PRODUCTION TECHNOLOGY AND ECONOMIC POTENTIALITIES OF LATKAN (*Baccaurea ramiflora Lour*) BASED AGROFORESTRY SYSTEMS AT SHIBPUR UPAZILA OF NARSINGDI DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled,**" PRODUCTION TECHNOLOGY AND ECONOMIC POTENTIALITIES OF LATKAN (*Baccaurea ramiflora Lour*) BASED AGROFORESTRY SYSTEMS AT SHIBPUR UPAZILA OF NARSINGDI 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 IN AGROFORESTRY AND ENVIRONMENTAL SCIENCE**, embodies the result of a piece of bona fide research work carried out by **ZINIA NAZ LINDA** Registration No. **18-09158** under my supervision and my guidance .No part of the thesis has been submitted for any other degree or diploma.

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

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ABSTRACT

Latkan based agroforestry system is profitable and has a great opportunity to increase national production to feed the growing population. A survey was carried out at Narsingdi District to identify the Latkan based agroforestry systems, access the contribution of Latkan based agroforestry system of the farmers in the study area and identify the problems and constrains phase in practicing the system. To achieve the objectives, a simple random sampling technique was adopted to collect the necessary information from 80 respondents through a structured questionnaire during January to September 2020. SPSS 16.0 Computer package program was used to analyze the data. Based on crop condition with Latkan trees, a total of 10 Latkan based agroforestry systems were identified. Most of the farmers (46.25%) used coriander as associated crop with Latkan and minority (11.25%) farmers used other crops. Most (66.25%) of them used jackfruit as associated tree and minority (2.5%) used other trees. Most of them (50%) said that the maximum fruit production age of the tree was 15-20 years old and minority (15%) said 10-15 years. Some problems were identified in respect of Latkan based agroforestry systems. About 13.75%% respondents faced problems for marketing of Latkan because the price was low in the local market. The discounted benefit cost ratio (1.90), and the internal rate of return (52.9%) clearly indicated that Latkan based agroforestry system was productive and economical. There is a scope of adopting improved management practices and it may increase the total production.

LIST OF ABBREVIATIONS AND ACRONYMS

BBS - Bangladesh Bureau of Statistics

ICRAF - International Centre for Research in Agroforestry

MRF - Makiling Forest Reserve

VFFP - Village and Farm Forestry Project

SAAO - Sub Assistant Agricultural Officer

DAE - Department of Agricultural Extension

SPSS - Statistical Package for the Social Sciences

Wt. - Weight

% - Percentage

e.g. – *Exempli gratia* (by way of example)

et al. - And others

g- Gram

kg - Kilogram

i.e. - *Edest* (means that is)

ha. - Hectare

Tk. – Taka

BCR – Benefit Cost Ratio

SDC – Swiss Agency for Development and Co-operation

df - Degrees of freedom

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CHAPTER I

INTRODUCTION

Agroforestry has the potential to maintain the ecological balance while producing crops at the same time. Agroforestry can be defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. Agroforestry systems are crucial to Bangladesh because of space constraints in most small farms. A multi-storied technique can provide greater economic return per unit area. Land cultivated in this way can maintain an ecological balance and provide for efficient use of all natural resources. In particular, agroforestry is crucial to smallholder farmers and other rural people because it can enhance their food supply, income and health. Agroforestry systems are multifunctional systems that can provide a wide range of economic, sociocultural, and environmental benefits. (FAO, 2015).

In Bangladesh, the need for maintaining the population-food-nutrition balance can hardly be overemphasized. The country, which has only 148.39 lakh hectare land, has to feed about 160 million people (BBS, 2018). The population has doubled in the last 30 years. The Homestead agroforestry system is very important in the economy of Bangladesh. The many woody species grown in the homesteads are a significant source of fuelwood; they also provide fodder, building materials and other forms of wood. In the context of the prevailing shortage of fuelwood and excessive deforestation in Bangladesh, this homestead agroforestry system needs to be strengthened. Bangladesh has 2.46 million ha of forestland covering about 17% of the country's area. Bangladesh Forest Department (FD) controls, manages and protects all state-owned forests except Unclassed Stated Forest (USF) (FD, 2012). More than 90% of the state-owned forest land is concentrated in 12 districts in the eastern and south-western regions of the country and out of 64 districts, 28 districts have no state-owned forest at all (GoB, 1990). Besides the traditional forestry practices in the forest lands, agroforestry practices in the croplands and homesteads play a vital role in

increasing tree coverage and to supply annual, perennial and animal products and services.

Burmese grape (*Baccaurea ramiflora Lour*.) is an underutilized fruit crop belonging to family Euphorbiaceae. The generic name is derived from Latin *'baccaurea'* referring to the golden-yellow color of the fruits (Chakrabarty and Gangopadhyay, 1997). It is native to South-east Asian region. In Nepal, India, Myanmar, Bangladesh, South China, Indo-China, Thailand and Malaysia, this fruit is grown as wild as well as under cultivation (Bhowmick, 2011). It is grown mainly in the forest and homestead garden in Narsingdi, Sylhet, Gazipur, Netrokona and Kishoregonj districts of Bangladesh. Recent year, Bangladesh exports few amounts of this minor fruit from Narsingdhi (Hoque *et al.*, 2017). Considering its importance, quality and availability, Bangladesh Agricultural Development Corporation (BADC) has expanded Latkan cultivation program among the growers since last 1990 and it is exported about 1-1.5 tons by local exporters with vegetables in the local market as well as London and countries of Middle east and Europe during July to August. On an average, about 200 kg Latkan are found from a 10 years aged tree. Locally the fruit is known as 'Latkan' and it is a mild acidic fruit and mainly used as fresh fruit consumption (Khan, 2008). Aril is the edible portion of the fruit and the number of aril per fruit is mainly 3-4. This edible portion is covered by leathery rind, fruits found in bunch and the bearing habit is cauliflowery (Bhowmick, 2011). Simple leaf is arranged alternately, leaf has petiole and shape of the leaf is ovate to ovate-lanceolate. Mild biennially cropping pattern is seen in this fruit tree (Pal *et al*., 2008; Hoang *et al*., 2008). Northern Thailand's hill-tribes use this plant as medicine (Yang *et al.*, 2007). Young leaves are also used as vegetable, flavoring agent with curries and minced meat in Bangladesh (Hasan *et al*., 2009). Fresh bark is chewed or juice is used orally to cure constipation (Khan, 2008). Fruit juice is used for making wine. Local peoples use this fruit for ritual purpose during Holy Chariot Procession of Lord Jagannath (Goyal *et al*., 2013). Seeds of Burmese grape produce valuable annatto dye (Abdullah *et al.*, 2005). For this reason, it is grown in Bangladesh for fresh consumption as well as dye production and the percentage of annatto dye content is 4.8 – 6. Annatto dye is used for coloring silk, cotton and other textile materials. As it is a dioecious plant seed propagation is not favorable. Now propagation is done by stem cutting (Abdullah *et al.*, 2005). Due to climate and soil type mutation and segregation is always conducted which is

responsible for variability among different genotypes. For this reason, seed propagation is not favorable.

Narsingdi district is a populated area and its population increases rapidly day by day. As a result, the land for cultivation of Agricultural crops are decreasing. On the other hand, the environment and soil is very suitable for Latkan production. For this reason, maximum farmers and land owners of this area depend on Latkan orchard for their lively hood. So, cultivation of crops under Latkan orchard can effectively utilize the underground space as well as it can increase the production of the land for the increasing population. It also utilizes the light, water and nutrients use efficiency which are otherwise will be wasted. It improves social and economic value of the locality. Along with it also improve food and nutrition which are essential for healthy and peaceful life for the village people. Burmese grape is very popular fruit in Bangladesh but few experiment was conducted on Burmese grape in Bangladesh to improve this fruit. With this end in view, the present study was, therefore carried out to know the agro-economic performance of Latkan based agroforestry system.

On the above considerations, the study was done to fulfill the following objectives:

i. To identify the different types of Latkan based agroforestry systems,
ii. To know the production technologies of Latkan followed by the farmers and
iii. To assess the economic potentiality of Latkan based agroforestry systems of the farmers at Shibpur Upazila of Narsingdi district.

CHAPTER II

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, 1983).

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 5 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 home garden (Millat-e-Mustafa, 1997), cropland (Roy, 1996), forestlands etc. However, the sustainability of these practices, a major concern in Bangladesh. Agroforestry is considered an efficient and sustainable land use option especially 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 referring 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 labor. 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 agroforestry 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 incorporates 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 agro silvicultural 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 m3 and the timber at 0.92 million m3 whereas the supply is presently 0.61 million m3 and 0.76 million m3, resulting in a deficit of 1.42 million m3 of fuel wood and 0.16 million m3 of timber. There is possibility of meeting this deficit through the practice of Agroforestry system.

Nair (1990) 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 outside 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 Agroforestry in Bangladesh

Agroforestry is a century old livelihood production system 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, 1996) 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 *Mangifera indica, 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 agroforestry 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 flabellifer* 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 system such

as *Dalbergia sissoo* based system, tree betel leaf peeper association. Lac culture, sericulture and apiculture arc also traditionally practiced. 12 Hocking (1986) stated that some 15 million household of the country occupy about 0.3 million hectares 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 agroforestry 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 Distribution and botanical features of Latkan

The species *Baccaurea sapida* (Roxb.) Muell. Arg. is synonyms of the species *Baccaurea ramiflora* Lour.(mai fai) and King ex. Hook f. This fruit tree belongs to the Euphorbiaceae family, the same as *Baccaurea motleyana* (rambai). It is native to the Southeast Asian region and found growing wild as well as under cultivation in Nepal, India, Myanmar, South China, Thailand, the Andaman Islands, and Peninsular Malaysia (FAO website).

