ASSESSING THE AGRO-ECONOMIC POTENTIAL OF CONVERSION OF JHUM CULTIVATION TO MANGO ORCHARD IN KHAGRACHHARI DISTRICT

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CERTIFICATE

*This is to certify that the thesis entitled '**ASSESSING THE AGRO-ECONOMIC POTENTIAL OF CONVERSION OF JHUM CULTIVATION TO MANGO ORCHARD IN KHAGRACHHARI DISTRICT** submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science (MS)** in **Agroforestry and Environmental Science** , embodies the result of a piece of bonafide research work carried out by **Prethindra Chakma**, Registration number: **14-06245,** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated: JUNE, 2021
Dhaka, Bangladesh

Professor Dr. Nazmun Naher
Supervisor

Dedicated To
My
Beloved Parents

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ABSTRACT

A survey was conducted in Khagrachhari District to determine the best option between Jhum cultivation and mango orchard, as well as the economic returns and issues faced by the respondents. From January to December 2020, a purposive random sample technique was used to collect the relevant information via a structured questionnaire in order to meet the objectives from 80 respondents. Stata was used to analyze the data. Results revealed that the mango orchard is more profitable than jhum cultivation and has a great opportunity to increase national production to feed the growing population and reduce poverty in hilly areas. There is scope for adopting improved management practices, and it may increase the total production. Based on collected data, it was found that in mango orchards first four years, farmers did not get any return. After that, the farmer's net return will increase year by year. In jhum cultivation, farmers get their return the same year. But in jhum cultivation BCR is 1.64 and in Mango orchard BCR is 1.88. BCR is lower in jhum cultivation than mango orchards as well as polluting the environment. Jhum cultivation is not possible every year in the same land because farmers do not use chemical fertilizer in their fields and there is no irrigation management. So, for higher production and higher returns, most of the farmers are shifting from jhum to mango and other orchards, which ensure their basic needs.

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LIST OF ABBREVIATIONS AND ACRONYMS

AEZ-Agro ecological zone

wt – Weight

OECD- Organization for Economic Co-operation and Development

% - Percentage

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

et al. - And others

g- Gram

CHT-Chattogram Hill Tracts

BBS-Bangladesh Bureau of statistics

kg - Kilogram

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

ha. - Hectare

Tk. – Taka

BCR – Benefit Cost Ratio

df - Degrees of freedom

CHAPTER I

INTRODUCTION

Chittagong Hill Tracts (CHTs) comprise 10% of country's landmass, is located at southeastern parts of Bangladesh characterized by alternating beds of little-consolidated sands and shale providing a basis for the formation of complex mixtures of deep and shallow soils (Zakaria and Majumder, 2019; Hossain, 2011). Bandarban, Khagrachari and Rangamati districts are called together Chittagong Hill Tracts. The CHTs comprising 70% of the hilly areas of Bangladesh and covers 13,184 km^2, of which 90% are sloping lands (Hossain *et al.,* 2017). The area is mild to very steep ranging from 15% to over 70% slope, often breaking or ending in cliffs (SRDI, 2018). High hills ranged from 200-1000 m and lower hills from 15-200 m above the mean sea level (Hossain *et al.,* 2017). Among three districts khagracharri has 2,749.16 km^2 areas and it has both plain and hilly area.

Agriculture, the backbone of Bangladesh economy, occupies more than half of its populations. Mostly, rural people rely on agro-based livelihood (Raihan *et al.,* 2017). They are used to with the traditional agricultural practice. Moreover, in CHT areas, there is lack of source of income except agricultural. So, people in this region hardly think of switching occupation. It is not always possible to produce the same crop all over the years continuously. That is why, people prefer shifting cultivation, putting some lands fallow for several months or years (Chakma and Ando, 2008). It has become a common practice in CHT along with different Asian countries, where technological practice in cultivation is highly limited. Lack of knowledge and financial support hinder the farmers to practice modern production method. With the increasing demand of population, it has become very difficult to satisfy the needs with backdated method. The geographical structure of Bangladesh does not allow all the regions to choose any kinds of crops. Major part of this country contains hilly area where natural disaster and land slide causes immense losses each and every year. Only, 12 percent of land area is the hilly region, among them Chittagong absorbs 10 percent. In Chittagong Hill Tracts, different tribal people live and earn their livelihood focusing jhum cultivation (White and Bhuchar, 2005; Shoaib, 2002).

They produce different kinds of crops all over the year following shifting cultivation. Initially, the population in that location was little but the scenario is changing nowadays with rapid growth of population (Mantel *et al*., 2006; Swapan *et al.*, 2010). It is not possible anymore to attain sufficient return by selling the output into the market along with meeting subsistence necessity. People are trying to focus on profit maximization which is no longer possible through jhum cultivation. Crop productivity in jhum has declined due to soil erosion and associated reduction in essential soil nutrients (Karim and Mansor, 2011). On an average 40-45 t $ha^{-1}yr.^{-1}$ soil is eroded due to shifting cultivation, the highest erosion was observed in steep slopes (33-42%) and the lowest in gentle slopes (15%) (Shoaib *et al.* 1998). Conservation of natural resources and sustainable crop production are twin development issues in the CHTs. Government, NGOs and some foreign agencies have been trying for about 20 years to promote alternative land uses in the CHTs for restoring natural resources and biodiversity, and improving the livelihoods of the hill dwellers (Kibria *et al.*, 2015).

The existing cropping pattern in Bangladesh's hilly areas should be changed to adopt a better pattern in order to increase production to meet the various required crops and also to provide a higher economic return to the household (Farmer), resulting in increased income. Increased income means increased purchasing power, which leads to adequate food consumption. As a result, the agricultural cropping pattern has an impact on food consumption. Proper nutrition is the most important fundamental requirement for good health, functional efficiency, and productivity. Because agriculture is directly related to the production and supply of food items, agricultural cropping pattern is an essential component of food security. Increased nutrition awareness can help the agricultural sector better meet its own needs.

In order to achieve higher yields respective to higher returns, farmers in the hilly area are now concentrating on mango production. Mango production has become extremely profitable as it requires small amount of and compared to jhum cultivation (Chakma and Ando, 2008). Privatization of land system again pushed them to alter the cultivation pattern. But only a few people have considered the potentiality of this change. Some factors have influenced them to alter and some factors have hindered the rest of the farmers to follow the trend. Again, the impact of this conversion varies among various regions. This

agricultural diversification has both agricultural and economic implication. The identification of such impact will help other farmers to Figure out the rational farming decision.

On the above considerations, the following objectives are considered regarding "Assessing the Agro-Economic Potential of Conversion of Jhum Cultivation to Mango Orchard in Khagrachhari District"

1. To find out the comparison between mango orchard and jhum cultivation;
2. To assess the economic potentiality of jhum cultivation and mango orchard and
3. To identify the problems and constraints faced by the farmers in jhum cultivation and mango orchards

CHAPTER –II

LITERATURE REVIEW

2.1 Review of Hills

Bangladesh's hills are divided into two groups based on the creation of Dupitila (43%) and Tipam-Surma (57%) in various districts (Table 1). Chittagong Hill Tracts (Rangamati, Bandarban, and Khagrachari hill districts) contains the majority of the country's hilly terrain (69.93%), followed by Chittagong (17.68%), and Sylhet (11.49%). Greater Mymensingh, Cumilla, and Noakhali account for less than 1% of Bangladesh's overall hilly lands.

Table 1. Distribution of high and low hills in Bangladesh

Greater District	High Hills (ha) Tipam-surma formation (57%)		Low Hills (ha) Dupitila formation (43%)		Total (ha)
CHT	650887	86.0%	279461	48.7%	930348 (69.93%)
Chittagong	100516	13.3%	134700	23.5%	235216 (17.68%)
Sylhet	5284	0.7%	147638	25.7%	152922 (11.49%)
Mymensingh	-	-	7567	1.4%	7567 (0.57%)
Cumilla	-	-	3120	0.5%	3120 (0.23%)
Noakhali	-	-	1226	0.2%	1226 (0.09%)
Total	756687	100	573892	100	1330399 (100%)

Source: Hossain (2011)

2.2 Cropping system

Agriculture is the primary source of livelihood, and poverty is quite common in hilly areas (Ahammad and Stacey, 2016). In CHT, almost two-thirds of rural households are farming households (*Barkat et al.,* 2009), with 19% jhum households, 34% field cropping (plough cultivation) households, and 9% field and jhum agriculture; the other 38 % are non-agricultural (Ullah and Shamsuddoha, 2014). Hills and valleys are the two most common terrain types in hilly locations. Plough and jhum cultivation technologies are used in CHT for crop production, depending on the appropriateness of the area. 35.87 % in CHT is used for forest, 27.60 % for horticulture crops, 16.22 % for plough land, 15.52 % for Jhum land,

and the remaining 4.79 % is used for settlements (Figure. 1). CHT hill residents mostly participate in shifting cultivation (jhum), with some fruit horticulture thrown in for good measure. Valley inhabitants participate in paddy rice ploughing as well as a good amount of vegetable and fruit agriculture (Nathan *et al.,* 2013). Other hills in Sylhet and Chittagong, aside from CHT, are utilized to cultivate a variety of high-value commercial crops like as tea, rubber, lemon, orange, pineapples, bananas, and other fruits, as well as forest species (Hossain, 2011). In CTH, agricultural income is distributed differently depending on the season; total income is highest during the wet season, when households can harvest grain crops, fruits, and vegetables (Rahman *et al*., 2014). Agricultural income of CHT farmers was greater during the rainy season (June to November) and lower during the cold and dry season (December to May) (Rahman *et al*., 2014). Farmers in hilly locations cannot cultivate any crops during the cold and dry seasons owing to a lack of water; only bananas may be gathered at this time.

