the majority respondent farmers (60.00%) pruned mango tree after harvesting where the minority respondent farmers (40.00%) pruned mango tree before flowering. The most of the respondents (50.00%) estimated that powdery mildew was the harmful diseases and almost the minimum number of respondents (6.25%) opinioned by black banded diseases attacked mango garden in mango based agroforestry system. It was found that insects were available in mango garden with mango based agroforestry where (40.00%) of respondents confirmed that mango leafhopper attacked mango tree seriuosly and the minimum number of respondents (6.25%) expressed that fruit piercing moths attacked mango tree. Another way (90.00%) of the respondents applied

control measures against diseases but (10.00%) of them did not apply any control measures.

Maximum respondents (72.50%) was agreed with that the maximum production of mango was obtained from (10 – 12) years old mango tree. The highest number of respondent farmers (50.00%) sold their products by the contract basis or lease system and the lowest number of respondent farmers (15.00%) sold their products by self marketing system.

The result showed that the highest number of respondent farmers (70.00%) sold their vegetables to wholesaler and the least number of respondent farmers (8.00%) sold their vegetables by self marketing system. There were some marketing problems were faced by the farmers and about (40.00%) of the respondent faced medium level of problems regarding mango marketing. Different suggestions were achieved for improving marketing infrastructure. The maximum respondents (80.00%) suggested improving marketing infrastructure. The minimum number of respondent farmers (20.00%) suggested for practicing of HYV. The maximum respondent farmers (85.00%) agreed with the term 'Production is increasing day by day' and only (6.25%) of respondent farmers did not agree with that.

From the 5^{th} year the gross and net return was increased and higher production period of mango was 10 to 12 years and it gave more production at the age of 15 year. The highest gross and net return in the 15^{th} year that was Tk. 600000 and 481900 respectively. The results revealed that higher BCR was obtained from mango + ginger (3.43) and lower BCR was found from mango + snake gourd (2.55). The discounted benefit cost ratio (2.006), net present value (Tk.678766) and internal rate of return (29%) clearly indicated that mango based agroforestry system was productive and economical agroforestry system.

5.2 Conclusion

The following conclusions were drawn based on the findings of the present study:

Only mango gardening was not much more profitable. But when it is practiced with other crops, then it is called mango based agroforestry and it is much more profitable than sole one. Under the present study, a total of 12 mango based agroforestry systems were identified. The most frequent observed mango based agroforestry systems were Mango + Turmeric (85.00%), Mango + Ginger (78.75%), Mango + Chilli (75.00%), Mango + Eggplant (55.00%). The most of the respondents (50.00%) opined that powdery mildew was the harmful diseases and also (40.00%) of respondents confirmed that mango leafhopper attacked mango tree seriuosly. Another way (90.00%) of the respondents applied control measures against diseases but (10.00%) of them did not apply any control measures.

The cost of mango production and land use cost were similar for all the systems which was Tk. 85630.00 and 50000.00/ha respectively. The higher BCR was obtained from mango + ginger (3.42) followed by mango + turmeric (3.17) where lower BCR was obtained from mango + snake gourd (2.55) followed by mango + eggplant (2.60). The discounted benefit cost ratio (2.006), and internal rate of return (29%) clearly indicated that mango based agroforestry system was productive and profitable agroforestry system.

Some problems were identified in respect of mango based agroforestry systems. Among the entire problems faced by the farmers, lack of communication facilities, middle man interference, lack of storage facilities, lack of marketing infrastructure and lack of processing industries as well as infestation of insect and disease was the severe problems.

5.3 Recommendations

Some recommendations can be made on the basis of present investigation as follows:

1. Hence, the present study area was at Shibgonj Upazilla under Chapai Nawabgonj District, the number of location along with sample size and observed view should be increased to attain more information and for better interpretation about the objectives of the study.
2. Research program should be conducted to identify the best mango based agroforestry system and to imply them for practicing.
3. A good marketing system is hampered due to some severe problems. A considerable damage was occurred due to lack of marketing facilities and price return was not also desirable as their demand. So, marketing problems should be removed by improving marketing infrastructure and communication.