In Bangladesh, Latkan grows well in Madhupur Tract over Narshingdi and Gazipur districts having red clay soils (AEZ 28) (Anonymous, 2004a). About one lac Latkan trees grow naturally year by year in homesteads of villages in Gourypur upazila under Mymenshing district named “Kissmoth Barabugh”. This fruit is big-sized and sweet to taste. (Anonymous, 2004b).

The Latkan tree can grow up to 5-6 m tall with simple leaves. The leaves are simple. The leaves are generally 10-12cm in length and 6-8 cm in width. The tree is dioecious in nature. The inflorescences are found in cluster and every fruit weight is from 12 to 20g, have 3-4 segments in every fruit. Young fruit is as round, green color but ripened fruits are 3-4 cm in diameter and shell color is light pinkish-yellow in color. The flowering time is in the month of February-March (Khan, 2001).

Rashed *et al.* (1987) also described about Latkan tree is a medium sized tree. The leaves are obovate and 10-20 x 4-8 cm in size. Mono-sex flowers are borne on the inflorescences. The inflorescences appear on the stems and branches, fruits are round, 2-3 am in diameter, ripened fruit is yellow in color. Fruit shell is soft and thick, every fruit contains three seeds and thin layer of acidic sweet flesh stays around the seed. The flower blossoms after winter and ripened in June-July.

FAO (FAO website) reported that the species *Baccaurea ramiflora* (Lour.) can grow up to 25m tall. The leaf is simple, alternately arranged, with petiole. It is ovate to ovate-lanceolatein shape and 10-20 X 4-9 cm in size. The petiole is 1-8cm long with lanceolated and fimbriated stipules. Tomentose inflorescences appear on branches and on the trunk. The male racemes are 3-8 cm long; flowers are fascicled on very short rachises with 4-5 sepals, and 4-8 stamens. the female racemes are 14 cm long and are born lower at the trunk. Female flowers are solitary, with 4-5 sepals, 3-locular ovary and 2-lobed stigmas. The fruits are glabrous and 2.5-3 am in diameter. The fruits can be of various color from yellowish, pinkish to bright red.

Morton (1987) described about *Baccaurea sappida* known as Burmese grape, called tempui in Malaya, lutqua in India, and mai fai in Thailand, grows to 30 or even 70 ft (9-21m). The leaves are rarely hairy: the fruit, in strands 6 to 12 inch (15-30 m) long, is smooth, nearly round or oval, 1 to 1.25 inch (2.5-3.2 cm) long. The skin turns from ivory to yellowish or pinkish-buff or sometimes bright red. The pulp is not translucent: is whitish, occasionally deep-pink near the seeds: varies from acid to sweet.

2.4.1. Soil, Environment and Climatic requirement for Latkan

Latkan tree grows well in moist weather of warm and temperate region. Therefore, sandy-loam or clay-loam, light acidic soil of the area, which is characterized by upstanding water but more rainfall is suitable for Latkan cultivation. The soil acidity (PH) 5.5 to 6.0 is well for Latkan cultivation. The Latkan tree cannot tolerate waterlogged condition. The tree is well grown in partial shade, it is cultivated under the big trees like Mango or Jackfruit tree (Khan, 2001).

Anonymous (2003a) stated that 68 and 22% of the farmers planted Latkan under Jackfruit tree and both mango and Jackfruit trees, respectively, while others planted under Mango tree only. FAO (FAO website) also reported that Latkan tree is cultivated in the home and intercropped with other tropical fruits like Durian, Rambutan and Mango.

Loquat a similar fruit to Latkan is highly exacting in its climatic requirement. A milder subtropical climate with an average rainfall of 60 to 100 cm well-distributed throughout the year is best suited for its normal growth and fruiting. Science flowering takes place from October to late January, at certain places the crop may be destroyed by moderate winter frosts. The plants are permanently injured when the temperature falls to zero and remains for any length of time in places where summer sets in early and scorching hot winds begin to below before the fruits ripen, the fruits remain very small and do not mature properly (Boss, 1985).

2.4.2. Cultivation techniques

Anonymous (2003a) described that farmer collected saplings from local sources and planted them in pit. The size of pit varied from one farmer to another but most of the farmers (86%) planted 2-3 years old saplings in the pit with size of 30 cm X 30 cm. About 50% of the farmers planted Latkan during June-July, while 45% of the farmers planted saplings in June and the rest of the farmers in August – September. In most cases (78%), plant to plant distance of Latkan was 4-5m. However, 8% of the farmers

planted saplings at 6-7m spacing while others planted saplings of spacing of 8m or more. The farmers is not applied any manure or fertilizer in the pit before planting seedlings but 42% of them applied 15-20 kg cow dung to growing plants but not regularly. About 26% of the farmers pruned their trees during September- October while others did not practice pruning. The farmers were not applied irrigation in the Latkan field.

Anonymous (2003a) also described those fruits were first harvested at 3-4 years after planting. Fruits were harvested mostly in June –July in a single harvesting and harvest duration extended for one month.

2.4.3. Contribution of Latkan based agroforestry system (yield and profit)

A Latkan tree started bearing fruits at age of 6-7 years. Fruits are harvested during June-July in a single harvest. Fruit yield varied widely depending on age, size and shape of the tree. Farmers cited those yields range from 19 to 120 kg/plant i.e. 3.4 to 32 ton/ha (on average 246 trees/ha). Farmers earned an average gross margin of Tk 3,27,256, /- from one hectare of land against a total variable cost of Tk 14,992/ha that occurred mostly during planting (Anonymous, 2004a).

The Loquat tree starts bearing fruit generally from the fourth year of planting. The yield increases as the tree grows older and the maximum yield is obtained when the tree is about 15 years old. The average tree should give 30 to 40 kg fruits (Bose, 1985).

In Mymenshing district, a farmer sold his Latkan fruits at the rate of Tk 600-700 per Mound with a highest price of Tk. 2000 (Anonymous, 2004b).

2.4.4 Latkan based agroforestry system

Participant farmers in all field research activities repeatedly described the Jackfruit-Burmese grape-based agroforestry system. They find jackfruit and Burmese grape

suitable to grow together. According to a timeline participant from Shibpur: ‘Burmese grape grows well in the shadows of jackfruit tree. Jackfruit tree is very high but a Burmese grape tree does not grow after a certain height. So now everybody cultivates Burmese grape as an agroforestry crop with jackfruit’. (Swallow *et al*., 2015).

2.4.5. Nutritive values and uses

Moniruzzaman (1998) stated that the fruit is rich in nutrition. In every 100g edible flesh contains; protein -1.42%, fiber-0.64%, mineral salts-0.90%, vitamin B-1-0.03mg, iron-0.30 mg and energy-91K. Cal, and it is also rich in Vitamin-C.

Khan (2001) also described that scented acidic sweet juice present in the capsules of the fruit. Peel of fruit with seed weight is about 66% and rest 34% is edible pulp, which contain 72.4% water. Khan also opined that 100g edible flesh contains; protein-1.0g, fat-0.5g, carbohydrate-25.2g and fibre-0.4g. The Latkan fruit contains 2 mg Ca, 6 mg p and 0.3 mg Fe. Also, fruit contains vitamin-A, B1, B2, niacin and ascorbic acid 28IU, 0.04, 0.07, 0.6 and 8 mg respectively.

Loquat fruits are generally used for desert purposes as well as for making jam, jelly, preservers and canning. Chutney is also made from semi-ripe fruits. The Liquor jelly is an important product because the fruits are good source of acid and pectin. The fruit consist of pulp 60-70 percent and seed 15-20 percent. The edible parts of fruit contain 87.4 percent water, 10.2 percent carbohydrate, 0.7 percent protein,0.3 percent fat, 0.5 percent mineral, 0.9 percent fiber, 0.03 percent Calcium, 0.02 percent Phosphorous and 0.7 mg Iron/100 g (Rajput and Singh, 1964).

2.4.6 Problems and constraints phase of Latkan based Agroforestry system

Over-whelming majority (86 percent) of the farmers had medium to high constraints in Latkan cultivation. They faced main constraints as "lower price in the field than the urban market", "lower germination of female plant" and "lack of necessary technical advice from the extension workers"(Hasan, 2011)

The leaf eating insect attacks to the young leaves and for controlling this insect, 2.0 g carbaril (sevin/carbin/other name in market) 85 WP or 2.0 ml Fenitrothion (Summithion/Follithion/other name in market) 50 EC per 1 L water are sprayed on the leaves of trees. The scale insect stays on the lower portion of leaves and sucks the juice. Where the insect stays, blackish cover created by fungi, which called as sweaty molt. For these reasons, quality of fruit is hampered. these insects were controlled by sraying insecticides as Malathion, Sevin. Bidrin, Diazinon or Dimeeron. Also, fruit borer attacks to the fruits, as a result fruit were rottened. Therefore, Dipterex-80 SP 1.0g or Dipterex-50 EC 1.5 ml per 1-liter water are sprayed with 15 days' interval during young fruit stages (Anonymous, 2003b). Anonymous (2003a) described that the only significant problem was drying of branches from the tip (53%) I.e.; die back.