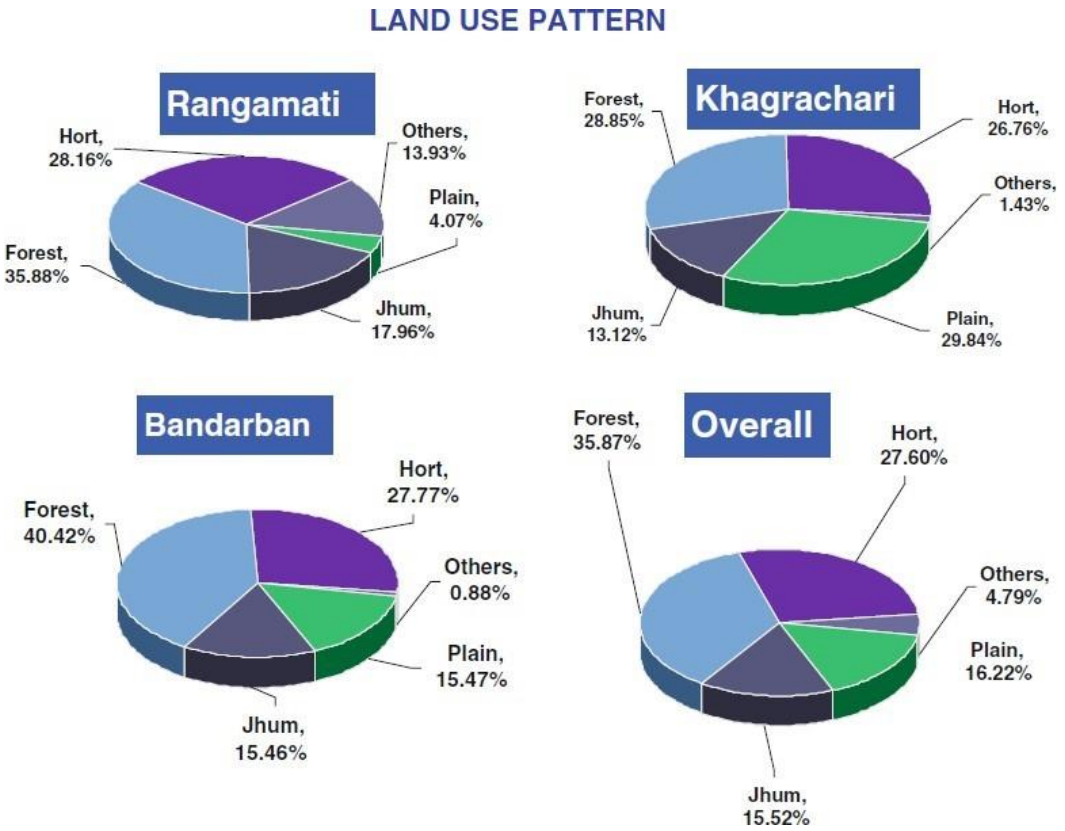


Figure 1. Land use patterns of the Chittagong Hill Tracts (CHT) Source: Bala *et al*. (2013)

2.3 Cropping Pattern in Hilly areas

Boro-Fallow-T. Aman was the most common cropping pattern in the Chittagong Hill Tracts, accounting for 15.07 % of NCA, followed by Fallow-Fallow-T. Aman (13.68 % of NCA), Fallow-Aus+Non-rice (shifting agriculture 9.24 % of NCA), and others (Table 2). On the top of the hillock and in mild slopes in Lalmai, farmers adopt fallow-country bean cropping patterns. The most common cropping patterns were fallow-bitter gourd-country bean, fallow-cucumber-country bean, long bean-fallow-country bean, fallow-cucumber-country bean, and others (Sarker *et al.,* 2014).

Table 2. Major cropping patterns in CHT

SL.	Cropping pattern	Practicing site	Area (ha)	% of NCA of CHT
1	Boro-Fallow-T. Aman	valley	19400	15.07
2	Fallow-Fallow-T. Aman	valley	17610	13.68
3	Fallow-Aus+Non-rice (Jhum)	hill slope	11900	9.24
4	Vegetable-Fallow-Fallow	floodplains	6310	4.90
5	Vegetable-Fallow-T. Aman	valley	5450	4.23
6	Boro-Fallow-Fallow	floodplains	4950	3.85
7	Vegetable-Vegetable-Fallow	valley	4890	3.80
8	Tobacco-Aus-Fallow	valley	2250	1.75
9	Vegetable-Vegetable-T. Aman	valley	1850	1.44
10	Tobacco-Fallow-T. Aman	valley	1540	1.19
11	Fallow-Aus-T. Aman	valley	1320	1.03

NCA: Net Cropped Areas Source: (Quais *et al.,* 2017)

2.4 Shifting Cultivation (Jhum) in CHT

Jhum cultivation is a type of subsistence farming practiced by the indigenous highland people of CHT on sloppy slopes. "Slash and Burn" or "Swidden" cultivation are other names for this kind of cultivation. In CHT, about 60,000 families are involved in shifting cultivation (Khan and Alam, 2015). Land selection, land preparation, seeding and planting, weeding, pest management, harvesting, threshing, and storing are the major phases in Jhum farming (Figure. 2). For jhum farming, land preparation normally begins in March. During the dry season, the standing vegetation is sliced and allowed to dry. During the months of April and

May, the dried vegetation and fallen logs are burned. Sowing begins as soon as the monsoons arrive and the ground becomes wet, usually in May and June. Different crop seeds are mixed together in a single hill according to the cultivator's wishes. Harvesting begins in July and lasts until December.

Jum cultivation process	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Land selection												
Land clear/ Preparation												
Sowing and planting												
Weeding												
Pest and management												
Vegetables, marpha Harvesting												
Melon harvesting												
Cucumber, gourd harvesting												
Maize, rice harvesting												
Chilli harvesting												
Pumkin, cheena harvesting												
Brinjal harvesting												
Cassava harvesting												
Cotton, turmeric, ginger, arum harvesting												
Drying												

Figure. 2. Jhum cropping calendar in CHT Source: Chakma and Ando (2008)

2.5 Jhum Cycle Practices in Shifting Cultivation

The fallow time of shifting cultivation is known as the jhum cycle. Jhum cycle duration has decreased throughout time, and fallow periods of 2-3 years are now only used for shifting agriculture. Farmers used to follow a cycle of more than 5 years in the past (before 2000). (Table 3). The jhum cycle period has been shortened as a result of the construction of hydroelectric dams, the relocation of plains people to the hills, demographic pressure, the

declaration of forest protected areas, and the expansion of new plantation lands. The jhum cycle was 10 to 20 years or more before the Kaptai Dam was built (Chakma and Ando, 2008).

Table 3. Trend of reduction of Jhum cycle period for shifting cultivation

Period	Fallow period	Causes for reduction of fallow period
1990-2000	5-10 years	Because of construction of hydroelectric dam, many low land people moved to high hill
2000-2005	4-5 years	Because of huge settlement of plain land people
2005-2010	3-4 years	Because of increasing population and declaring of protected areas
2010 to till date	≤3 years	Because of increasing population and plantation forest

Source: Karim and Mansor, 2011; Chakma and Nahar, 2012; Hossain and Ahmed, 2017

2.6 Crops of Shifting Cultivation

Farmers in Jhum cultivate whatever crops they require, including as cereals, vegetables, pulses, oilseeds, spices, fruits, and fiber. In general, annual crops such as upland rice, ginger, turmeric, chilli, cassava, cucurbits, pigeon pea, sorghum, and maize are grown on flat to moderately sloping land; steep-sloping land is used for growing various annual crops with the maintenance of vegetative covers such as contour bio-hedgerows of leguminous plants and trees to protect top soil; and very steep land is used for growing jackfruit, guava (Table 4). Previously, 15-20 crops were planted together in a Jhum field; presently, 5-8 crops are typically produced in a Jhum field (Chakma and Ando, 2008). Rice is the most important crop in jhum fields, yielding an average of 1.15 t ha^{-1}, though rice planted as the main crop banana yields the highest yield of 108 t ha^{-1} (Jamaluddin *et al*., 2010). Due to rainfall variability, the number of crops sown, and management practices, crop yields in jhum plots varied greatly. However, in recent years, a small number of Jhum cultivators have expressed an interest in growing cash crops such as ginger and turmeric rather than paddy.

Table 4. Basic sloping-land farming practices in jhum plots of CHT, Bangladesh

Slope Category	Crop Types					
	Annual cereal/tuber	Annual vegetable	Annual pulse	Annual spice/ herb/oilseed/other	Annual fruit	Perennial fruit
Moderate slope (0-35 degree)	Rice, Sorghum, Millet, Maize, Cassava	Cucurbits	Pigeon pea	Ginger, Turmeric, Chilli, Sugarcane, Sesame, Tobacco, Cotton	Melons	Mango, Wood apple
Steep slope (36-65 degree)	Rice, Sorghum, Maize, Cassava	Cucurbits	Pigeon pea	Ginger, Turmeric, Chilli, Cotton		Leguminous tree species, Aonla
Very steep slope (>65 degree)	-	-	-	-	Banana, Plantain	Jackfruit, Guava, Lemon

Source: Misbahuzzaman, 2016

2.7 Advantages and Disadvantages of Jhum Cultivation

Despite the benefits of jhum cultivation, there are numerous drawbacks. Jhum cultivation's main advantages are its traditional and simple way of cultivation, as well as its inexpensive investment. Jhum farming, on the other hand, has a number of drawbacks, including soil erosion, biodiversity loss, deforestation, a heavy reliance on nature, lesser yields, and a negative response from government authorities. Figure 3 depicts a research of farmer opinions on jhum farming in terms of costs and advantages.

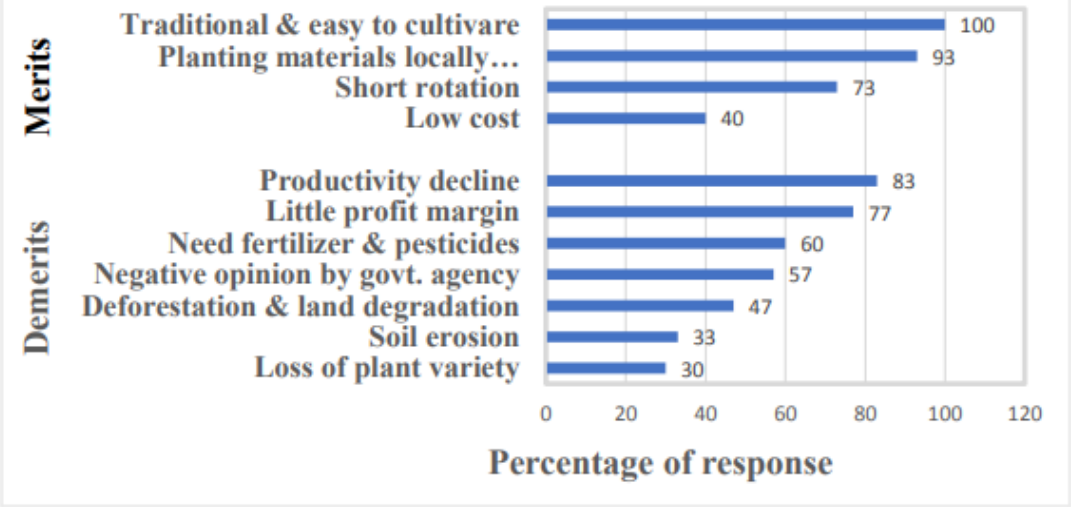


Figure. 3. Participant's opinion on merits and demerits of jhum. Source: (Nath *et al.*, 2016)

2.9 Alternate Land use in CHT

Multi-storey Fruit Garden (MSFG), Multi-strata Agroforestry System (MAFS), Sloping Agricultural Land Technology (SALT), Modern Agricultural Technology (MATH), and Contour Hedgerow Intercropping Agroforestry Technology are only a few of the modern farming techniques available in the CHT (CHIAT). Fruit cultivation and agroforestry practices have piqued the interest of both Bengali and ethnic indigenous farmers. Since 1860, efforts have been made in CHT to restrict shifting cultivation and encourage alternate land-use regimes. Alternative land uses with perennial horticulture plants with or without wood trees have increased in CHT during the last few decades. Farmers' preferences for land uses in CHT were evaluated using a pair-wise comparison of three sustainability variables (social, economic, and environmental). Participants favored the economic element (75%) above the social (17%) and environmental (8%) aspects (Table 5). Orchards had the highest priority vector (0.628 and 0.618) in terms of social and economic issues. Agroforestry has the highest environmental priority vector (0.44). In terms of overall priority, orchards were shown to be the most favored land use, with a composite weight of all priority vectors (0.60 or 60% preference), followed by agroforestry (0.25) among the four land uses (Table 5). According to Bala *et al.* (2013), different types of fruit plantations cover at least 30% of total land uses

in the CHT. CHT's fruit production is steadily expanding. In these locations, commercial mango, sweet orange, litchi, pineapple, dragon fruit, and other fruit gardens have been built. In the mountainous parts of Chittagong and Sylhet, there has been an increasing trend of fruit producing area and production (Hossain *et al*., 2017).