REFERENCES

Abedin, M.Z. and Quddus, M.A. (1990). Household fuel situation, homegardens and agroforestry practices at six agro-ecologically different locations of Bangladesh In: Homestead Plantation and agroforestry (Abedin et al. eds.) Procedding of a National workshop held 17-19 July 1998 in Joydebpur. Bangladesh. BARI/WINROCK. pp. 19-53.

Abedin, M.Z. and Quddus, M.A. (1991). Agroforcstry system in Bangladesh with particular reference to economic and tenurial issues. In: Agroforestry in Asia and the Pacific. No. 1995/5. FAO regional office for Asia and the Pacific. Bangkok, Thailand, pp. 13-33.

Abedin, M.Z., Akhtar, M.S., Haque, M.E. and Alam, S. (1990). Uses of multipurpose trees on the small farms of low rainfall Ganges floodplain soils of Bangladesh. In: Proc. of the international workshop on 'Multipurpose tree for small farmers' use' held November 2-5, 1987 in Pattya, Thailand. Winrock International for agricultural development and the International Research Centre of Canada, pp. 31-47.

Agreda, F.M., Pohlan, J. and Janssens, M.J.J. (2006). Effects of Legumes Intercropped in Mango Orchards in the Soconusco, Chiapas, Mexico. Conference on International Agricultural Research for Development. University of Bonn, October 11-13, 2006. Tropentag 2006.

Ahmed, K.U. (1989). Climate and soil. In: Manual on mango cultivation in Bangladesh.(Ed.A.K.M.A. Hossain). Horticulture division, BARI and FAO/UNDP Mango Improvement and Development BG D/81/022). pp3-6.

Ahmed A.K.M.A. (1994). Production Technology of Mango, Horticultural Research Centre, BARI, Joydebpur, Gazipur-1701, Bangladesh, pp.122.

Ahmed, H., Martadihardja, A. and Suharto, A. (1980). Social and cultural aspect of home garden. Int. Soc. Trop. Fcol. Kualalampur, Malaysia.

Ahmed, M.F.U. (1999). Homestead Agroforcstry in Bangladesh: A case study of Gazipur district. M. S. Thesis, Department of Agroforestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur.

Ahmed, M.N. (2008). Agro-Economic Performance of Guava Based Agroforestry System in the Southern Part of Bangladesh. M.S. Thesis, Department of Agroforestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur.

Akhter, M.S., Abedin, M.Z. and Quddus, M.A. (1989). Why fanners grow trees in agricultural field: some thought some results. In: Research Report, 1988-89. On-Farm Research Division. Bangladesh Agricultural Research Institute, Jcssorc. pp. 161-178.

Alam, M.S., Haque, M.F., Abedin, M.Z. and Akter, S. (1990). Homestead trees and household fuel uses in and around the FSR site, Jessore. In: Homestead plantation and agroforestry in Bangladesh. By M. Z. Abedin,C. K. Lai and M. O. Ali (eds.). BARI Joydebpur Bangladesh. Pp. 106- 119.

Anoja, W. and Wickramasinghe, A. (1992). Village agroforestry systems and tree-use practices: a case study in Srilanka Multipurpose tree species network research series report. 17:51: 8 ref. Arlington, USA; Forestry/Fuel wood Research and Development (R/FRED) Project, Winrock, International Institute for Agricultural Development.

Asaduzzaman, M. (2003). Impact of Microfinance towards Empowerment through Decision Making Ability of Women Beneficiaries Under Proshika. M.S. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Basavaraju, T.B. and Gururaja, R.M.R. (2000). Tree-crop interactions in agroforestry systems: a brief review: *Indian Forest*, **126** (11)**:**1155-1164.

BBS (2008). Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning. Government of the people Republic of Bangladesh, pp.*73-79.*

BBS (2011). Statistical Year Book of Bangladesh. Bangladesh Bureau of Stastistics, Ministry of Planning. Government of the people's Republic of Bangladesh.

BBS. (2010). Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Statistical Division, Ministry of Planning, Government of the Peoples Republic of Bangladesh.

Beer, J. (1988). Litter production and nutrient cycling in coffee (*Coffea arabica)* or Cacao (*Theobroma cacao*) plantations with shade trees. *Agroforestry systems,* **7**: 103-114.