Also sometimes, brown spot appears on the green fruit shell by fungi, for these reasons, fruits become small and quality of fruit as well as market price is decreased. This disease may be causes by fungi. So, Dithane M-45 or Ridomil fungicide should be applied for controlling this insect (Khan, 2001).

CHAPTER III

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 survey was conducted at Shibpur Upazilla under Narsingdi district during January, 2020 to September, 2020. This Upazila was selected purposively for data collection on Latkan based agroforestry practices, because this Upazila is very much famous for Latkan production in Bangladesh. After short visit and discussion with local people of Shibpur Upazilla under Narsingdi district was selected for this study. Out of nine (9) unions of Shibpur Upazilla, five (5) 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 Latkan gardens

ii) Easy accessibility to collect required information and

iii) Good co-operations from the respondents in view of getting reliable and valuable information

Table 1. Selection of the study area

District Name	Upazila Name	Union Names	Village Names	No of Respondents
Narsingdi	Shibpur	Ayubpur	Ayubpur	8
			kandapara	8
		Baghab	Baghab	8
			Borokanda	8
		Joshor	Joshor	8
			Shorifpur	8
		Jaynagar	Betagia	8
			Jaynagar	8
		Machhimpur	Machimpur	8
			Moddhopara	8
		Total		80

3.2 Geographical location and area

The study was conducted at Shibpur Upazila of Narsingdi District under Dhaka Division. The study area is located in the north-east region of Dhaka. It was about 56 km away from Dhaka City and about 20 km away from Narsingdi District head quarter (Figure 1 and 2 showing Map of Shibpur Upazila and Narsingdi district).

3.3 Agro-ecological region

The study area belonged to the different Agro-ecological Zone (AEZ). Narsingdi district is under the AEZ-9: Old Brahmaputra Floodplain, AEZ-19: Old Meghna Estuarine Floodplain and AEZ-28: Madhupur 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, Latkan, 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 Narsingdi district.

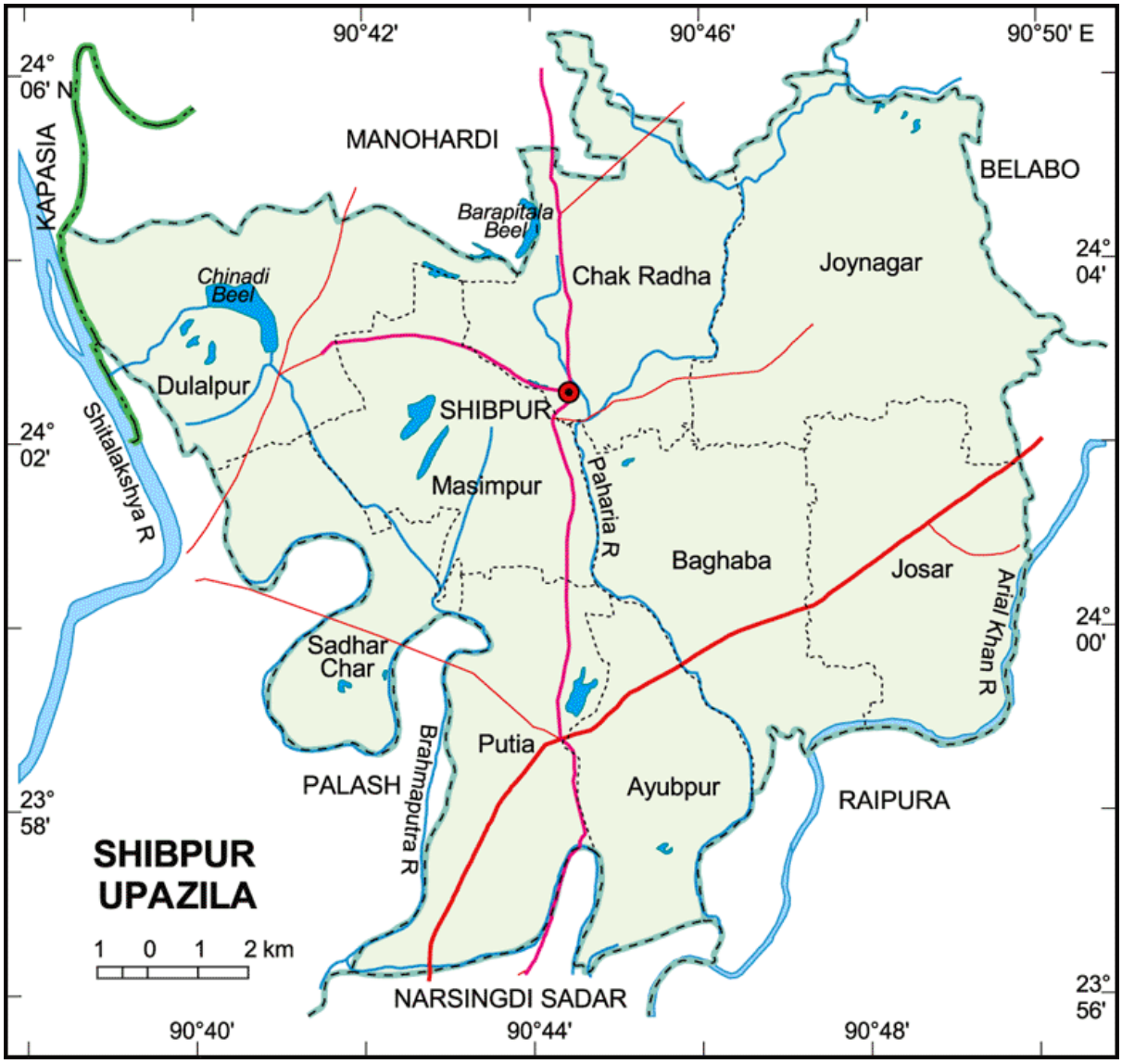

Figure 2. Map showing locale of the study area at Shibpur Upazila under Narsingdi district.

3.5 Period of the study

The study was conducted during the period from January, 2020 to September, 2020 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

Generally, it is not possible to make survey covering all the respondents. For the convenience of time and money, a simple random sampling technique was followed.

All Latkan growers of nine (9) unions of Shibpur Upazila constitute the population of the study. There are about 1505 Latkan farmers in these 9 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 Latkan 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 the data. In order to achieve meaningful conclusions, tabular technique of analysis was intensively used because its simplicity.

3.9.1 Characteristics of the Respondents

a) Age

Age of the farmers were categorized into three groups as young age <40, 40-50 and >50.

b) Education

Education of the farmers was categorized into five groups as no education (0), primary education (1 - 5), secondary education (6 -10), HSC education (11 - 12) and above HSC education (> 12).

c) Family Size

Family size (number of family members) of the farmers was categorized into three groups as small family containing up to five members, medium family containing five to ten members and large family containing more than ten members.

d) Occupation

Various occupations were observed among the respondents. The main occupations of the respondent farmers are presented.

e) Land Size

Land size of the farmers was categorized in three groups such as small farmers having less than 1ha of land, medium farmers having 1 to 2 ha and large farmer having more than 2 ha of land.

f) Annual income

Annual income of the farmers was categorized in three groups such as small, medium and large income.

3.9.2 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, Bt = Gross benefit in period t

Ct = Total cost in period t

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

3.9.3 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.

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

3.9.4 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 Latkan 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, cow dung, 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 varied from TK 80 to 100 per man-day in present year and from TK 30 to 35 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 Latkan seedlings varied from TK 150 to 300.

(c) Cost of manures and fertilizer

Farmers use different types of manures and fertilizers such as cow dung, urea, TSP, MP, oil cake etc. for growing Latkan and associated crops. Cost of fertilizer was estimated on the basis of actual market price. The price of cow dung, urea, Triple

Super Phosphate (TSP), Murate of Potash (MP), oil cake was 7.50, 18.00, 39.00, 30.00, 30.00 respectively in the present year and 2.50, 6.00, 13.00, 10.00, 10.00 respectively in the 15 years ago.

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

Very few farmers used irrigation for their Latkan production and also used irrigation in the recent years. Costs of irrigation were estimated on the basis of electricity charge per day. This charge was on average Tk 200.

(e) Cost of interest on operating capital

Interest on operating capital was calculated taking into account of nonmaterial 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 Latkan production. Hence, interest was charged as per prevailing bank rate of 12% per annum interest rate of opportunity capital for Latkan 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 Latkan, the effective return was considered from the age of 3. A feature of other crops in Latkan garden like turmeric, ginger etc. production is also done continuously during the year round. In the study area, price of Latkan varied from Tk. 70 to 80 per kg.

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation was conducted with a survey from sample farmers of Shibpur Upazila under Naringdi District in respect of Latkan 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 <40, 40-50 and >50 (Table 2). The observed ranges among the respondents were (25 – 75) years with mean values of 50. The results showed that maximum farmers were aged more than fifty (48.8%) where the lowest was less than forty years old (21.2%) and 30% was forty to fifty years old farmers. Under the present study, results revealed that relatively aged farmers were exclusively involved with Latkan based agroforestry system. But recently many young aged farmers are also getting involved with Latkan based agroforestry system as it is growing popularity day by day.

4.1.2 Education

Education of the farmers was categorized into five groups as no education (0), 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 5 (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 (21.25%) and HSC education (15%) respectively. It was also observed that only (7.5%) farmers had above HSC level education which was the lowest in number among the respondents. But there are still 16.25% uneducated farmers whom we should give proper training so that they can understand the technologies well. There is also a noticeable outcome that now more educated farmers are coming forward which can bring a nice future in agriculture.