Table 5. Land use priority considering the sustainability factors

Land use category	Contribution to Household income (%)	Weight			Composite weight
		Social (0.17)	Economic (0.75)	Environmental (0.08)	
Fruit orchard	62	0.628	0.618	0.308	0.595
Agroforestry	55	0.174	0.246	0.447	0.250
Shifting cultivation	48	0.046	0.090	0.066	0.080
Village common forest (VCF)	35	0.152	0.046	0.179	0.075

Source: (Kibria *et al.*, 2015)

2.3 Jhum Cultivation in Bangladesh

The practice of shifting cultivation in the hilly area of Bangladesh is widely known as jhum cultivation. People in that area largely depend on them. They produce different types of crops. After meeting subsistence demand, they try to earn a profit by selling the rest in the market. The landslide has become very common in the hilly area, which crushes the lives and livelihood of people. So, relying on jhum cultivation is quite risky as jhum cultivation requires a large area for irrigation (Chakma and Ando, 2008). When farmers intend to produce so many crops, they need to divide the whole cultivation area into several plots. When it is segregated, diversified crops can be produced but at a minimum quantity. These produced outputs are then divided into two parts – subsistence and saleable. The amount sold in the market is the ultimate earning of the farmers. The small amount of output reduces

earnings. Even if they have subsistence crops, it is still important to have sufficient monetary earning to meet other non-farm needs. The world is upgrading, which is making people feel the need for different goods. To get that, they must have to earn a lump-sum amount. If the farmers in the hilly area, who are blindly following the tradition of jhum cultivation, continue doing so, they will no longer be able to enjoy the basic needs of their life (Chakma and Ando, 2008; Swapan *et al*., 2010; Shoaib, 2002). North-East India (NEI) comprises eight states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura) and covers 26.3 million hectares or ~8% of the total geographical area of India. NEI is situated at the confluence of Indo-Malayan, Indo-Chinese, and Indian bio-geographical realms. Because of its geographical location, NEI represents diverse ecosystem types dominated by mountains and is endowed with rich forest resources. There are over 100 different tribes in NEI, differing linguistically and culturally, practicing shifting agriculture for millennia. This agricultural practice has evolved as a part of the culture of the hill people of the region, and the agricultural procedures are closely linked with socio-cultural practices and religious beliefs. However, increasing population pressure has drastically reduced the jhum cycle and has been the cause of poverty and food insecurity for the hill farmers and environmental degradation in the hilly areas.

2.4 The Introduction of Mango Production in CHT

Some farmers have already Figured out the feasible solution of jhum cultivation. Producing a variety of crops shortens the amount of output as well as the level of profit. So, it would be better to cultivate a single item. Nowadays, the production of mango is an attractive sector of investment as it ensures a prominent amount of income. Bangladesh is now standing in the 7th position of producing mango in the world (Uddin and Rashid, 2019). Even though the production cost of mangoes is quite high, the profit it assists in obtaining offsets that higher cost (Khondoker *et al*., 2017; Zonayet *et al*., 2020). Overall the hilly area of Bangladesh has great potentiality for fruit production. If it is possible to increase mango production, the export earnings will rise. Bangladesh can be a dominant exporting country in mango production. This change will immediately develop the lifestyle of the people

residing in that area (Rana and Moniruzzaman, 2020). Tribal people are negligible in our country in many aspects. If they can enhance their contribution to the country's economy and make the country noticeable and strong, they will eventually turn themselves strong. So, this change will ultimately make those people socio-economically developed. Again, this form of cultivation is environmentally friendly. Bangladesh, which is heading towards accomplishing attaining Sustainable Development Goals (S.D.G.) within 2030, can be one step ahead of its aim (Zonayet *et al*., 2020).

The mentality of this country people basically prefers traditional thought. They do not like to make a change even if they have to suffer. People in this country have a great lacking of proper education and knowledge. They do not understand which is beneficial to them, to the country, or to the environment. Especially, aged people show extreme reluctance in accepting any changes or modifications. In terms of converting jhum cultivation to mango orchards, the scenario is not different. Elderly people still like to continue jhum production and are unwilling to introduce mango cultivation. It is not possible to make them realize the importance of this shifting within a night. For this, proper planning is obvious. To educate them regarding agricultural problems and prospects, the government must need to make a blueprint, and the starting points need to research. With the help of agricultural research, it will be easier for the authority to understand the root level problems. Without understanding the complications, it becomes very difficult to Figure out suitable solutions. So, this study will assist the authority to detect the undefined facts regarding the conversion of jhum cultivation mango production and reflect the necessity of the change.

From 1996 to 2015, Bangladesh Agricultural Research Institute (BARI) has developed 11 types of improved high-yielding mango varieties (Azad *et al*., 2017). Agricultural development is accelerated by adopting improved farming technologies and formulating policies favoring appropriate institutional and infrastructural changes (Rajni *et al*., 2009). Adoption to improved production practices is the key to higher production of fruits and higher income to farmers. The technical knowledge of farmers appears to be the critical link to a higher level of adoption. Among farmers, there is significant variation in their levels of knowledge and their readiness to accept, try new methods, and adopt improved production practices (Singh *et al*., 2010). Among the mango varieties of BARI, BARI Aam-3 is an

essential innovation in Bangladesh. It is a hybrid mango variety, has been produced by crossing between Kiron (female) and Deshari (male) (Hossain *et al*., 2003). At the field level, this variety is well known as Amropali. The tree is Dwarf, regular bearer, cluster bearing, small-sized fruits, and good keeping quality. Its flesh is deep orange-red, and the fruit contains approximately 2.5–3.0 times more β carotene content than other commercial mango varieties (Wikipedia).

The climate and soil of Bangladesh are suitable for high-yielding BARI Aam-3 cultivation, and farmers get yield within three years of plantation with relatively less effort. Out of 11 BARI mango varieties, five varieties such as BARI Aam-1, BARI Aam-2, BARI Aam-3, BARI Aam-4 and BARI Aam-8 were evaluated by Barua *et al*. (2013) as suitability judgment for the Chittagong region where the highest T.S.S. content (21.36%) and the lightest fruit (172.6 g) was in BARI Aam-3. Uddin *et al*. (2018) also found that per household, the highest yield was recorded from BARI Aam-3 followed by BARI Aam-4 and BARI Aam-8. Shiblee (2015) conducted a study on assessing BARI released mango varieties at the field level. It was found that BARI Aam-3 was the best in all the firms under investigation in terms of the sale of stations (stock + scion). But there is no specific research on the adoption of BARI Aam-3 mango variety and the factors responsible for wide acceptance of this variety and constraints towards its further expansion in Bangladesh.

2.5 Climate and Soil for Mango Forestry

The growth of mangoes is almost similar to all types of soil. However, a well-drained, deep loamy soil is generally conducive to thriving mango culture. The pH range of soil from 5.5 to 7.5 is a desirable level of height 4,000 feet, but the fruiting is poor above2,000 feet (Singh, 1969). Due to the low temperatures that prevail in northern India, attributes the late of the latter (Chacko and Randhawa,1971). Many mango-growing areas have well-drained loamy soil with pH 5.0-7.0(Bondad, 1989). Despite Bangladesh is basically good for mango cultivation yet the more favored areas are the North-West and relatively lesser favored are in the extreme South-East and North-East considering the climate (altitude, latitude, temperature, rainfall, relative humidity) and soil (Hossain, 1994). The northwestern region

has a high temperature, low rainfall, and humidity than the Eastern side, which favors the production of good quality mango.

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

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

CHAPTER III

MATERIALS AND METHODS

The detailed procedures used in conducting the study were included in this Chapter. This Chapter also included a brief description of the study area as well as information about the sample farmers. The following sections describe the sample farmers' geographical location, agro-ecological region, topography, climate, land use, and socioeconomic characteristics:

3.1 Selection of the study area

The study was conducted at Khagrachhari sadar, Mahalchhari, Panchari and Dighinala Upazilla under Khagrachhari district during April to September 2020. The Upazilas were selected purposively for data collection on Jhum Cultivation and Mango Orchard practices, because those Upazilas are very much famous for jhum cultivation and mango production in Bangladesh. After short visit and discussion with local people of Khagrachhari sadar, Mahalchhari, Panchari and Dighinala Upazilla under Khagrachhari district were selected for this study. Out of nine (09) upazila of Khagrachhari district, four (04) upazillas 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 jhum cultivation and Mango orchards
ii) No systematic study on this prospect had yet been conducted
iii) Easy accessibility to gather required information and
iv) Respondents' cooperation was excellent in order to obtain credible and meaningful information.