Behera, D., Munsi, P.S. and Ray, D. (2014). Studies on the performance of intercrops on the nutrient uptake and yield attributes of mango cv. Amrapali. *Advance research journal of crop improvement.* **Volume-5**, Issue- 2.

Bene, J.G., Beall, H.W. and Cote, A. (1977). Trees, food and people. International Development Research Centre (IDRC), Oltowa, Canada.

Bhattnagar, P., Kaul, M. K. and Singh, J. (2007). Effect of intercropping in Kinnow based production system. *Indian J. Arid Hort.,* **2**:15-17.

Biswas, S.C. (2003).Accessibility of Rural Women to Family Decision Making Process. M.S.(Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Bondad, N.D. (1989). The Environment. In: The mango (Especially as observed in the Philippines). Rex Book Store, Manila, Philippines, pp 186-190.

Bondad, N.D. and Valmayor, R.V. (1979). It is "Kachamitha" not "Indian mango". Greenfields. **9**(10)**:** 46.

Chacko, E.K. and Randhawa, G.S. (1971). Towards and understanding of the factors affecting flowering in mango (Mangifera inclica L.). *Andhra Agric. J.* **18**: 226-236.

Chowdhury, M.K. and Satter, M.A. (1992). Agroforestry practice in traditional farming system of Bangladesh. A report prepared for BARC/Winrock Intl., Dhaka, Bangladesh.

Chowdhury, M.K. and Sattcr, M.A. (1993). Homestead and Cropland Agroforcstry Practices in the High Ganges River Floodplain. Research report Series 2 BARC-Winrock Int., Dhaka, pp. 23-55.

Duldulao, A.C. (1983). Sociological aspects of agro forestry. Agroforestry in perspective: Proc. of the Agroforcstry symposium workshop, December 19- 21, PCARRD, Los Banos, Laguna, Philippines.

FAO (Food and Agricultural Organization). (1986). Tree growing by rural people. Forest paper. 64.

Fernandes, E.C.M. and Nair, P.K.R. (1990). An evaluation of the structure and function of tropical homcgardcns. *Agricultural Systems.* **21**: 279-310.

Franzel, S. (2004), Financial analysis of agroforestry practices, in J.R.R. Alavalapati and D.E. Mercer (eds), Valuing Agroforestry Systems, Kluwer Academic Press, Dordrecht, the Netherlands, pp. 9−37.

Garrett, H.E., (1994). Agroforestry: an integrated land-use management system for production and farmland conservation, Assn. for Temperate Agroforestry, 58 pp.

Grado S.C. and Husak, A.L. (2004). 'Economic analyses of sustainable agroforestry systems in the Southeastern United States', in J.R.R. Alavalapati and D.E. Mercer (eds), Valuing Agroforestry Systems, Kluwer Academic Press, Dordrecht, the Netherlands, pp. 39−57.

Guittinger, J.P. (1982). "Economic Analysis of Agricultural Projects" (Second Edn.). Jhons Hopkins University Press, Baltimore.

Halladay, P. and Gilmour, D.A. (1995). Conserving bio-diversity outsitc protected area. The role of traditional agro-ecosystem. IUCN publication, Switzerland, pp. 172-175.

Hartless, A.C. (1914). Mango crops and some factors influence them. *Agric. J. India.* **9**:140-159.

Hasan, M.K; Miah, M.T.H. and Mondal, M.A.S. (1991). Returns from power tiller utilization I Bangladesh. An analysis of level data. *Bang. J. Agril. Econ. M(1)*, 87-97.

Haque, M.A. (1996). Homestead Agroforestry in Bangladesh. In: Agroforcstry in Bangladesh. VFFP, BAU, Mymensingh and SDC. Dhaka, pp. 64-70.

Hocking, D. (1986). Village and Farm forestry in Bangladesh, Oxford Forest. Inst. Oxford.

Hossain, A. and Shailo, I. (1987). Deforestation in Bangladesh: Towards and Ecological Infer. ADAB News, Vol. XVII. No. 2. March-April, 1989.