4.1.3 Family size

Family size (number of family members) of the farmers was categorized into three groups as small family containing up to five members, medium family containing five to ten members and large family containing more than ten members. Among the respondents 50% farmers had medium family, 27.5% had large family and 22.5% had small family (Table 2). Here it can be stated that in Latkan based agroforestry system family member also contribute by helping in several events. They can also monitor the Latkan orchard to prevent theft problem.

4.1.4 Occupation

Various occupations were observed among the respondents. The main occupations of the respondent farmers are presented in (Table 2). In the present investigation it was observed that there were four categories of occupation as agriculture, business, poultry farming and service. The observed mean value was 3.18. 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%) and service (10%). Here it is noticeable that many new farmers are getting involved with Latkan based agroforestry system with their

regular job because Latkan based agroforestry system need less input and time but very profitable. As a result, number of trees are increasing which is beneficial to our environment.

Table 02. Distribution of respondents according to their Age, Education, Family size, Occupation, Land size and Family income

Characteristics	Category	Range		Mean	Frequency	Respondent (%)
		Minimum	Maximum			
Age	<40	25	75	50	17	21.2
	40-50				24	30
	>50				39	48.8
Total					80	100
Education	No education (0)	0	16	5	13	16.25
	Primary (1-5)				32	40
	SSC (6-10)				17	21.25
	HSC (12)				12	15
	Above HSC (>12)				6	7.5
Total					80	100
Family size	Small (Up to 5)	2	13	7	18	22.5
	Medium (5 to 10)				40	50
	Large (Above 10)				22	27.5
Total					80	100
Occupation	Agriculture	8	42	3.18	42	52.5
	Business				18	22.5
	Poultry farming				12	15
	service				8	10
Land size (ha)	Small farm (Up to 1)	0.03	4.50	2.265	22	27.5
	Medium farm (1 to 2)				34	42.5
	Large farm (Above 2)				24	30
Annual income (000 tk)	Small income (Up to 50000)	30	400	240	20	25
	Medium income (50500 to 150000)				42	52.5
	Large income (Above 150000)				18	22.5

4.1.5 Land size

Land size of the farmers was categorized in three groups such as small farmers having less than 1ha of land, medium farmers having 1 to 2 ha and large farmer having more than 2 ha of land which is showed in (Table 2). Among the respondents the highest

number was medium farmers (42.5%), then large farmers and small farmers (30%) and (27.5%) respectively and the mean value was 2.265.

4.1.6 Annual income

The annual income of a respondent was determined by adding his income from (crop, vegetables, tree, cattle, poultry, fisheries, business, job, and other sources) during a year. Annual income of the farmers was categorized in three groups such as small, medium and large income which is shown in table 2. Among the farmers most of them had medium income (52.5%), then small (25%) and large (22.5%). And the mean value was 240.

4.2 Production technologies followed by the farmers in the study area

4.2.1 Annual income from Latkan based agroforestry system

This is categorized in three groups as low, medium and high (Table 3). Most of the farmers (45%) had medium income from Latkan based agroforestry system. 36.25% farmers had high income which was more than 75 thousand per year. And the rest (18.75%) farmers had low income.

Table 3. Distribution of farmers according to their annual income from Latkan

Categories	Respondents	
	Frequency	Percentage (%)
Low (<25000 tk)	15	18.75
Medium (25000-75000tk)	36	45
High (>75000 tk)	29	36.25

4.2.2 Area of land having Latkan based Agroforestry system

Respondents applied kinds of Latkan based Agroforestry system on the basis of suitability of their land as required. Respondents were categorized into three groups as shown in Table 04.

Table 4. Distribution of respondents according to their area of land in which they have Latkan trees

Area of land (decimal)	Mean	Range		Respondents	
		Minimum	Maximum	Frequency	Percentage (%)
54-108				27	33.7
108-162	127	54	290	30	37.5
>162				23	28.8
Total				80	100

Data in Table 4 shows that the highest proportions (37.5%) of the respondents had 108-162 decimal of land in which they have applied Latkan based Agroforestry system. 33.7 % respondents had 54-108 decimal where 28.8% had more than 162 decimal lands applied Latkan based Agroforestry system.

4.2.3 Number of Latkan trees owned by farmers

The farmers were categorized in three groups' shows in Table 5. Most of the farmers (45%) had more than 20 trees, 38.75% farmers had 10-20 Latkan trees and the rest (16.25%) had less than 10 trees.

Table 5. Distribution of farmers according to the number of Latkan trees

Categories	Respondents	
	Frequency	Percentage (%)
Low number of trees (<10)	13	16.25
Medium number of trees (10-20)	31	38.75
Large number of trees (>20)	36	45

4.2.4 Location of Latkan trees

The location of Latkan trees were categorized in three groups (Table 6). According to most of the respondents (70%) planted Latkan trees both in orchard and in homestead. Among them 18.75% farmers only had Latkan orchard and 11.25% of them had Latkan trees in their homestead only.

Table 6. Distribution of respondents according to the locations of their Latkan trees

Characteristics	Respondents	
	Frequency	Percentage (%)
Only in homestead	9	11.25
In Latkan orchard	15	18.75
Both	56	70

4.2.5 Farmers experience with Latkan based agroforestry system

The experience of farmers with Latkan based agroforestry system was categorized in three groups (Table 7). Among them the highest number of farmers (51.2%) practiced Latkan farming for 10-15 year, 30% for 5-10 years and 18.8% farmers practiced Latkan cultivation for more than 15 years.

Table 7. Distribution of respondents according to the time they are practicing Latkan cultivation

Time(years)	Mean	Range		Respondents	
		Minimum	Maximum	Frequency	Percentage (%)
5-10				24	30
10-15	14	5	30	41	51.2
More than 15				15	18.8
Total				80	100

4.2.6 Latkan variety

There was not much knowledge about Latkan variety among the farmers. Although there was little knowledge about variety the farmers collected plant material for Latkan cultivation by observing some qualities in Latkan.

Table 8. Distribution of Respondents according to their usage of Latkan variety

Categories	Respondents	
	Frequency	Percentage (%)
No recognized variety	39	48.7
Variety having large fruit size	22	27.5
Variety with sweeter fruits	19	23.8
Total	80	100

So Latkan variety was categorized in three groups(table-07). Most of the farmers (48.7%) responded that they had no idea about variety. Some (27.5%) farmers collected planting material form mother plant having large fruit size and others (23.8%) farmers collected varieties with sweeter fruits.

4.2.7 Propagation method

Propagation method in Latkan cultivation was not a known topic between farmers even in few years back. because the seed germination rate of Latkan seed is high so farmers used to grow seedlings from seed. But with this process there was a major problem which is male and female plant ratio. because there was no way to know which will be male and which will be female. But nowadays many nurseries have grown in Narshingdi especially in shibpur upazila and these nurseries provide good quality grafted seedlings which are grafted from good variety mother plant. Many farmers are now using grafted seedling for their orchard especially new farmers. But old farmers are still not very convinced in grafted seedlings. Some farmers also graft seedlings from their own mother plants.

Keeping this thing in mind propagation method of Latkan are categorized in three groups which shows in Table 9. Among them most of the farmers (60%) propagate seedling from seed, (33.75%) used grafting and (5%) used stem cutting.

4.2.8 Source of planting material

Source of planting material was categorized in three groups which shows in Table 9. Among the farmers 51.25 farmers grew their own seedling, 35% farmers collected seedling form successful orchard and 13.75% farmers collected seedling from nurseries.

4.2.9 Age of seedling

Age of seedling was categorized in three groups' shows in Table 9. Most of the farmers (52.25%) collected seedling of 3 years old, 36.25% collected seedlings of 2 years old and the rest (11.25%) collected seedling of 4 years old.

Table 9. Distribution of respondents according to their responses in propagation method, source of planting material, age of seedling, height of seedling

Characteristics	Categories	Respondents	
		Frequency	Percentage (%)
Propagation method	From seed	48	60
	From stem cutting	5	6.2
	From grafting	27	33.75
Source of planting material	Own source	41	51.25
	From successful orchard	28	35
	From nurseries	11	13.75
Age of seedling (Year)	2	29	36.5
	3	42	52.25
	4	9	11.25
Height of seedling(cm)	20-25	15	18.75
	25-30	41	51.25
	>30	24	30

4.2.10 Height of seedling

Height of seedling was categorized in three groups shows in Table 9. Most farmers (51.25%) preferred seedling with 25-30 cm or 4 feet height. And 30% preferred seedling with more than 30cm height and the rest (18.75%) 20-25cm.

4.2.11 Planting distance

In Latkan based agroforestry system planting distance is a very important criterion as the production depends on it. If a farmer plant Latkan trees very closely the production will be less as a Latkan tree is very bushy so if planted very closely no sunlight will pass as a result the overall production will be less. And it will also damage the Latkan based agroforestry system.

Planting distance is categorized in three groups (Table 10). Most of the farmers (52.25%) maintained planting distance more than 8m. 27.5% farmers maintained 5-7m and the rest (20.25%) maintained 2-4m planting distance.

4.2.12 Pit size

Before planting Latkan seedling a pit is made and then fertilizers are put into the pit. And after some days' seedlings are planted in that pit. Pit size is categorized in three groups (Table-09). Most of the farmers (76.25%) farmers used 30 m x 30 m x 30 m pit size.