3.2 Geographical location area and climate condition

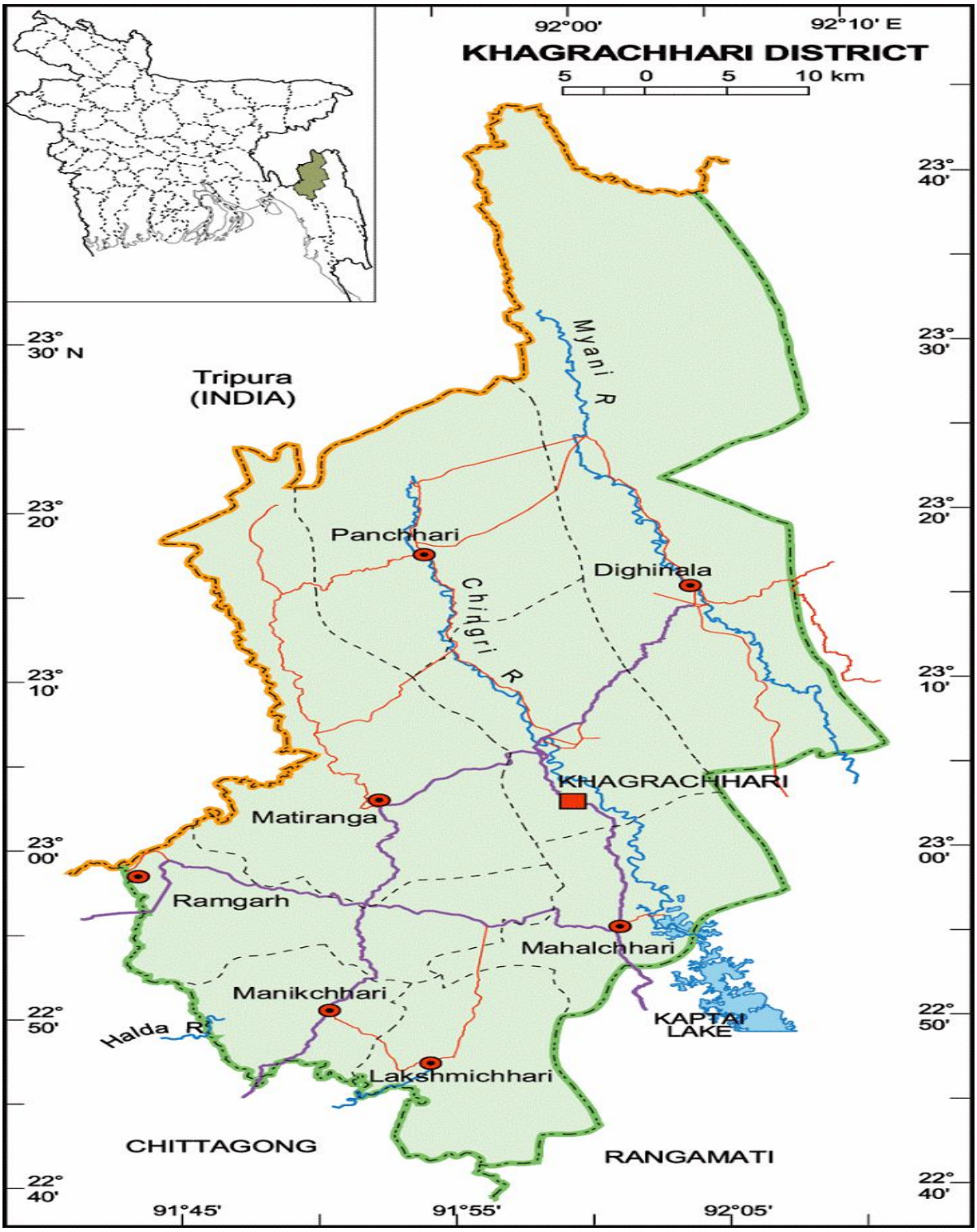
The study was conducted at Khagrachhari sadar, Mahalchhari, Panchari and Dighinala Upazilla under Khagrachhari under Chattogram Division. The study area is located in the south-eastern region of Bangladesh. It was about 113.5 km away from Chattogram City. (Figure 1,2,3,4 and 5) showing Map of Khagrachhari district, khagrachhari sadar, Mahalchhari, Panchari and Dighinala Upazilla). Khagrachari is a hilly region. It is bordered on the north by the Indian state of Tripura, on the south by the districts of Rangamati and Chittagong, on the east by the district of Rangamati, and on the west by the district of Chittagong and the Indian state of Tripura. The zila's yearly average temperature ranges from 13 °C to 34.6 °C, with an average annual rainfall of 3031 mm. It is located in between 22°38' and 23°44' north latitudes and in between 91°44' and 92°11' east longitudes.

3.3 Agro-ecological region

The study area belonged to the same Agro-ecological Zone (AEZ). Khagrachhari district is under the AEZ-29: Northern and Eastern Hills (BBS 2010).

3.4 Crops and jhum cultivation pattern

In Jhum area rice, maize, millet, sesame, cucumber, pumpkin, melon, cotton, banana, ginger, turmeric, etc are mainly cultivated. In moderate slope (0-35 Degree) rice, sorghum, millet, maize, cassava, cucurbits, ginger, turmeric, chilli, sugarcane, sesame, melons and mango are cultivated. In Steep slope (936-65 degree) rice, sorghum, maize, cassava, ginger, turmeric, chili, cotton, leguminous tree species and anole are cultivated and Very steep sloop (>65 degree) Banana, Jackfruit, Guava and Lemon are cultivated. In jhuming, seeds are sown after the first rain in April. A broad blade knife, commonly known as Tagol/dao, is used to sow the seeds. Small holes are made throughout the field byTagol/ dao and a mixture of different crop seeds are placed in them. Fallow-Aus+Non - rice is the highly practiced jhum cultivation pattern in khagrachhari.



Source:thebangladesh.net

Figure 4. Map showing locale of the study area at Khagrachhari District.

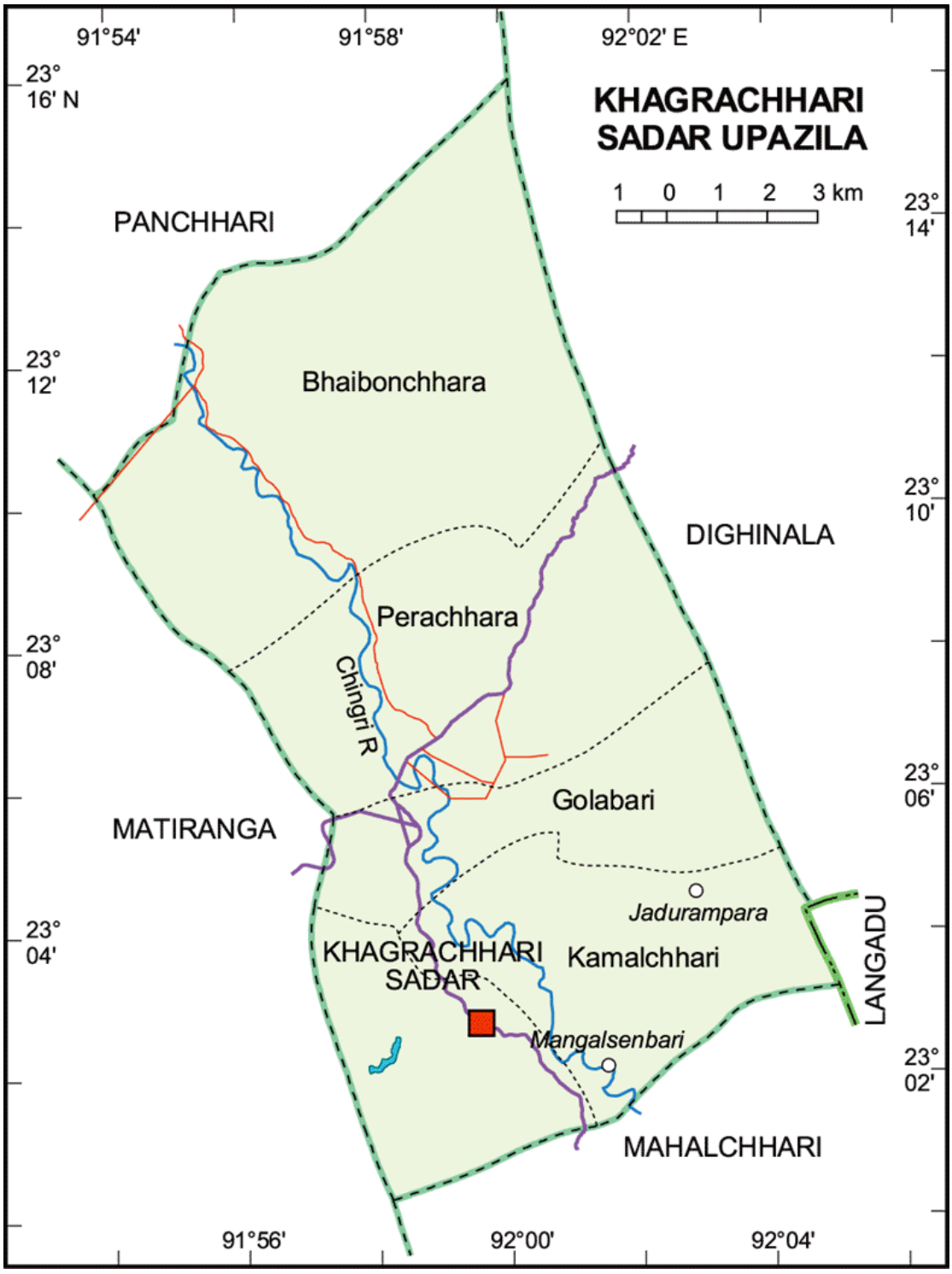


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Figure 5. Map showing locale of the study area at khagrachhari sadar upazila under khagrachhari district.