Hossain, A.K.M.A. (1994). In: Production Technology of Mango. Book-4. Horticulture Research Centre, BARI, Joydebpur, Gazipur. 122 p.

Hossain, S.M.A. and Bari, M.N. (1996). Agroforcstry farming system. In: Agroforcstry in Bangladesh, pp. 22-29.

Jackson, I.E. (1987). Tree and crop selection and management to optimize overall system productivity, especially light utilization in agroforcstry. Meteorology and Agroforestry. 1CRAF, WMO and UNEP.

Khandaker, K. (1991). Homestead agroforcstry in Bangladsh and its development, paper presented in a Train. Course Res. Tech. Agrof. Bangladesh Forest. Res. Insti. Chittagong, Bangladesh. P. 12.

Lai, C. K. (1988). Design of Agroforestry systems with special reference to Bangladesh. Prob. Workshop on Homestead plantation and Agroforestry in Bangladesh, BARI, Gazipur, Bangladesh.

Lawrence, J.H. and Hardostry, L.H. (1992). Mapping the territory: agroforestry awareness among Washington stale land managers. In: Agroforcstry systems, Development of Natural Resources, Washington, State University, Pullman, WA 9916406410, USA. **19** (1): 27-36.

Leaky R. (1996), 'Definition of agroforestry revisited', *Agroforestry Today **8**(1):* 5−7.

Linda, C. (1990). Homestead in the tropical Asia with special reference to Indonesia, In: Kathleen L. and Mark, B. (ed.). Tropical home garden United National University Press. pp. 921.

Lundgren, B.O. and Raintree, J.B. (1982). Sustained Agroforestry. In: Nestel. B. (ed.) Agricultural research for development, potentials and challenges in Asia. 1SNAR, The Netherlands, pp. 37-49.

Mango committee. (1978). The Philippines recommends for mango. Philippines Council for Agriculture and Resources research, Leguna, Philippines.

Mannan, M.A., Mian, M.A.K., Aziz, M.A. and Haque, H. (2004). Evaluation of some stone originated Mango Accession. *Bangladesh JPL Breeding and genetics, **17**(1):* 25-29, 2004.

Mannan, M.A. (2000). Plant biodiversity in the homestead of Bangladesh and its utilization in Crop improvement. Ph. D thesis, Bangabandhu Shekh Muzibur Rahman Agricultural University, Gazipur, Bangladesh.

Manandhar, P.K. (1986). "Introduction to Agroforestry in Bangladesh." Community Forestry Project Report, BGD/81/028, Banbhaban, Dhaka.

Miah, G., Abedin, M.Z., Khair, A.B.M.A., Shahidullah, M. and Baki, A.J.M.A (1990). Homestead plantation and household fuel situation in the

Ganges floodplain of Bangladesh. In: Abedin et al. (eds.). Homestead plantation

Miah, M.G. (1993). Performance of selected multipurpose tree species and field crops grown in associated as affected by tree branches pruning. A Ph.D. dissertation, CLSU, Philippines.

Miah, M.G., Ahmed, F.U., Ahmed, M.M., Alam, M.N., Choudhury, N.H. and Hamid, M.A. (2002). Agroforestry in Bangladesh: Potentials and Opportunities. Paper presented in South Asia Regional Agroforcstry Consultation Workshop held on 23-25 November, 2002 at New Delhi. India.

Millat-c-Muslafa, M. (1997). Floristics and indigenous management techniques of homegardens in Bangladesh. In: Agroforestry: Bangladesh Perspective, Alam *et al. (cds).* APAN-NAWG-BARC. pp. 34-63.

Mustafa, M. (1996). Structure and floristries of Bangladesh homegarden agroforestry system; 33: 263-280

Nair, P.K.R. (1983). An Introduction to Agroforestry. Kluwer Academic Publishers, ICRAF. pp. 121 & 273.

Nair, P.K.R. (1993). Agroforestry systems in the Tropics. Kluwer Academic Publishers, ICRAF.

Nair, P.K.R. (1990). An Introduction to Agroforestry. Kluwer Academy Publishers, ICRAF. pp. 37-54.