Table 10. Distribution of Planting distance, pit size and planting time of Latkan cultivation

Characteristics	Categories	Respondents	
		Frequency	Percentage (%)
Planting distance (m)	2-4	16	20.25
	5-7	22	27.5
	>8	42	52.25
Pit size (cm) (length ×width × depth)	(30 ×30 ×30)	61	76.25
	(23 ×23 ×23)	13	16.25
	(45 × 45 ×45)	6	7.5
Planting time	June	13	16.25
	July	56	70
	August	11	13.75

4.2.13 Planting time

The planting time of Latkan cultivation was categorized in three groups as shows in Table 10. Most of the farmers (70%) plant Latkan trees in July. 16.25% planted in June and others (13.75%) in August.

4.2.14 Involvement of farmers with different organization

There was not so much active organization as the respondents said. But nowadays as Latkan cultivation is gaining popularity among farmers the upazila krishi office often pay visit to farmers and give them advice.

The involvement with organization was categorized in yes\no question. Where most of the farmers (85%) stated no as their answer.

Table 11. Involvement of Latkan farmers with organization

Categories	Respondents	
	Frequency	Percentage (%)
Yes	12	15
No	68	85

4.2.15 Training facilities

Training facilities are very necessary as it is a rising sector of our country. Nowadays the Latkan of our country are going in many Europe countries. If proper training can be given to the farmers the production can be increased and the storing capacity also canbe improved so that it can be exported in foreign country easily. Nowadays upazila krishi officers are providing farmers with many training facilities even they sometime visit in many orchards to give instructions. If the farmers can follow their instructions the production will increase.

Training facilities were categorized in three groups (Table 12). Most of the farmers (61.25%) stated that there were no training facilities. Where (36.25%) said medium and 3.75% said high training facilities.

Table 12. Training facilities of Latkan farmers

Categories	Respondents	
	Frequency	Percentage (%)
No training facilities	49	61.25
Medium training facilities	29	36.25
High training facilities	3	3.75

4.2.16 Application of fertilizer

This is categorized in two groups (Table 13). Most of the farmers (82.5%) use fertilizer once in a year after harvesting. the rest (17.5%) didn't use any fertilizer. So, it is known that using fertilizer is not mandatory for Latkan cultivation but if it is used after harvesting the production will increase. A lot of farmers complain about low bearing of fruits in alternating year which can be caused by not using fertilizer once in a year.

Table 13. Management techniques of Latkan cultivation

Characteristics	Categories	Respondents	
		Frequency	Percentage (%)
Application of fertilizer	No fertilization	14	17.5
	Once in a year (after harvesting)	66	82.5
Pruning time	September-October	62	77.5
	October-November	9	11.25
	December	9	11.25
Irrigation	No irrigation	67	83.75
	February	6	7.5
	March	7	8.75

4.2.17 Pruning time

Pruning is difficult in Latkan trees because every little branch of Latkan tree bears fruit as a result farmers fear that pruning will decrease the production. But after harvesting if pruning is done the production increases which is instructed by the upazila krishi officer as the farmer said.

Pruning time is categorized in three groups (Table 13). Most of the farmers (77.5%) prune Latkan trees in Sep-Oct. Some (11.25%) in Oct-Nov and some (11.25%) in Dec.

4.2.18 Irrigation time

Irrigation time is categorized in three groups (Table 13). Among them most of the farmers (83.75%) didn't apply any irrigation. some (8.75%) applied irrigation in March and other (7.5%) in February.

4.2.19 Flowering time

Flowering time of Latkan is categorized in three groups as shown in Table 14.68% farmers responded that the flowering time of Latkan is Feb-March. 12.5% farmers responded February and the rest (2.5%) farmers responded Jan-Feb.

Table 14. Flowering and Fruiting time of Latkan

Characteristics	Categories	Respondents	
		Frequency	Percentage (%)
Flowering time	January-February (Magh)	2	2.5
	February (Magh-Falgun)	10	12.5
	February-March (Falgun)	68	85
Fruit harvesting time	June-July (Ashar)	29	36.25
	July (AShar-Shravan)	37	46.25
	July-August (Shravan)	14	17.5

4.2.20 Fruit harvesting time

Fruit harvesting time of Latkan was categorized in three groups (Table 14). Here the highest number of farmers (46.25%) harvested fruit in July month. Then 36.25% farmers harvested in June-July and the rest (17.5%) farmers harvested Latkan in July –August.

4.2.21 First fruit production age

It was categorized in three different groups which is shown in Table 15. According to most of the farmers (53.75%) the Latkan tree first bear fruit at the age of 4 years old. Some (32.5%) farmers mentioned 5 years old and others (13.75%) mentioned 3 years old. The bearing of fruit also depends on propagation method as grafted seedlings bear fruit earlier than seedling grown from seed.

Table 15. Age of Latkan tree for first fruit production and maximum fruit production

Characteristics	Categories	Respondents	
		Frequency	Percentage (%)
Frist fruit production (Age)	3	11	13.75
	4	43	53.75
	5	26	32.5
Maximum fruit Production (Age)	10-15	12	15
	15-20	40	50
	20-25	28	35

4.2.22 Maximum fruit production age

Maximum fruit production age is categorized into three groups shown in Table 15. According to most of the farmers (50%) the maximum fruiting age was 15-20 years old. Some (35%) farmers suggested 20-25 years old Latkan tree give maximum production. Only (15%) farmers said that 10-15 years old Latkan tree gives maximum production.

4.3 Identification of Latkan based agroforestry system in the study area

4.3.1 Farmer's opinion on Latkan based agroforestry system

Farmer's opinion on Latkan based agroforestry system was categorized in two groups such as sole Latkan and Latkan based agroforestry system (Table 16). According to most of the respondent (81.25%) Latkan based agroforestry system was preferable. On the other hand, only (18.75%) respondent preferred sole Latkan.

Table 16. Farmer's opinion on Latkan based Agroforestry system

Type of production system	Respondents	
	Frequency	Percentage (%)
Sole Latkan	15	18.75
Latkan based Agroforestry system	65	81.25

4.3.2 Associated crops

46.25% respondents planted coriander as associated crop with Latkan .26.25% farmers planted turmeric as associated crop, 16.25% farmers planted brinjal and the rest (11.25%) farmers planted other crops. (Table 17.)

4.3.3 Associated trees

According to most of the farmers (66.25%) jackfruit is used as associated trees with Latkan. Some other trees were also planted with Latkan such as papaya (6.25%), guava (6.25%), banana (5%), akashmony (2.5%), mahogany (2.5%), gammer92.5%), and others (7.5%). (Table 17.)

Table 17. Associated trees and crops with Latkan cultivation in farmer's field

Characteristics	Names	Respondents	
		Frequency	Percentage (%)
Associated crops	Brinjal (*solanum melongena*)	13	16.25
	Coriander (*Eryngium ffoetidum*)	37	46.25
	Turmeric (*Curcuma domestica*)	21	26.25
	Other crops	9	11.25
Total		80	100
Associated trees	Jackfruit (*Artocarpus heterophyllus*)	53	66.25
	Guava (*Psidium guajava*)	5	6.25
	Papaya (*Carcia papaya*)	6	7.5
	Banana (*Musa sapientum*)	4	5
	Akashmoni (*Acacia auriculiformis*)	2	2.5
	Mahagony (*Swietonia macrophylla*)	2	2.5
	Gammer (*Gamelina arborea*)	2	2.5
	Other trees	6	7.5
Total		80	100

4.4 Contribution of Latkan based agroforestry in the study area

4.4.1 Economic performance of Latkan based agroforestry system

For estimation of economic performance, it is necessary to calculate different types of cost and return of production. For Latkan based agroforestry system year wise cost and return are shown in Table 18.

4.4.2 Cost of Latkan based agroforestry system

In Latkan 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 18). The cost for seedling, and land preparation during orchard establishment were Tk. 21000 and 7450/ha respectively. Other costs were fertilization, land use cost, intercultural operational cost, and 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 Latkan based agroforestry system were Tk. 33432, 34504, 38329, 49828, 66640, respectively (Table 18.).

4.4.3 Benefit from Latkan based agroforestry system

Harvesting of fruit was started from third to fourth year of Latkan orchard establishment. But in the initial year of fruiting, the number 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 Latkan was 10 to 12 years and it started to give more production at 15 years and up to 25-30 years. The highest gross and net return in the 15th year that was Tk. 320000 and 253360 respectively.

4.4.4 Inter-temporal budgeting for Latkan based agroforestry system

Intertemporal budgeting for Latkan based agroforestry System is presented in Table 19. For intertemporal budgeting all cost incurred and benefit accrued from the trees and vegetables have been taken into consideration.

4.4.5 Cost

Latkan tree gave first fruit at the age of four. The economic life of Latkan based system is considered for 25-30 years. For 1st, 2nd, and 3rd year the production cost was tk. 34504, 32902, 34194 respectively (Table 18). The production cost was increased with the increase of age of Latkan garden.

4.4.6 Benefit

In Latkan based agroforestry system the benefit was started from 4th year of plantation. From eight year of plantation, it was higher because at this stage Latkan give maximum yield and it continued up to15 years of plantation

4.4.7 Evaluation of intertemporal budget for Latkan based agroforestry system

Intertemporal budget for Latkan based agroforestry system showed that the cash flow at the 1st, 2nd, and 3rd year were negative, but it became positive from the 4th year and continuing up to 15th year (Table 18). The discounted benefit cost ratio (1.90), net present value (Tk.305067) and internal rate of return (52.29%) clearly indicated that Latkan 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. 190. Again, the difference between discounted gross benefit and discounted gross cost indicated that the net present value was Tk. 305067(Table 18).