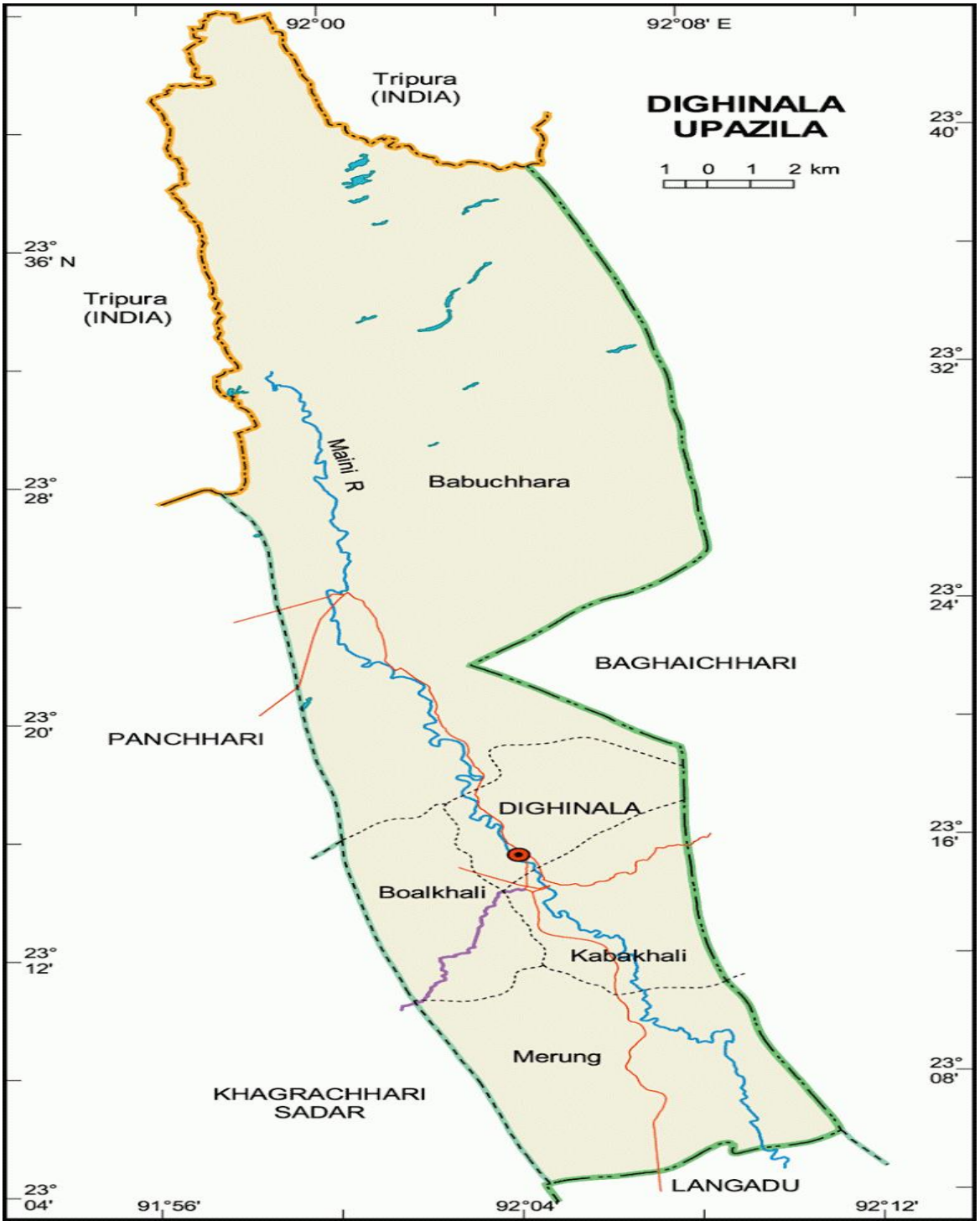

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Figure 6. Map showing locale of the study area at Dighinala upazila under khagrachhari district.

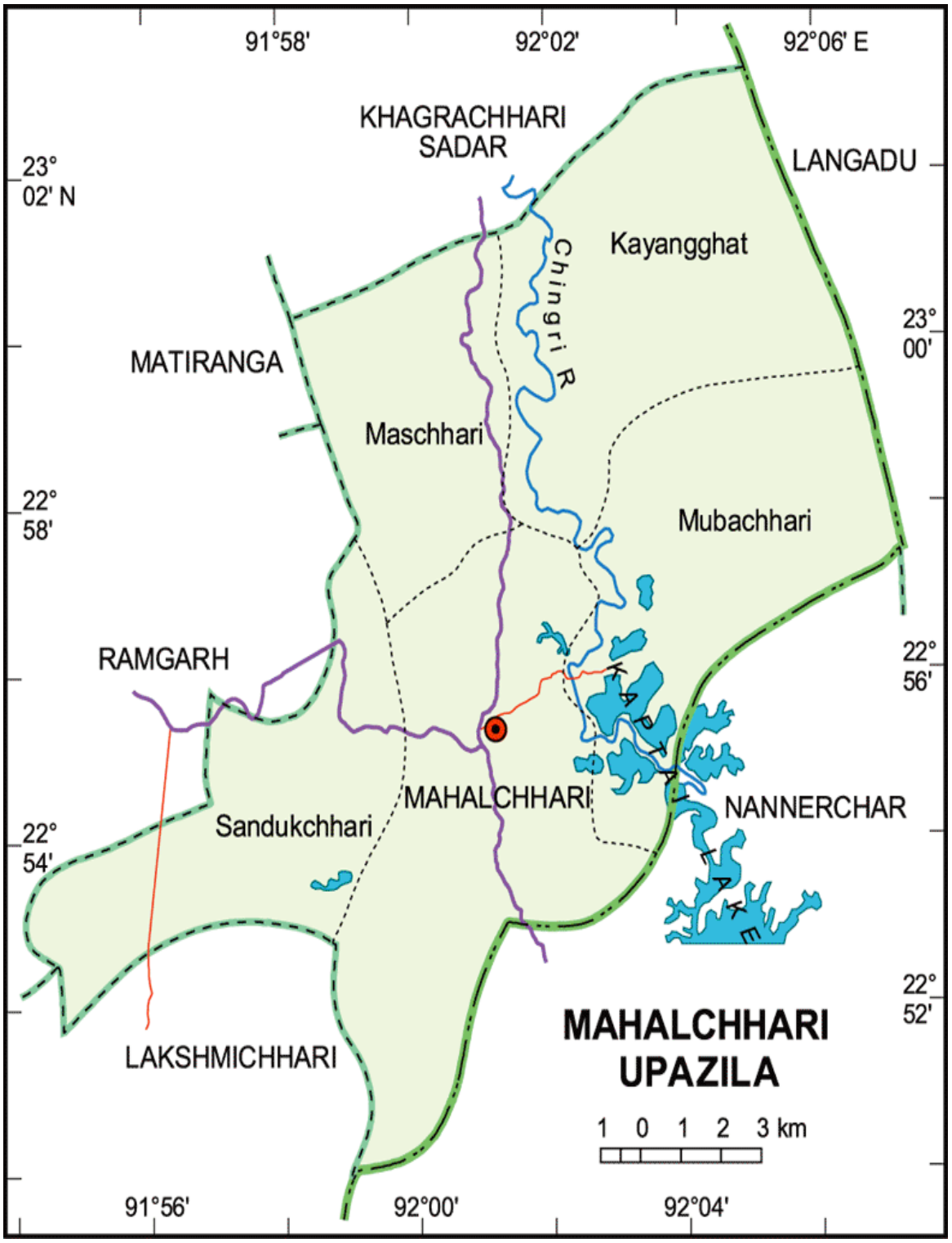

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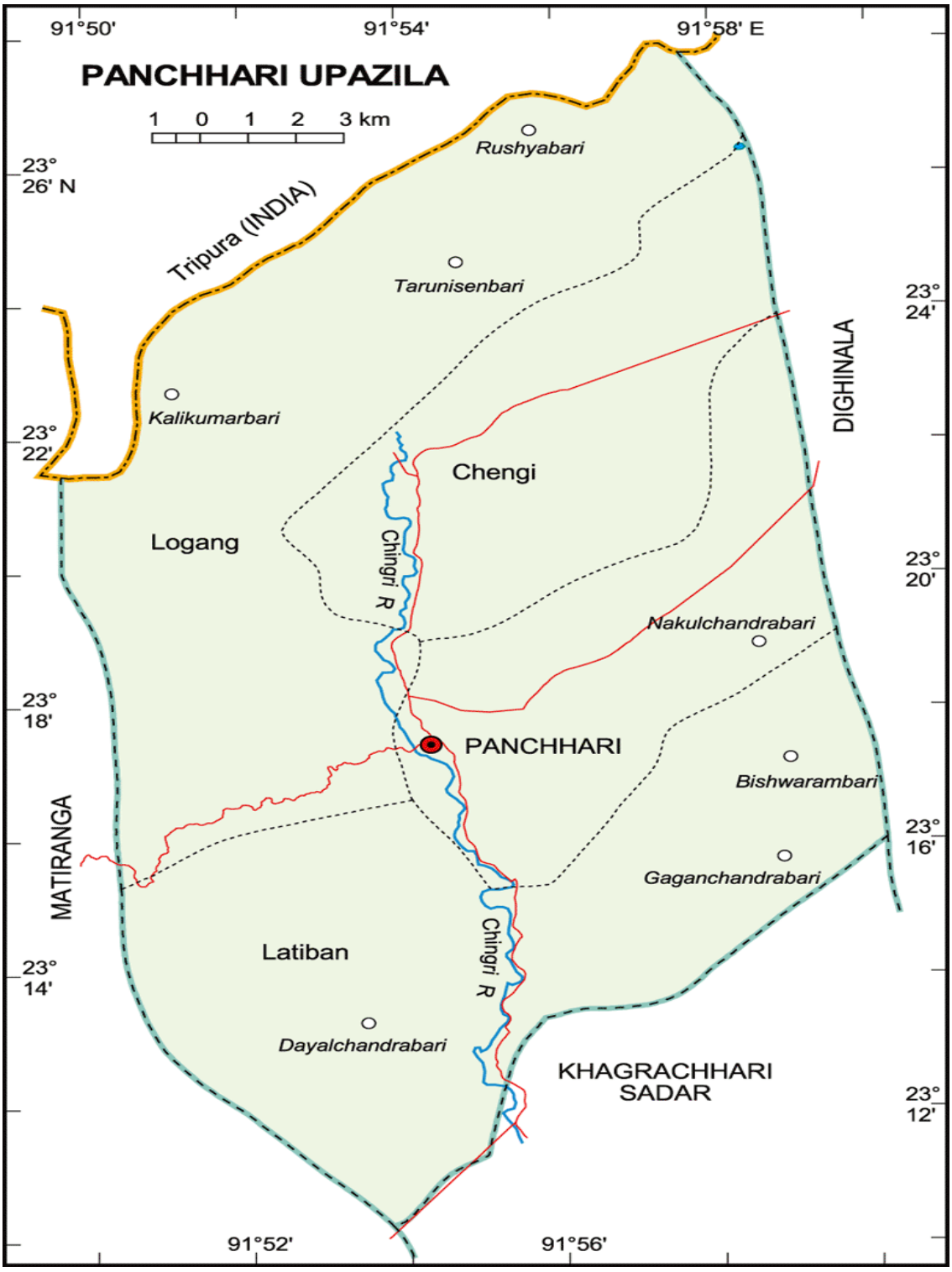
Figure 7. Map showing locale of the study area at Mahalchhari upazila under khagrachhari district.



Source:thebangladesh.net

Figure 8. Map showing locale of the study area at Panchhari upazila under Khagrachhari district.

3.5 Period of the study

The study was carried out from April to September, 2020, and it included field testing of the interview schedule, direct interviews with respondents, field visits and observations, and discussions with concerned experienced farmers.

3.6 Sampling procedure

A purposive random sample strategy was used to conduct a survey. All jhum cultivars and Mango growers of four (04) Upazilas of khagrachhari district constitute the population of the study. There are about 500-600 mango farmers and 500-600 jhum cultivars in these 4 upazilas. Using a random number table, (6.67%) percent of the population was proportionately chosen as the study's sample. Thus, the study's sample size was 100 farmers, and eighty (80) respondents were chosen purpasively from the selected areas. A structured questionnaire was used to collect information from the selected respondents.