Nasaruddin, R., N., Mohd. S., Suhaimi, D., Jiwan. A. W., Jasery and Choon, K.K. (2000). A Preliminary Survey of Agroforcstry Practices in Malaysia. Conference on Forestry and Forest Products Research. Proceeding of the Fourth Conference Forest Research Institute. Malaysia, 2-4 October 1997. Faculty of Applied Science, Depart of Wood Technology, ITM, Malaysia.

Neupane, R.P. and Thapa, G.B. (2001). Impact of Agroforestry intervention on farm income under the subsistence fanning system of the middle hills, Nepal. *Agroforestry systems, **53** (1):* 31 -37.

Rhaman, M.L. and Hasanuzzaman, M. (2009). Homegarden Agroforestry: Impact on biodiversity conservation and household food security: A case study of Gazipur district, Bangladesh. MS Thesis, DOSI Publications. pp. 133-142.

Roy, L., Siddiqui, A.R. and Huda, A.T.M.A. (1996). Village and Farm Forestry Programme: An analysis of trend to plant for VFFP phases (1997-2001): An input for Evaluation cum Planning Mission Village and Farm Forestry Project, Swiss Dev. Coop., Dhaka.

Saka, A.R., Bandcrson, W.T., Mbckcani, Y and Ilinu, O.A. (1990). Planting and implementing agroforestry for small-bolder fanners in Malawi. In: Budd *et al.* Planning for agroforcstry. Elsevirt Applied Science; London.

Sarker, F.I.M.G.W., Biswas, J.C. and Maniruzzaman, M. (2014). Climate Change Adaptation and Economic Profitability: Crop Land Shifting to Mango Orchard in Rajshahi Region. *Bangladesh Rice J. **18***(1&2): 8-17.

Scherr, S.J. and Franzel, S. (2000). Promoting new agroforestry technologies: policy lessons from on-farm research. Trees on the farm assessing the adoption potential of agroforestry practices 1-Africa, 145-168; 35.

Sellathurai, P. (1997). Homegarden Agroforestry and sustainability in Kandy district, Srilanka. M. Sc. Thesis. Agricultural University of Norway.

Singh, H., Gurbachan. S., Singh, II. and Singh, G. (2001). Performance of turmeric (Curcuma longa) in association with multipurpose tree species. Central Soil Salinity Research Institute, Karnal, Haryana, India. Applied Biological research, **3 (1-2)**: 57-60.

Singh, R. (1969). Mango. In: Fruits. 4th edn. National Book Trust, India, pp 20-23.

Singh, R.N. (1960). Fruit-bud differentiation in mango as affected by some climatological factors. *Indian J. Hort.* **17**: 185-192.

Singh, S.R., Banik, B. C. and Hasan, M.A. (2013). Effect of different intercrops on yield, quality and shelf-life in mango cv. Himsagar(Mangifera indica L). *Intl. J. Agric. Env. Biotech.* ***6***(1):121-126.

Solanki, K.R. (1998). Agroforcstry Research in India. *Indian J. Agril. Sci.*, ***68*** *(8) 559- 566.*

Stocking, M., Bojo, J. and Abdel, N. (1990). Financial and economic analysis of agroforestry: Key issues. In prinsley, R.T. (ED.), Agroforestry for sustainable production economic implications. Commonwealth Science Council, London, pp. 13-119.

Swain, S.C. (2014). Performance and profitability study of different mango based intercropping systems in Easternghat high land zone of Odisha. *Journal of Crop and Weed,* ***10(2)****:170-178.*

Wester, P.J. (1920). In: The Mango. Philipp. Bur. Agric. Bull., p. 18.

Wickramasinghe, A. (1997). The evaluation of Kanadyan (Srilanka) home garden. An indigenous strategy for conservation of biodiversity out side the protected area. IUCN.

Wojtkowski, P.A. (1998). The Theory and Practices of Agroforcstry Design, p.2-6.

Uddin, M.J. and Hasan, M.K (2003). Homestead Agroforestry in Char areas at Noakhali; An economic analysis. *Bang. J. Agril. Res.* ***28***(3), 421-430.