Table 18. Year wise different cost and return per hectare (Tk./ha) of Latkan production of 15 years

Age of Latkan	Seedling	Pit preparation	Bamboo stick	Seedling transplanting									Interest on operating capital	Total cost	Gross benefit	Net return
Initial	21500	1450	2000	4000									3582	33432	0	-33432
	Cow dung	Urea	TSP	MoP	Oil Cake	Irrigation	Fertilizer App.	Irrigation App.	Digging And pesticide	Punning	Harvesting	Land use				
1	540	213	84	36	100	200	500	500	600	0	0	26000	5812	34504	0	-34504
2	300	132	258	60	84	200	500	500	600	0	0	26675	3525	32902	0	-32902
3	642	156	306	66	84	200	500	600	600	0	0	227376	3664	34194	0	-34194
4	468	162	336	78	84	200	500	600	600	0	0	28087	3734	34849	45000	10151
5	942	186	420	90	84	400	500	600	600	400	500	29500	4207	38329	60000	21671
6	1896	390	744	186	228	222	600	600	600	500	700	32000	4640	43306	75000	31694
7	1896	400	750	190	225	220	600	600	600	500	700	33000	4762	44443	80000	35557
8	1900	400	750	190	200	250	600	700	700	600	700	34500	4979	46469	90000	43531
9	1900	400	760	200	210	300	600	700	700	600	700	37000	5288	49538	120000	70642
10	2000	410	800	200	250	350	700	700	800	700	800	37000	5338	49828	150000	100172
11	2000	410	800	200	250	350	700	700	800	700	800	38500	5629	52539	180000	127461
12	2100	450	810	230	310	400	700	800	800	800	800	39000	5664	52864	200000	147136
13	2100	450	800	250	330	420	700	800	900	900	900	39500	5706	58962	220000	161038
14	2500	500	820	250	350	500	700	800	900	900	900	40000	5894	55014	250000	194986
15	2500	500	850	300	350	500	700	800	1000	1000	1000	50000	7140	66640	320000	253360
	23684	5068	9268	2536	3189	4662	9000	10000	10700	7600	80000	518138	79464	727633	1790000	1072367
BCR=2.46																

Table 19. Intertemporal budgeting (per ha) for Latkan based agroforestry for 15 years

Age of Latkan 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	34504	0	-34504	1	-34504	1	-34504	1	34504	0	-34504
2	32902	0	-32902	.500	-16451	.476	-15661	.901	29645	0	-29645
3	34194	0	-34194	.025	-855	.227	-7762	.812	27766	0	-27766
4	34849	45000	10151	.125	1269	.108	1096	.731	25475	32895	7420
5	38329	60000	21671	.063	1365	.051	1105	.659	25259	39540	14281
6	43306	75000	31694	.031	983	.024	761	.593	25680	44475	18794
7	44443	80000	35557	.016	569	.012	427	.535	23777	42800	19022
8	46469	90000	43531	.008	348	.006	2612	.482	22398	43380	20981
9	49538	120000	70642	.004	283	.003	212	.434	21499	52080	30658
10	49828	150000	100172	.002	200	.001	100	.391	19483	58650	39167
11	52539	180000	127461	.001	127	.001	127	.352	18494	63360	44866
12	52864	200000	147136	0	0	0	0	.317	16758	63400	46642
13	58962	220000	161038	0	0	0	0	.286	16863	62920	46066
14	55041	250000	194986	0	0	0	0	.258	14201	64500	50306
15	66640	320000	253360	0	0	0	0	.232	15460	74240	58779
Total					-46666		-51487		337262	642240	305067

(Discounted Benefit Cost Ratio) DBCR=1.90 and (Internal Rate of Return) IRR=52.29%

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

4.4.7 Productivity performances on different Latkan based agroforestry system

In the study area 12 types of Latkan based were found (Table 18). Among them four systems are described below.

4.4.8 Latkan-Brinjal based agroforestry system

In this system all the costs were estimated by the help of previous results and the help of respondent farmers. Here the total cost of production for Latkan was 39600tk/ha (Table 20). And the total cost of production for brinjal was 9300tk/ha (Table 20). And the selling price of Latkan and brinjal was 120000tk/ha and 22000tk/ha respectively (Table 20.) the BCR was 2.93(Table 20.) which is more than sole Latkan cultivation BCR (2.46) (Table 18.) It proves that Latkan based agroforestry system is beneficial than sole Latkan cultivation.

Plate 1. Latkan-Brinjal based Agroforestry system

4.4.9 Latkan-Coriander based agroforestry system

The total cost of production for Latkan in the system was 39600tk/ha (Table 21.), and the total cost of production for coriander was 6000tk/ha (Table 21), and the selling price of Latkan and coriander was 120000tk/ha and 10000tk/ha respectively (Table 21). Here the BCR was 2.88 (Table 21.) which is more than sole Latkan cultivation BCR (2.46), it was shown in Table 18. Which proves that Latkan based agroforestry system is beneficial than sole Latkan cultivation.

Plate 2. Latkan- Coriander based Agroforestry system

4.4.10 Latkan-Turmeric based agroforestry system

In this system the total cost of production for Latkan was 39600tk/ha (Table 22). Total cost of production for turmeric was 7700tk/ha (Table 22.), the selling price of Latkan and turmeric was 120000tk/ha and 18000tk/ha respectively (Table 22). And the BCR was 2.94 which is more than sole Latkan cultivation BCR (2.46) therefore, proves that Latkan based agroforestry system is beneficial than sole Latkan cultivation.

Plate 3. Latkan – Turmeric based Agroforestry system

4.4.11 Latkan-Jackfruit based agroforestry system

This is the most planted tree with Latkan (Table 17). In this system all the costs were estimated by the help of previous results and the help of respondent farmers. Here the total cost of production for Latkan was 39600tk/ha, the total cost of production for jackfruit was 2600tk/ha, the selling price of Latkan and turmeric was 120000tk/ha and 20000tk/ha respectively (Table 23). The BCR was 3.35 which is more than sole Latkan cultivation BCR (2.46), this proves that Latkan based agroforestry system is beneficial than sole Latkan cultivation.

Plate 4. Latkan – Jackfruit based agroforestry system

Table 20. Cost of Production of Latkan- Brinjal based Agroforestry system per hectare

Items	**Material Cost (Tk.)**	
	Latkan	**Brinjal**
Planting material cost		1500
Fertilizer cost	3000	1000
Irrigation application cost	300	1000
Instrument cost	100	100
Items	**Non-material Cost (Tk.)**	
	Latkan	**Brinjal**
Land preparation cost		1000
Intercultural operation cost	500	500
Labor cost	500	1000
Harvesting cost	700	2000
Marketing cost	500	700
Fixed cost	34000	500
Total cost	39600	9300
Grand total	**48900**	

b. Gross Return/Output:

Items	**Latkan**	**Brinjal**
Sell price	120000	22000
Own consumption	1000	500
Total income	120000+1000+22000+500=143500	

Benefit Cost Ratio:

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost of Production}} = \frac{143500}{48900}$$

$$= \mathbf{2.93}$$

Table 21. Cost of Production of Latkan- Coriander based Agroforestry system per hectare

Items	Material Cost (Tk.)	
	Latkan	**Coriander**
Planting material cost		800
Fertilizer cost	3000	500
Irrigation application cost	300	500
Instrument cost	100	100
Items	**Non-material Cost (Tk.)**	
	Latkan	**Coriander**
Land preparation cost		1000
Intercultural operation cost	500	500
Labor cost	500	600
Harvesting cost	700	1200
Marketing cost	500	500
Fixed cost	34000	300
Total cost	39600	6000
Grand total	**45600**	

b. Gross Return/Output:

Items	Latkan	Coriander
Sell price	120000	10000
Own consumption	1000	400
Total income	120000+1000+10000+400=131400	

Benefit Cost Ratio:

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost of Production}} = \frac{131400}{45600}$$

$$= \mathbf{2.88}$$

Table 22. Cost of Production of Latkan- Turmeric based Agroforestry system per hectare

Items	**Material Cost (Tk.)**	
	Latkan	**Turmeric**
Planting material cost		1000
Fertilizer cost	3000	800
Irrigation application cost	300	800
Instrument cost	100	100
Items	**Non-material Cost (Tk.)**	
	Latkan	**Turmeric**
Land preparation cost		1000
Intercultural operation cost	500	500
Labor cost	500	900
Harvesting cost	700	1500
Marketing cost	500	700
Fixed cost	34000	400
Total cost	39600	7700
Grand total	**47300**	
b. **Gross Return/Output:**		
Items	**Latkan**	**Turmeric**
Sell price	120000	18000
Own consumption	1000	500
Total income	120000+1000+18000+500=139500	

Benefit Cost Ratio:

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost of Production}} = \frac{139500}{47300}$$

$$= \mathbf{2.94}$$

Table 23. Cost of Production of Latkan- Jackfruit based Agroforestry system per hectare

Items	Material Cost (Tk.)	
	Latkan	**Jackfruit**
Planting material cost		
Fertilizer cost	3000	500
Irrigation application cost	300	
Instrument cost	100	100
Items	**Non-material Cost (Tk.)**	
	Latkan	**Jackfruit**
Land preparation cost		
Intercultural operation cost	500	500
Labor cost	500	
Harvesting cost	700	500
Marketing cost	500	1000
Fixed cost	34000	
Total cost	39600	2600
Grand total	**42200**	

b. GrossReturn/Output:

Items	Latkan	Turmeric
Sell price	120000	20000
Own consumption	1000	500
Total income	120000+1000+20000+500=141500	

Benefit Cost Ratio:

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost of Production}} = \frac{141500}{42200}$$

$$= \mathbf{3.35}$$

4.5 Problems and constraints of Latkan based agroforestry system

There are many problems which are faced by farmers in case of Latkan based agroforestry system which are shown in Table 24. In the table it was seen that farmers (13.75%) ranked selling price as number one problem as Latkan trees cannot tolerate water stagnation. The 2nd problem was insects supported by 11.25% farmers though they also mentioned that in Latkan cultivation insect attack is not as dangerous as other fruit trees like mango, litchi etc. And the 3rd problem mentioned by the farmers (10%) was complexities in vegetative propagation as the concept is very much new to many farmers. The other problem was ranked in the Table 24.