Table 6. Distribution of population and sample of the selected unions

District	Upazila	Population	Sample	Reserved
Khagrachari	Khagrachari sadar	300	20	5
	Mahalchari	300	20	5
	Panchari	300	20	5
	Dighinala	300	20	5
Total		1200	80	20

3.7 Preparation of interview schedule

An interview schedule was created based on the field observations and study objectives. The draft interview schedule was validated in the field, and any necessary changes were made

based on the data gathered during the testing of the interview schedule. Following pretesting and any necessary adjustments, a final schedule was developed to collect data from the chosen respondents. Appendix 1 contains the interview schedule for the current study.

3.8 Methods of data collection

Prior to doing the actual interview, each respondent received a brief explanation of the study's aims and objectives. They cooperated with the researcher after being convinced that the study was entirely academic and had no alternative motive. The researcher gathered the relevant data during the study's duration. After each interview concluded, the schedule was checked and validated to ensure that the responses were accurate. To reduce errors, data collection took place in local units. Later on, the local units were transformed to standard units.

3.9 Data analysis

The current study's collected data were carefully summarized and scrutinized for statistical analysis using Stata, computer software for analyzing Social Science data. Because of its simplicity, the tabular technique of analysis was extensively used to reach meaningful conclusions. Finally, relevant Tables were created in accordance with the requirements of data presentation in order to meet the study's objectives. In order to evaluate the mango orchard and jhum cultivation production, investment analyses were carried out considering the timing of benefit and costs throughout the production time. Three discounted measures as suggested by Guittinger (1982) and followed by Hasan *et al.* (1991) and Uddin and Hasan (2003) for the present investigation.

3.9.1 Benefit cost ratio (BCR)

The benefit-cost ratio is calculated by dividing the discounted benefit by the discounted cost. It represents the value derived from a single unit of cost.

Benefit cost Ratio = $$\frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}$$

Where,

Bt = Gross benefit in i^{th} year

Ct = Total cost in i^{th} year

t = Number of years (1, 2, 3,….n)

i = Interest rate

3.10 Procedure for computation of cost and return

To determine profitability, all cost items must be computed and deducted from the gross value of outputs produced by the farmer.

3.10.1 Estimation of cost

Farmers engaged in jhum cultivation and mango orchard systems had to incur costs for various inputs used in the production process. The input items were valued at the current market price as well as a government price. The cost of various components such as human labor, seedling, cow dung, fertilizer, irrigation, interest on operating capital, land use, pruning, thinning, and so on were considered when calculating the production cost.

(a) Cost of human labor

The cost of human labor for various activities such as land preparation, sapling/seedling transplantation, fertilizer and irrigation application, pruning, harvesting, and marketing was determined using actual wages (with/without meal). The farmers were compensated for their efforts. Labor was previously quantified in man-day units, which typically consisted of eight

hours per day. Labor wages were assumed to be Tk. 200 per man-day 10 years ago and 450 tk now a day in this study based on farmer's assumptions.

(b) Cost of seedlings

The cost of seedlings is determined by the market price at the time of transplantation. At the time, the cost of mango seedlings was estimated to be Tk. 60.00 per seedling.

(c) Cost of manures and fertilizer

Farmers grow mango and jhum crops with a variety of manures and fertilizers, including cowdung, vermicompost, urea, TSP, MP, oil cake, and others. The fertilizer cost was calculated using the current market price. Cowdung/vermin compost, urea, Triple Super Phosphate (TSP), Murate of Potash (MP)DAP and oil cake cost 1.50, 16.00, 23.00, 15.00,16.00and 20.00 Tk in the current year, and 2.00, 12.00, 15.00, 10.00, and 16.00 respectively 10 years ago.

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

Farmers must apply irrigation in the mango garden during and/or before/after cultivation as well as drainage, pruning/thinning, and pesticide application under the same conditions. In jhum cultivation irrigation and drainage is not practiced. The cost of an operational item was calculated for one, two, or more operations.

(e) Cost of interest on operating capital

Interest on operating capital was calculated by taking into account non-material inputs such as human labor for land preparation, transplantation, fertilizer and pesticide application, weeding, harvesting, and so on, as well as material inputs such as seedlings, fertilizers, and so on, used in mango production. As a result, interest was charged at the current bank rate of 12 percent per annum on opportunity capital for mango production. It was assumed that if

the farmers deposited the money in a bank, he would receive some interest at that rate. It was calculated using the following formula:

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

(f) Land use cost

The cash rental value of land was used to determine the cost of land use. The average rental value of land per hectare for a given year was used to calculate the land use cost. According to the farmers' declaration, the rental value of land use cost was estimated. In jhum cultivation there is no land use cost because most of the cultivable area are khash.

(g) Yield and return

The effective return was calculated for grafted mango trees starting at the age of three. Other crops in the mango garden, such as turmeric and ginger, are produced continually throughout the year. Mango prices in the research area ranged from Tk. 15 to Tk. 50 per kg.

The price of jhum crops are varies in different times. Rice, Chilli, Marpha (Cucumber), maize, ginger, turmeric, Brinjal are sold around 45-60 Tk ,120-320 Tk,15-30 Tk, 20-30 Tk, 80-100 Tk ,20-30 Tk, 15-80 Tk Respectably.

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation was conducted with a survey from sample farmers of Khagrachhari sadar, Mahalchhari, Panchhari and Dighinala Upazilas under Khagrachhari District in respect of Jhum cultivation and mango orchar regarding different production technologies, existing situations on problems and advantages, productivity and profitability and management practices against adverse situation. The main purpose of this chapter is to assess the costs, returns and profitability of jhum cultivation and mango orchard. Profitability is a major criterion to make decision for producing any crop at farm level. It can be measured based on net return, gross margin and ratio of return to total cost. The costs of all items were calculated to identify the total cost of production. The returns from the crops have been estimated based on the value of main products and byproducts. Obtained results, different suggestions and future plan from the selected respondents have been discussed by the following headings:

PROFITABILITY OF JHUM CULTIVATION

This Chapter presents a conclusive and extensive explanation of the scientific research study's conclusions. This Chapter is divided into three subsections. The first segment examined social profile of the respondents. The second portion discussed the profitability of jhum cultivation in the Khagrachai. Finally, the final segment explored the profitability of mango orchard.

4.1 Individual characteristics of the respondents:

In this section the findings of the participants' individual characteristics have been discussed.

4.1.1 Age

80 samples were taken from four upazilas called Khagrachhari Sadar, Panchhari Mohalchhari, and Dighinala, respectively, to reflect the whole population. In Khagrachhari Sadar upazila, 44% of sample populations were 30-39 years old, 48% were 40-49 years old, and 8% were above 50 years old. In Panchhari upazila, 20% of sample populations were 30-39 years old, 65% were 40-49 years old, and 15% were above 50 years old. In Mohalchhari upazila, 11% of sample populations were 30-39 years old, 83% were 40-49 years old, and 6% were above 50 years old. In Panchhari upazila, 9% of sample populations were 30-39 years old, 83% were 40-49 years old, and 8% were above 50 years old (Figure 9) and overall 22% were 30-39 years old, 68% were 40-49 years old and 10% were above 50 years old in the study area. In each upazila, the majority of persons were between the ages of 40 and 49.

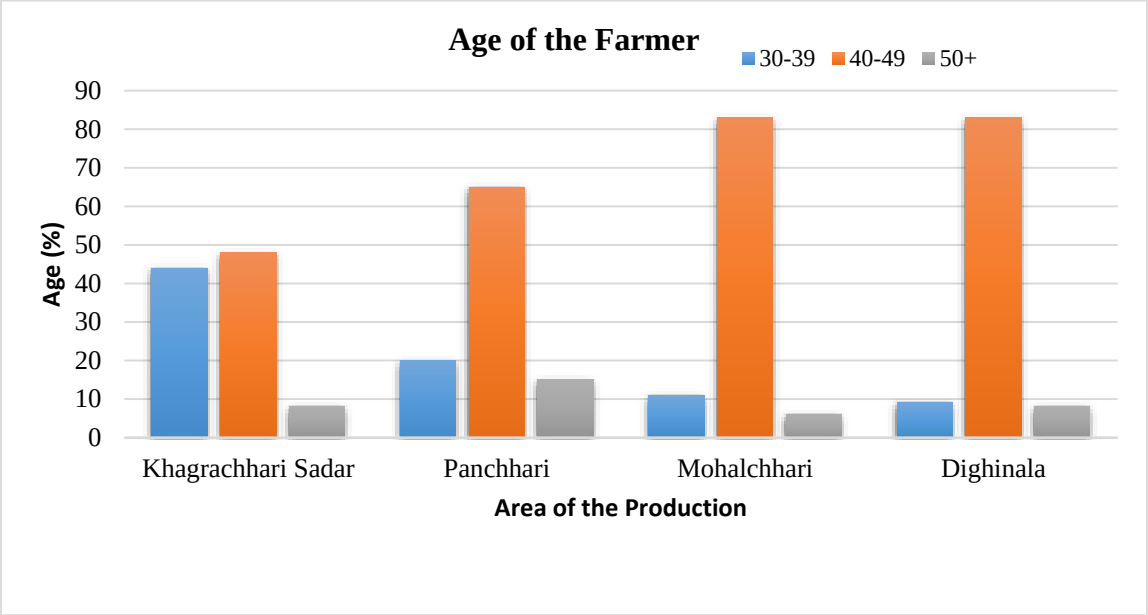


Figure 9. Age of the respondent by Study Area

4.1.2 Education

According to Figure 10, around 28% of individuals have a primary level of education, approximately 64% have a secondary level of education, and 8% have a higher secondary level of education in Khagrachhari Sadar upazila. Around 26% of individuals have a primary level of education, 62% have a secondary level of education, and 12% have a

higher secondary level of education in Panchhari upazila. Around 39% of individuals have a primary level of education, 50% have a secondary level of education, and 11% have a higher secondary level of education in Mohalchhari upazila. Around 22% of individuals have a primary level of education, 69% have a secondary level of education, and 9% have a higher secondary level of education in Dighinala upazila. And overall, we can see from this number that 29% have a primary level of education, 61% have a secondary level of education and 10% have a higher secondary level of education in the study area. Finally, the majority of individuals in each upazila have a secondary education.