Appendix I

(English Version of the interview Schedule)

Department of Agroforestry and Environmental Science

SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA -1207

Questionnaire on

Study on Agro-Economic Performance of Mango Based Agroforestry System at Shibgonj Upazila under Chapai Nawabgonj District

A. Personal details

1. Identification of the respondent:

   Name:
   ……..
   Father's name:
   ……..
   Mother's name:
   ……
   Village:
   ……
   Upazilla:
   …….
   District:
   ……..
   Age:
   ……..

   Occupation:

   a) Main: ……
   b) Alternative: …….

2. Educational level: No education/ Primary/ SSC/ HSC/ Above HSC

3. Family status: Single/ Combined

4. Number of Household members: Male: …… Female: ……

5. Are you a member of any local organization? Yes/ No

   Duration of membership: …… and Name: ……

6. Land clarification of farmer:

Homestead	Lease in	Lease out	Agreement	Total land

7. Please inform your yearly income from

Homestead	Garden	Vegetables	Poultry	Livestock	Business	Day labor	Another	Total

B. Location details
   a) Soil: (i) Fertility level – L/ M/ H, (ii) Soil type: Sandy/ Loamy/ Sandy-loamy/ Clay
   b) Land type: Hilly/ Plain/ Low land/ Other

C. Detail history and purpose of cultivation
   1. From when and how you have to related with mango gardening?

   2. Why do you choose mango plantation in your Homestead?
      a) Own consumption
      b) Sale/ business
      c) Both
      d) Traditionally

   3. How long you are continuing mango gardening? ……

   4. What types of cultivars/variety you have cultivated in your mango garden? Please mention the following information:

Cultivar/ Variety	Origin	Duration of cultivation (year)

   5. What types of land you prefer for mango cultivation?

   6. Which location that you prefer to collect mango seedlings?

   7. What is the age of seedlings that you prefer for plantation and which procedure you maintain for raising of seedlings?

   8. Which season do you prefer for plantation of mango seedlings?

   9. Please mention the size of pit that you use to plant seedlings?

10. Please informed us about fertilizer application before plantation

11. Please inform the following information regarding methods of mango gardening that you follow

Planting materials	Planting methods	Spacing	Precautions

12. Please inform the use of different fertilizers in your mango garden

Name of fertilizers	Amount	Time	Methods

13. Please mention the cultural practices that you have done and have to do

Cultural practices	Duration of work	Time to work	What have to do
Weeding			
Irrigation			
Fertilizer application			
Pruning			
Fruit thinning			
Clearing of garden			
Spraying of pesticides			
Others (specify)			

14. Please mention the age of the tree, which gives the higher production …….. year

15. Please mention the first flowering time ……. Year

16. How can you identify the appropriate harvesting time (maturity time) of mango
……
……
……
……

17. What is your production status? Is your production more or less same in every year? If the answer is 'No' please mention 'why'

18. Please inform year wise production of mango with age of plants

Age category of mango tree	Production (kg)
2 to 8	
9 to 15	
15 to above	

19. What are the problems that you faced at the time of planting other crops like ginger, turmeric, sweet pumpkin, bean etc. in your mango garden?

20. Other crop cultivation in mango garden is profitable? Yes/ No
    Please specify the reasons –

21. Please mention the following information about mango marketing
    - Where and how you sell your product?
    - Do you get desired return? Yes/ No
      Please specify the reasons –
    - Please advice the marketing infrastructures that is needed to improve marketing system that will help you to get maximum return

22. Please inform about other crops that you like to cultivate in your mango garden

Name of crops	Time of plantation	Methods	Production status

23. Please specify the fertilization system in mango garden for other specified crops

Name of fertilizer	Amount	Time of application	Methods

24. Please mention the management practices for other crops in your mango garden

Type of works	Frequency of works	Time of works	Reasons of works

25. Your production is increasing day by day - Do you think? Please mention Yes/ No regarding 10 years production status ……..
    If Yes/ No, please notify ……

D. Cost of production and net return

1. Production cost

Item	Material cost	
	Mango	Other crops
Planting material cost		
Fertilizer cost		
Pesticide application cost		
Instrument cost		