Table 24. Problems faced by the farmers in practicing Latkan based agroforestry systems

Types of problem	Categories	Respondents		Rank order
		Frequency	Percentage (%)	
Biological problem	Insects	9	11.25	2nd
	Diseases	7	8.75	4th
	Complexities in vegetative propagation	8	10	3rd
	Bearing lower fruits in alternative years	5	6.25	6th
	Lack of sunlight for growing crops	4	5	7th
Economic problem	High cost of seedlings	9	11.25	2nd
	Lack of capital	2	2.5	9th
	High price of inputs	5	6.25	5th
Marketing problems	Lack of storing	3	3.75	8th
	Poor communication	1	1.25	10th
	Labor crisis	6	7.5	5th
Social problem	Problem of theft	5	6.25	6th
	Lack of skilled manpower	4	5	7th
	Insufficient extension service	1	1.25	10th
Selling price	Lower price in the field than the urban market	11	13.75	**1st**

4.5.1 Constraints faced by the farmers in Latkan cultivation

This was categorized in three groups. Farmers were asked about the level of constraints they were facing. 68.75% respondents said that they were facing medium level of constraints, 17.5% replied high and the rest (13.75%) faced low constraints in Latkan cultivation. So, it can be concluded that overall, 86.25 % farmers faced medium to high constraints, Table-25.

Table 25. Constraints faced by the farmers in Latkan cultivation

Categories	Respondent	
	Frequency	Percent (%)
Low constraint	11	13.75
Medium constraint	55	68.75
High constraint	14	17.5
Total	80	100

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

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

SUMMARY

The study was conducted at Shibpur upazila under Narsingdi district to identify the different Latkan based Agroforestry system and its economic potentialities. So respondents were selected randomly and data were collected by questionnaire during January to December 2020. Data were analyzed by SPSS 16.0 system. The maximum farmers were old age (48.8%) where the minimum was young age (21.2%). However, the maximum farmers (40%) were under primary education and the minimum numbers of respondents (7.50%) were under above HSC education. Among the respondents' maximum farmers (50%) had medium size family and the minimum farmers (22.5%) had small family. Among the respondents, agriculture was the primary occupation for more than half of the respondents (52.5%) where minimum number of respondents (10%) was in service like teacher, doctor etc. Majority of the respondent farmers (42.5%) had medium size farm and minority (27.5%) had small size farm or no farm at all. Majority of the farmers (52.5%) earned medium annually and the minority (22.5%) earned high income in a year which is more than 150000tk.

On the other hand, majority of the farmers (45%) earned 25000-75000tk per year from Latkan cultivation and minority of farmers (18.75%) earned less than 25000tk from Latkan cultivation. Most of the farmers (37.5%) had 108-162 decimal of land in which they had olanted Latkan trees and minority of farmers (28.8%) had 54-108 decimal land occupied with Latkan trees. Most of the farmers (45%) had more than 20 Latkan trees and minority of farmers (16.25%) had less than 10 Latkan trees. Most of the respondents (70%) planted Latkan trees both in the orchard and in their orchards

and only 11.25% farmers planted Latkan trees in the homestead area only. Most of the farmers (51.2%) were involved in Latkan cultivation for 10-15 years and minority (18.8%) farmers were involved in Latkan cultivation for more than 15 years. Among the farmers most of them (48.7%) had no idea which variety of Latkan they were using only (23.8%) farmers mentioned that they planted Latkan tree with sweeter fruits. Among them most of the farmers (60%) grew their seedlings from seed and minority farmers (6.2%) used stem cutting for growing seedling. But it is noticeable that growing seedling from grafting is getting popularity day by day. Most of the farmers (51.25%) grew their own seedling and minority of them (13.75%) collected seedling from nurseries. Majority (52.25%) collected seedling of 3 years old and minority (11.25%) collected seedling of 4 years old. Most of the farmers (51.25%) selected seedling with the height of 25-30cm and minority (18.75%) selected seedlings with the height of 20-25cm. Most of the farmers (52.25%) maintained planting distance more than 8m and minority (20.25%) maintained 2-4m planting distance. Most of them (76.25%) stated that pit size should be (30 x 30 x 30) cm in size and minority (7.5%) stated (45 x 45 x 45) cm in size. Most of them (70%) planted seedling in the month of July and minority (13.75%) planted seedling in August. Only 15% farmers were involved with different organization but 85% were not involved with any organization.61.25% farmers stated that there were no training facilities and only 3% said there were high training facilities. 82.5% farmers used fertilizer once in a year and 17.5% farmers used no fertilizer.77.5% farmers prune their Latkan trees after harvesting which is in Sep-Oct and the rest in Oct or Nov.83.75% farmers used no irrigation and 7.5% used irrigation in February. Most of them (85%) said that the flowering time is Feb-March and minority (2.5%) said in Jan-Feb. among them the majority (46.25%) harvested fruit in July and minority (17.25%) harvested in July-August. Most of them (53.75%) mentioned first fruit production age is 4 years old and minority (13.75%) mentioned 3years. Most of them (50%) said that the maximum fruit production age was 15-20 years old and minority (15%) said 10-15 years.

81.25% farmers supported Latkan based agroforestry system when only 18.75% supported sole Latkan. Most of the farmers (46.25%) used coriander as associated crop with Latkan and minority (11.25%) farmers used other crops. Most (66.25%) of them used jackfruit as associated tree and minority (2.5%) used other trees.

By observing 15 years of Latkan cultivation the BCR was calculated as2.46 which is beneficial. And from intertemporal budgeting the BCR was calculated 1.90 and IRR was 52.29%. for Latkan + Brinjal BCR was 2.93. Latkan + Coriander BCR=2.88. Latkan + Turmeric BCR=2.94. Latkan + Jackfruit BCR=3.35. so, we can say that the Latkan based agroforestry system is more profitable than sole Latkan cultivation.

Most of the farmers (13.75%) identified selling price as no. one problem and poor communication as the last. Most of the farmers (68.75%) said there were medium constraint and minority (13.75%) said low constraints.

CONCLUSION

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

1. From the study we get to know that the production technology of sole Latkan cultivation and Latkan based Agroforestry system is not very different, where the profit of Latkan based Agroforestry system is far more than sole Latkan cultivation.
2. In the study 10 different Latkan based Agroforestry system were identified. Among them Latkan+ Jackfruit based system held the highest BCR (3.35).
3. The discounted benefit cost ratio (1.90), and internal rate of return (52.23%%) clearly indicated that Latkan based agroforestry system was productive and profitable agroforestry system.

Some problems were identified in respect of Latkan 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.

RECOMMENDATIONS

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

1. Hence, the present study area was at Shibpur Upazilla under Narshingdi District, the number of locations 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. As holding the highest BCR (3.35) Latkan + jackfruit based Agroforestry system should be practiced more by the farmers.

3. This kind of research can also be conducted in Mymenshingh and Tangail rejoin as these areas have similar topography.

CHAPTER VI

REFERENCES

Abdullah, A.T.M., Hossain, M.A., Bhuiyan, M.K., (2005). Propagation of Latkan (*Baccaurea sapida Muell. Arg.)* by mature stem cutting. *Res. J. of Biol. Sci.* **1**:129–134.

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.). pp. 19-53.

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, pp. 31-47.

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.

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.

Anonymous. (2003a). Annual Research Report. On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. Pp-269-275.

Anonymous. (2004a). Latkan-A Promising Cash Crop. The observer Magazine, dated on 23rd April,2004.

Anonymous. (2010). Updating poverty maps of Bangladesh: Key findings. The World Bank, World Food Programme and BBS, 19 p.

Bangladesh Bureau of Statistics (BBS), (2005). Statistical year book. Bangladesh Bureau of Statistics, Dhaka, Government of People's Republic of Bangladesh.

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. (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. *Agrof. Syst.*, **7**: 103-114.

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

Bhowmick, N. (2011). Some lesser known minor fruits of Northern parts of West Bengal. Acta Horticulturae 890:61–63. doi: 10.17660/actahortic.2011.890.4.

Bose, T.K. (1985). Fruits of India Tropical and Subtropical. Naya Prokash, India.

Chakrabarty, T., Gangopadhyay, M. (1997). The genus Baccaurea (*Euphorbiaceae*) in the Indian subcontinent. *J. of Economic and Taxonom Botany*. **21**:525–534.

Devidson, J. (1984). Research in the Forest Management Branch of the BFRI. UNDP/FAO, BGD/79/017, Field Document No. 4.

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

FAO.http://www.fao.org/DOCREP/004/AB777E/ab777e04.htm-Euphorbiaceae family-Rambai/Mafai.