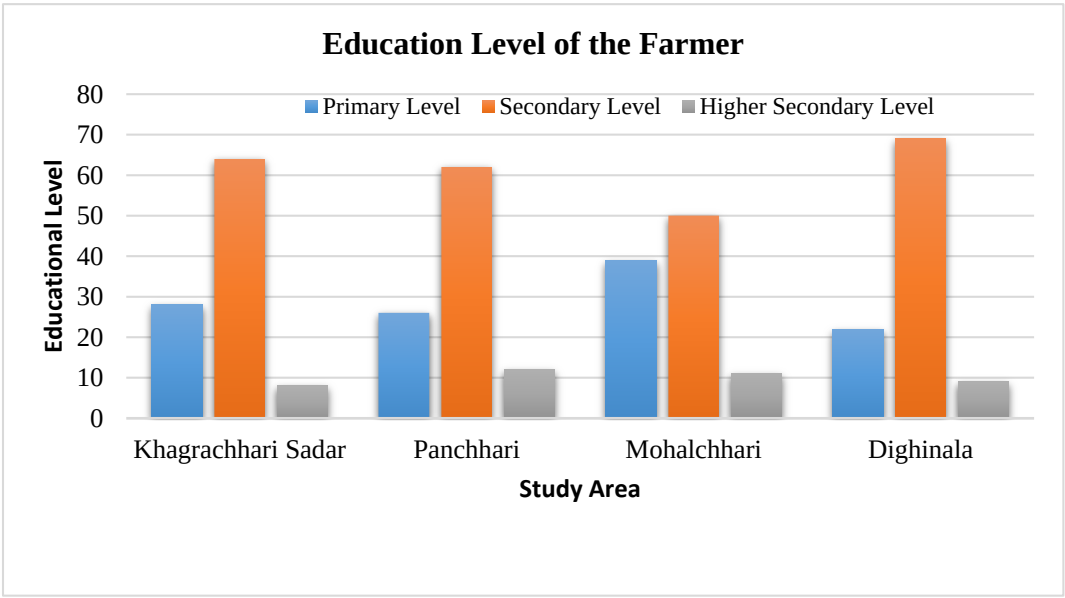


Figure 10. Education Level of the Farmer by Study Area

4.1.3 Composition of the Family Size

Family size is critical in terms of producing adequate nourishing grain for the ranch family. In this research, family was defined as the total number of persons living in a same kitchen and eating meals under the influence of a single family leader. The term "relatives" refers to the husband, children, unmarried little girl, father, mother, sister, and several other relatives who reside in the family permanently. According to Table 7, the average household size in Khagrachhari sadar upazila is 5.20, in Panchhari upazila it is 6.16, in Mohalchhari upazila it is 5.91, and in Dighinala upazila it is 5.65. And the average family

size in the study area is 5.65, while the average family size in the country is 4.06.

Table 7. Average Family Size and Distribution of Members According to Sex of the Sample Farmers in Study Area

Particulars	Male		Female		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Khagrachhari Sadar	3.05	58.65	2.15	41.35	5.20	100.00
Panchhari	3.31	53.73	2.85	46.27	6.16	100.00
Mohalchhari	3.23	54.65	2.68	45.35	5.91	100.00
Dighinala	3.33	62.71	1.98	37.29	5.31	100.00
All Farmer	3.23	57.17	2.42	42.83	5.65	100.00
National Average Family Size	4.06					

4.1.4 Agricultural Training

Only 7 % of responding farmers in Khagrachhari Sadar Upazila received instruction in jhum, compared to around 15% in Panchhari upazila, approximately 25% in Mohalchhari upazila, and approximately 25% in Dighinala upazila (Table 8). And overall 25% of the respondents received training where 75% were not. These training sessions heightened their awareness of proper plant handling, the use of resistant cultivars, the administration of insecticides and pesticides, water management, and new technologies, among other topics. BINA, Khagrachhari, and DAE provided the majority of the instruction on jhum cultivation.

Table 8. Agricultural Training of the respondent by Study Area

Training Received	Khagrachhari Sadar		Panchhari		Mohalchhari		Dighinala		Overall	
	No.	%	No.	%	No.	%	No.	%	No.	%
Yes	07	35	03	15	05	25	05	25	20	25
No	13	65	17	85	15	75	15	75	60	75
Total	20	100	20	100	20	100	20	100	80	100

4.1.5 Membership of any social/agricultural organization

In Panchhari upazila, just 10% of jhum were found to be members of various social and/or agricultural organizations, but in Khagrachhari Sadar upazila, 40% of jhum farmer were found to be members of various social and/or agricultural organizations. 30% of jhum farmers were members of various Social and/or agricultural organizations in Mahalchhari upazila and 20% of jhum farmer were members of various social and/or agricultural organizations in Dighinala upazila (Table 9). And overall 25% of the respondents have membership of various social and/or agricultural organizations where 75% were not.

Table 9: Membership in any social/agricultural organization of the respondent by Study Area

Member Ship	Khagrachhari Sadar		Panchhari		Mohalchhari		Dighinala		Overall	
	No.	%	No.	%	No.	%	No.	%	No.	%
Yes	08	40	02	10	6	30	4	20	20	25
No	12	60	18	90	14	70	16	80	60	75
Total	20	100	20	100	20	100	20	100	80	100

2 Farmers experience in Jhum cultivation

Experience with Jhum cultivation refers to the length of time that farmers have been involved in jhum cultivation. Farmers' experience with jhum cultivation was extensive in the research area, ranging from 5 to above 20 years, with a mean of (7.95) and a standard deviation of (4.28). Farmer experiences with mango farming were classified into four categories: 5–10 years, 11-15 years, 16–20 years, and 20 years above. The investigation revealed that the majority of respondents (50.00 percent) had been involved in jhum cultivation for between 11 - 15 years. On the other side, the lowest proportion of respondents (6.25 percent) had 5-10 years of experience, followed by respondents with 16-20 years and above 20 years of experience (18.75 percent) and (25.00 percent), respectively.

Table 10. Distribution of respondents according to their experience with Jhum cultivation

Experience (year)	Farmers opinions			
	Number of respondents	Percent	Mean	SD
5-10 years	5	6.25	7.95	4.28
11- 15 years	40	50.00		
16-20 years	15	18.75		
20 above	20	25.00		
Total	80	100		

Profitability of Jhum cultivation

4.2.1 Variable Costs

a) Cost of Land Preparation

The most essential part of the manufacturing process is land preparation. Land preparation entailed slash, burn and other activities required to prepare the soil for jhum cultivation. For land preparation in jhum cultivation, firstly cut down the forest after cutting down the forest they burn the cutted trees and shrubs. As a result, the average land preparation cost of jhum cultivation was discovered to be Tk. 2800 per hectare, representing 4.8 percent of total cost. This land of cost was included in hired human hired labor and family labor.

b) Cost of Hired Human Labor

One of the most significant cost components in the manufacturing process is human labor. It's one of the most important and often utilized components in jhum cultivation. Land preparation, sowing, weeding, fertilizer and insecticide treatment, harvesting and hauling, threshing, cleaning, drying, and storing are all examples of operations that require it. The average amount of hired human labor employed in jhum cultivation is less than any other production systems. Because in jhum cultivation most of the working activities done by family members. So it was determined to be around 4 man-days per hectare, with a Tk. 450 per man-day average price. As a result, the entire cost of contracted human labor was determined to be Tk. 5400, or 9.4 percent of the overall cost (Table 11)

c) Cost of Seed

Cost of seed varied widely depending on its quality and availability. In jhum cultivation process most of the time jhum cultivers stored their own seed as a result it required less amount of money. Sometimes they collect seeds from local market. Per hectare total

cost of seed for jhum cultivation were estimated to be Tk. 500, which constitut ed 0.87 percent of the total cost (Table 11).

d)Cost of Urea

In the study area, farmers used different types of fertilizers. In jhum cultivation less amount of fertilizer were used. On an average, farmers used urea 30 kg per hectare. Per hectare cost of urea was Tk.600, which represents 1.04 percent of the total cost (Table 11).

e)Cost of TSP

Among the different kinds of fertilizers used, the rate of application of TSP (18 kg). The average cost of TSP was Tk. 504 which representing 0.88 percent of the total cost (Table 11).

f) Cost of MoP

The application of MoP per hectare (13 kg) per hectare cost of MoP was found Tk. 247, which represents 0.43 percent of the total cost (Table 11).

g) Cost of Insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for jhum cultivation was found to be Tk. 1550 which was 2.70 percent of the total cost (Table 11).

h) Cost of Irrigation

Jhum cultivation is a totally rainfed Due to lack of irrigation facilities cultivars didn’t apply any irrigation. So Cost of irrigation is nearly zero in this cultivation process

Table 11. Per Hectare Costs of jhum cultivation

Cost Items	Quantity	Price Per Unit (Tk.)	Returns (Tk ha-1)	% of total
A. Gross Return				
Main product (Rice)	2500	18	45000.00	47.87
By-product (other crops)	1400	35	49000.00	52.12
Total return			94000.00	100.00
B. Gross Cost				
C. Variable Cost				
Seed		500	500	0.87
Irrigation		00	00	00
Power tiller	0	00	00	00
Hired labor	12	450	5400	9.4
Urea	30	20	600	1.04
TSP	18	28	504	0.88
MOP	13	20	247	0.43
Fertilizers cost			7251	12.65
Manure	10	5	50	0.08
Insecticides			1550	2.70
Total variable cost (TVC)			8851	15.44
D. Fixed Cost				
Land use cost			2500	4.36
Family labor	90	450	40500	70.66
Interest on operating capital			5160	9.003
Total Fixed cost (TFC)			48160	84.03
E. Total costs			57311	100.00

i) Cost of manure

It was observed in the present study area that farmers sometimes used cow dung for producing their enterprises. They collected cow dung from the milk producers and personal collection. It was found about Tk. 50 per hectare.

4.2.2 Total Variable Cost

Therefore, from the above different cost items it was clear that the total variable cost of jhum was Tk. 8851 per hectare, which was 15.44 percent of the total cost (Table 11).

4.2.3 Fixed Cost

a) Rental Value of Land

The rental value of land was calculated using the opportunity cost of land use per hectare over eight cropping period. The cost of land use has been calculated using the cash rental value of the land. Based on data collected from jhum cultivars, the land use cost was determined to be Tk. 2500 per hectare, accounting for 4.36 percent of the total cost (Table 11).

b) Cost of Family Labor

Human labor costs are one of the most expensive components of the production process. It is one of the most important and widely used inputs in the production of jhum crops It is generally required for a variety of operations such as land preparation, sowing, weeding, fertilizer and insecticide application, harvesting and carrying, threshing, cleaning, drying, and storing, among others. The average amount of family supply labor (without hired labor) used in jhum production was discovered

to be approximately 90 man-days per hectare, and the average price of human labor was Tk. 450 per man-day. If we pay those workers, the total cost is Tk. 40500, which is 70.66 percent of the total cost (Table 11).

c) Interest on Operating Capital

It should be noted that the interest on operating capital was calculated by factoring in all operating costs incurred during Jhum's production period. The interest on operating capital for jhum production was estimated at 12% as most of the farmers took it as a loan from local landlord and calculated at Tk. 5160 per hectare, representing 9.003 percent of the total cost (Table 11)

4.2.4 Total Cost (TC) of Jhum Production

The total cost was determined by adding the costs of all variable and fixed inputs. In the current study, the total cost of producing jhum crops per hectare was determined to be Tk. 57311 (Table 11).