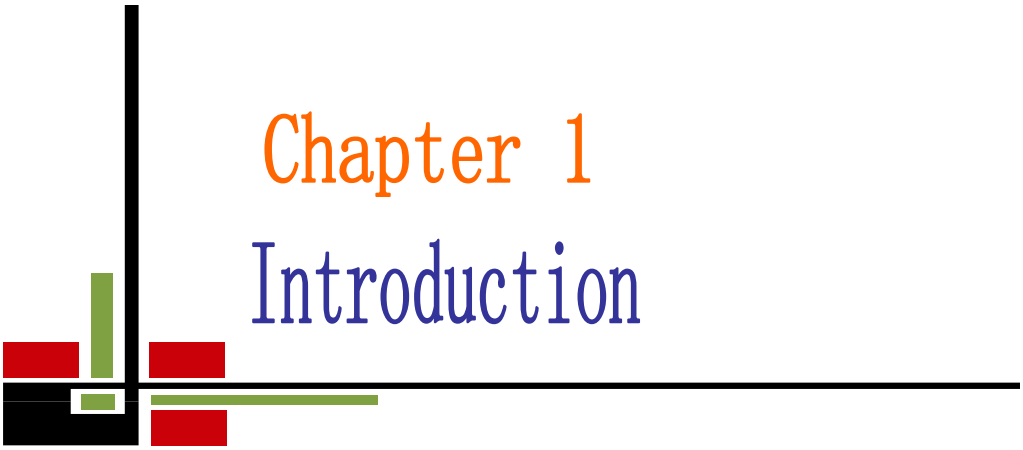
Item	Non-material cost	
	Mango	Other crops
Land preparation cost		
Intercultural operation cost		
Labor cost		
Harvesting cost		
Marketing cost		

2. Net return/ Output

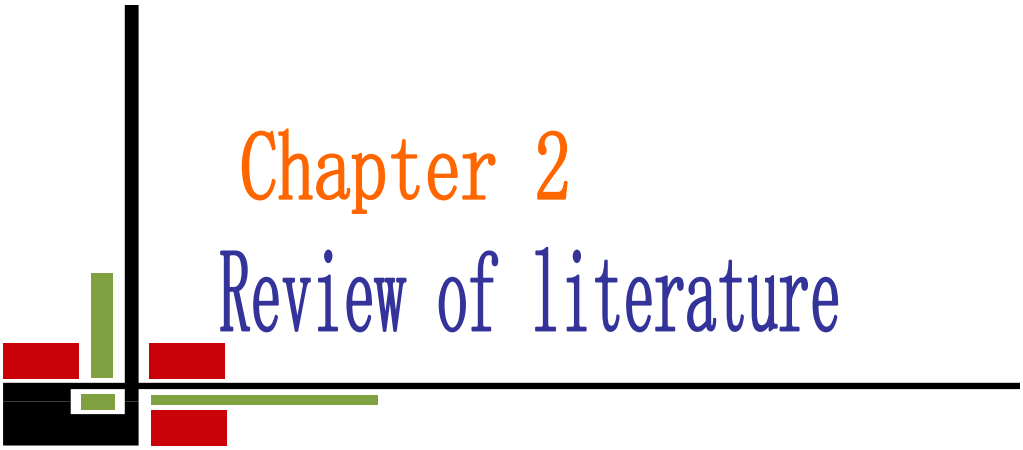
Item	Mango	Other crops
Sell price		
Own consumption		

Thank you for cooperation

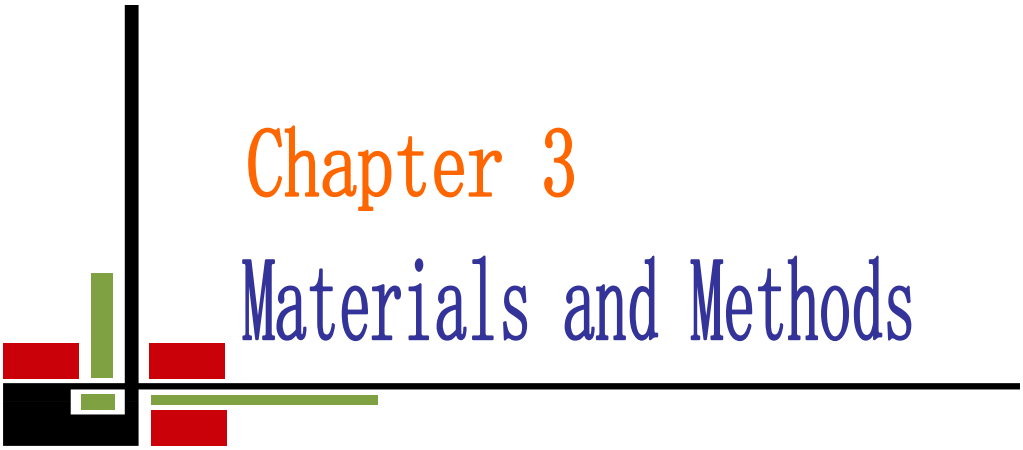
Date of data collection: …… Signature of the interviewer: ……..