Fernandes, E.C.M. and Nair, P.K.R. (1990). An evaluation of the structure and function of tropical home gardens. *Agri. Syst.* **21**: 279-310.

Forest Department (FD), (2012). Bangladesh Forest Department Conservation sites. Ministry of environment and Forests, Government of Bangladesh. Available at URL: http://www.bforest.gov.bd, last accessed on 20.08.2012.

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.

Government of Bangladesh (GoB), 1990. Resource Information Management System Data Bank. Forest Department, Mohakhali, Dhaka.

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.

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

Hasan, S., Hossain, M., Akter, R., Jamila, M., Mazumder, M., Rahman, S., (2009). DPPH free radical scavenging activity of some Bangladeshi medicinal plants. *J. of Medi. P. Res.* **3**:875–879.

Hoang, S.V., Baas, P., Keβler, P.J.A. (2008). Uses and conservation of plant species in a national park—A case study of Ben En, Vietnam. Economic Botany **62**:574–593. doi: 10.1007/s12231-008-9056-1.

Hoque, A.K.M.A., Mohammad, N., Ahmed, Q.M., Kundu,S., Islam. M.S. (2017). Morphological description of superior Burmese grape genotype. *J. of Eco-Friendly Agri*. **10**:82–85.

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

http://www.fao.org/forestry/agroforestry/80338/en/.

Islam, M., Islam, M., and Sadath, M. (2013). Contributions of Agroforestry Practice Towards Reducing Poverty at Keshabpur Upazila of Jessore District, A Case Study. *J. of Envir. Sci. and Nat. Resour.* **5(2**), 267-274.

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

Khan, B., (2008). Encyclopedia of Flora and Fauna of Bangladesh. Asia Society of Bangladesh, Dhaka, Bangladesh.

Khan, M.M.R. (2001). Latkan Chash (Folder). Agriculture Diversification and Intensification Project (ADIP). Khamar bari, Dhaka-1215.

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

Lawrence, J.H. and Hardostry, L.H. (1992). Mapping the territory: agroforestry awareness among Washington stale land managers. In: Agroforestry 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.

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

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.

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.

Morton, J. (1987). Fruits of warm climate pp.220.

Mustafa, M. (1996). Structure and floristries of Bangladesh home garden 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. (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.

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

Pal, R., Bhowmick, N., Suresh, C. (2008). Latka (Baccaure asapida Muell. Arg.)-an under exploited minor fruit crop of West Bengal. Abstracted in 3rd Indian Horticulture Congress: New R & D Initiatives in Horticulture for Accelerated Growth and Prosperity, OUAT, Bhubaneswar, India.

Rajput, C.B.S. and J.P. Singh. (1964). *Indian J. Hort*., **21**:204-5.

Rashid, M.M., Kabir M.A. and Hossain M.M. (1987). Bangladesher Fal. Rashid publishing House, Joydebpur, Gazipur.

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.

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.

Solanki, K.R. (1998). Agroforestry 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.

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

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

William A. Leuschner & Kibriaul Khaleque, (1987) *Agroforestry Systems*, **Volume 5,** Pages 139-151.

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

Yang, X.W., Wang, J.S., Ma, Y.L., Xiao, H.T., Zuo, Y.Q., Lin, H., He, H.P., Li, L., Hao, X.J., (2007). Bioactive phenols from the leaves of Baccaurea ramiflora. Planta Medica 73:1415–1417. doi: 10.1055/s-2007- 990235.

CHAPTER VII

APPENDICES

Appendix 1. Questionnaire of The Study

(English Version of the Interview Schedule)

Department of Agroforestry and Environmental Science

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

Dhaka-1207

Questionnaire on

Agro-Economic Potentialities of Latkan Based Agroforestry System in Shibpur Upozilla under Narsingdi District

A. Personal Details

1.Identification of the Respondent:

Name:
……..
Fathers name:
……..
Mothers name:
……...
Village:
……...
Upazilla:
……
District:
……....
Age:……

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: Narsingdi district

C. Detail history and purpose of Cultivation:

1. From when and how have you related with Latkan gardening?
2. Why do you choose Latkan plantation in your homestead?

   i. Own occupation
   ii. Sale/Business
   iii. Both
   iv. Traditionally

3. How long have you been practicing Latkan gardening? ……Years

4. What types of cultivars/varieties have you cultivated in your Latkan Garden?

Cultivar/Variety		Duration of Cultivation (Year)

5. What types of land will you prefer for Latkan Cultivation?
6. Which location that you prefer to collect Latkan Seedlings?

7. What is the age of seedling that you prefer for plantation and which procedure you maintain for raising seedling?
8. Which season do you prefer for plantation of Latkan seedling?
9. Please mention the size of pit that you use to planting seedling?

10. Please informed us about fertilizer application before plantation:

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

Planting materials	Planting methods	Spacing	Precautions

12. Please inform the dose of different fertilizers in your Latkan garden

Name of fertilizer	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 ……. years

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

16. how can you identify the appropriate harvesting time (maturity time) of Latkan

……
……
……
……

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 Latkan with age of plants:

Age category of Latkan tree	Production
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, pumpkin, bean etc. in your Latkan garden?

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

21. Please mention the following information about Latkan marketing

- Where and how you sell your product?
- Do you get desired return? Yes/No
  Please specify the reasons-
- Please advise 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 Latkan garden

Name of crops	Time of plantation	Methods	Production status

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

Name of fertilizer	Amount	Time of application	Methods

24. Please mention the management practice for other crops in your Latkan garden:

Type of work	Frequency of work	Time of work	Reasons of work

Contraints:

25. Do you think that your production is increasing day by day during previous 10 years' production status? Yes/ No

If Yes/ No, please notify……

D. **Cost of Production and Net income:**

1. Production Cost

Items	Material Cost	
	Latkan	Other Crops
Planting material cost		
Fertilizer cost		
Pesticide application cost		
Instrument cost		
Items	Non-material Cost	
	Latkan	Other Crops
Land preparation cost		
Intercultural operation cost		
Labor cost		
Harvesting cost		
Marketing cost		

2. Net Return/Output:

Items	Latkan	Other Crop
Sell price		
Own consumption		

(Thank You for Your Cooperation)

Date :…… **Signature…….**

Appendix 2. Some Photographs Related to The Study

Plate 5. Data collection

Plate 6. Visiting Latkan-Jackfruit based agroforestry system

Plate 7. Latkan seedling with jackfruit tree, papaya, Malta, guava etc

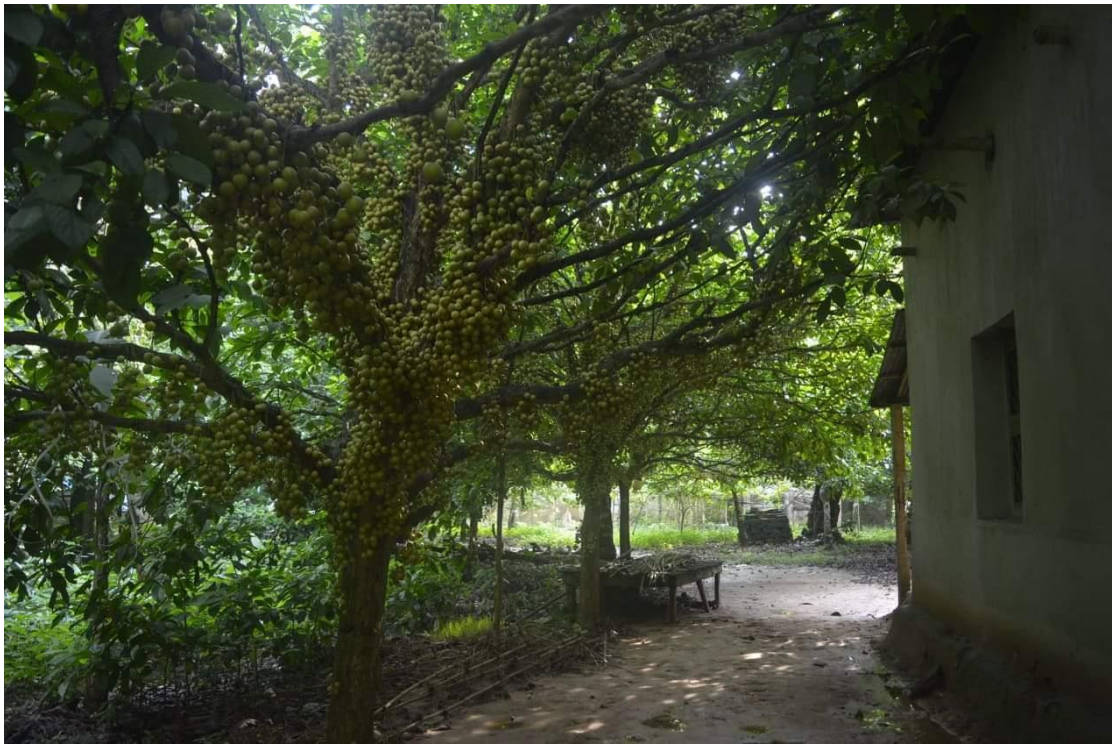

Plate 8. Latkan trees in the homestead area

Plate 9. Latkan seedling with poultry farm, coriander, banana

Plate 10. Farmers growing their own seedlings

Plate-11. A very old Latkan tree in the homestead area

Plate 12. A Latkan tree bearing frut from the bottom of the tree

Plate 13. Latkan orchard visit