Chapter 1
Introduction



Chapter 2
Review of literature

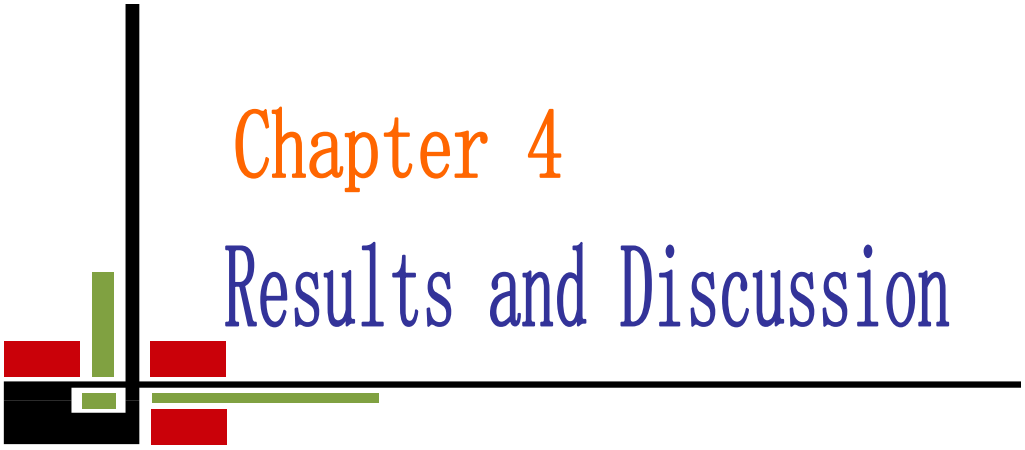


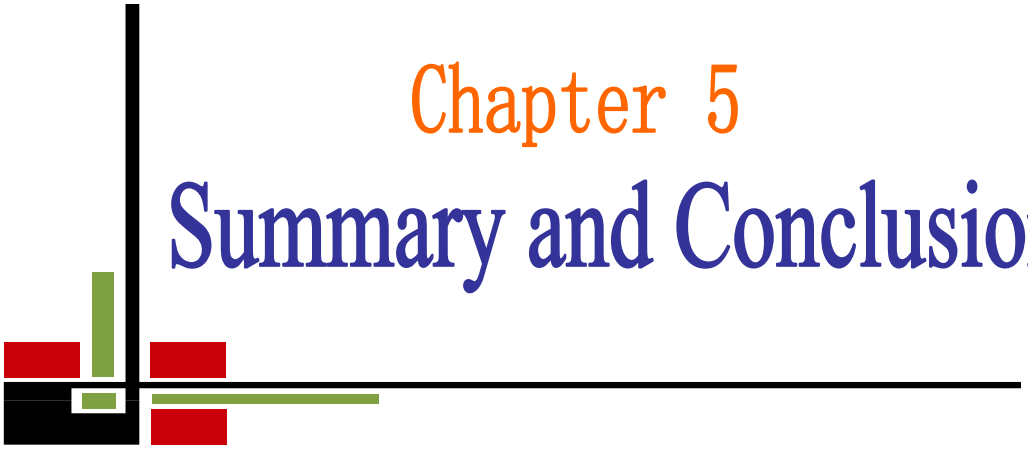
Chapter 3

Materials and Methods

Chapter 4

Results and Discussion





Chapter 5

Summary and Conclusion

References