Table 12. Per Hectare Cost and Return of Jhum Production

Cost Item	Cost/Returns (Tk/ha)
A. Gross Return	94000
B. Variable Cost	8851
C. Fixed Cost	48160
D. Total costs	57311
E. Gross Margin (A-B)	85149
F. Net Return (A-D)	36689
G. BCR (A/D)	1.64

$$\textbf{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Return}}{\text{Total Cost of Production}} = \frac{94000}{57311}$$

$$= \mathbf{1.64}$$

Return of jhum cultivation

4.2.5 Gross Return

The return on Jhum cultivation per hectare is given in Table 12. The gross return per hectare was computed by multiplying the total quantity of product by the per-unit price. As shown in the table, the average output of Jhum per hectare rice was 2500 kg at an average price of Tk. 18, whereas the average yield of other crops was 1400 kg at an average price of 35 tk. As a result, the gross return on investment was determined to be Tk. 94000.00 per hectare (Table 12).

4.2.6 Gross Margin

Gross margin is the difference between the gross return and variable costs. Gross margin was determined by subtracting all variable costs from gross return. On the basis of the data, a gross margin of Tk. 85149 per hectare was determined (Table 12).

4.2.7 Net Return

The net return or profit was determined by subtracting the whole cost of production from the gross return. On the basis of the data, a net return of Tk. 36689 per hectare was estimated (Table 12).

4.2.8 Benefit Cost Ratio (Undiscounted)

The Benefit cost Ratio (BCR) is a ratio that is used to compare the benefit per unit

of cost. The benefit-cost ratio (BCR) was determined to be 1.64, indicating that a taka invested in Jhum production generated Tk. 1.64. (Table 12). According to the following calculation, Jhum cultivation is profitable in Bangladesh.

4.3 PROFITABILITY OF MANGO ORCHARD

The present investigation was conducted with a survey from sample farmers of Khagrachari District in respect of mango orchard farmers and jhum cultivars 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 farmers have been discussed by the following headings:

4.3.1 Land ownership

The land ownership of the respondents' farmers is detailed in (Table 13). The study divided land ownership into five categories: landless (0-49 decimal), marginal (50-149 decimal), small (150-249 decimal), medium (250-749 decimal), and large (above 749 decimal) (above 750 decimal). The average land ownership percentage was 214.99 decimal, with a standard deviation of 199.44 points. More than Half of the respondents (52.25%) were marginal farmers, with the remaining 5%, 27.5%, 8.75%, and 6.25% percent being landless, small, medium, and large farmers, respectively. Here standard deviation is high because the lowest land owner has 38 decimal land and highest land owner has 890 decimal land.

Table 13. Distribution of respondents according to their land ownership

Categories of the farmers	Number of respondents	Percent	Total land (decimal)	Percent of total land	Average farm size (decimal)
Landless (0-49 decimal)	4	5	176	0.92	214.99
Marginal (50-149 decimal)	42	52.25	5124	26.69	
Small (150-249 decimal)	22	27.5	5395.50	28.10	
Medium (250-749 decimal)	7	8.75	3864	20.13	
Large (above 750 decimal)	5	6.25	4636	24.15	
Total (23 – 864 decimal)	80	100.00	19194.5	100	

4.3.2 Farmers experience in mango production

Experience with mango gardening refers to the length of time that farmers have been involved in mango producing. Farmers' experience with mango production was extensive in the research area, ranging from 1 to above13 years, with a mean of (7.95) and a standard deviation of (4.28). Farmer experiences with mango farming were classified into four categories: 1–3 years, 4-8 years, 9–13 years, and 13years above. The investigation revealed that the majority of respondents (45.00 percent) had been involved in mango cultivation for between 4 and 8 years. On the other side, the lowest proportion of respondents (11.25 percent) had 13 or more years of experience, followed by respondents with 1-3 years and 9-13 years of experience (17.50 percent) and (26.25 percent), respectively.

Table 14. Distribution of respondents according to their experience with mango gardening

Experience (year)	Farmers opinions			
	Number of respondents	Percent	Mean	SD
1-3 years	14	17.50	7.95	4.28
4 - 8 years	36	45.00		
9-13 years	21	26.25		
13 above	9	11.25		
Total	80	100		

4.3.3 Land type for mango gardening

In the study area the land type is categorized into two levels as hilly area and plain area. Among them 93.33% practiced mango gardening in hilly area and 6.66% practiced in plain land (Table -15

Table 15. Distribution of respondents according to land type for mango based agroforestry system

Land type	Number of respondents	Percent
Hilly area	75	93.33
Plain land	05	6.66
Total	80	100

4.3.4 Types of planting materials

Farmers in the research region established mango gardens using two types of planting materials: vegetative propagation materials and true seedlings from seed (Table 16). The survey revealed that the vast majority of respondents (95 percent) employed vegetative propagation materials for mango gardening, while just 5% used seedlings from seed. The popularity of vegetative propagation materials for mango gardens could be attributed to the high quality of the fruits and the rapid return of output.

Table 16. Distribution of respondents according to use of planting materials for mango gardening

Types of planting materials	Number of respondents	Percent
Vegetative propagation	76	95
Sapling from seed	4	5
Total	80	100

4.3.5 Source of planting materials

Respondent farmers in the study area were found that they collect planting supplies from nurseries, local markets, and both nurseries and local markets (Table 17). About (53.75

percent) of respondent farmers gathered seedlings from nurseries, whereas only 13.75% collected seedlings from both nurseries and local markets, and only 32.50% of total respondent farmers collected seedlings from local markets. The analysis revealed that nursery is the primary source, which may be owing to the high quality seedlings available at a lower price and convenient shipment from here. Price of per mango seedling is 60 Tk

Table 17. Distribution of respondents according to source of planting materials

Source of seedling	Number of Respondents	Percent
Nursery	43	53.75
Local market	26	32.50
Both nursery and local market	11	13.75
Total	80	100

4.3.6 Age of seedling

The age of the seedling is important for the fruit plant's growth and long-term production of mango. Generally, the age of a seedling is determined by its availability and supply. The study area is well-known for its nursery seedling output. Three distinct varieties of aged seedlings were put in the mango garden, according to the research (Table 18). The results indicated that the majority of respondents (51.25 percent) used 6 months to 1-year-old seedlings and the fewest respondents (2.5 percent) used 1.5 year to 2-year-old seedlings in their mango gardens, while the majority of respondents (46.25 percent) used 1 year to 1.5-year-old seedlings. Here, it is worth noting that seedlings aged six months to one year are better suitable for proper output, as demonstrated by the study's responders.

Table 18. Distribution of respondents according to seedling age use for mango gardening

Age of seedling	Number of respondents	Percent
6 months - 1year	41	51.25
1 year - 1.5 year	37	46.25
1.5 year - 2 year	2	2.5
Total	80	100

4.3.7 Planting time of seedling

Farmers in the study area begin planting mango seedlings in March and continue planting them until October (Table 19). The results indicated that the majority of respondents (60 percent) planted mango seedlings between June and July. On the other side, the smallest proportion of respondents (6.25 percent) planted mango seedlings in September-October, while the largest proportion (33.75 percent) planted mango seedlings in March-April. The analysis determined that June-July is the optimal planting season for mango seedlings in Khagrachari District, in terms of mango-based agriculture.

Table 19. Distribution of respondents according to perception of planting time of mango seedling

Planting time	Number of respondents	Percent
March – April	27	33.75
June – July	48	60
September - October	5	6.25
Total	80	100

4.3.8 Amount of fertilizer use

Farmers in the research region were discovered that apply a range of different types of fertilizers at varying rates for various mango tree ages (Table 20). The investigation revealed that the farmer used 400, 250, and 175gm of urea, TSP, and MP respectively for 1-3 years old mango trees; 750, 375, and 300 gm of urea, TSP, and MP respectively for 4-8 years old trees; 1000, 500, and 450 gm of urea, TSP, and MP respectively for 9-13 years old trees; and 1500, 700, and 500 gm of urea, TSP and MP for above 13 years (Table 20). The current study established that the fertilizer dose increases with the age of the mango tree.

Table 20. Amount of fertilizer used at different aged mango tree per year (g/tree/year)

Age category (in year)	Amount of fertilizer (g/tree/year)		
	Urea	TSP	MP
1 - 3 year	400(350 - 450)	250 (200 - 300)	175 (150 - 200)
4 - 8year	750(700 - 800)	375 (350 - 400)	300 (250 - 350)
9- 13 year	1000(900 - 1100)	500 (450 - 550)	450 (400 - 500)
Above 13	1500 (1400 - 1600)	700 (650 - 750)	500 (450 - 550)

4.3.9 Irrigation schedule

The frequency of irrigation in mango trees was discussed (Table 21). Farmers use three forms of irrigation for healthy mango tree growth and development, according to the findings. According to the respondent's practices, three times were chosen for irrigation: only before blooming, only before prematurity stage, and both before flowering and pre maturity stage. The bulk of the farmers who responded (77.50%) applied irrigation twice during the growing season, before blossoming and before maturity. Only 10% and

12.50% of respondents used irrigation in their mango gardens during the pre-mature stage and before flowering, respectively.

Table 21. Distribution of respondents according to application of irrigation in mango orchard

Time of irrigation	Responses of farmers	
	Number of respondents	Percent
Only before flowering	10	12.50
Only pre maturity stage	8	10
Both before flowering and pre maturity stage	62	77.50
Total	80	100

4.3.10 Pruning

Pruning is an important part of mango production since it reduces insect and disease infestation while also promoting balanced growth and development of the fruit and tree. Mango trees were pruned twice a year by farmers in the research region (Table 22). It was done twice: once before blossoming and again after harvesting. According to the findings, the majority of responding farmers (72.50%) pruned mango trees after harvesting, while 27.50% pruned mango trees before flowering.

Table 22. Distribution of respondents according to their opinion regarding pruning practices

Time of pruning	Responses of farmers	
	Number of respondents	Percent
Before flowering	22	27.50
After harvest	58	72.50
Total	80	100

4.3.11 Disease infestation

Mango production is under threat from disease invasion. Disease attack on mango trees was found to be extremely detrimental to intended mango production. Die-Back, sooty molds, scab, powdery mildew, pink disease, anthracnose, fruit rot, black banded disease, black mildew, and twig blight were among the diseases discovered in the research region (Table 23). Powdery mildew was ranked as the most dangerous illness by the majority of respondents (56.25 percent), followed by sooty molds (47.50 percent), dieback (42.50 percent), and scab (42.50 percent). Another way to look at it, almost a quarter of the respondents (6.25 percent) thought black banded diseases harmed mango trees, followed by pink diseases and black mildew (7.50 percent), Anthracnose (12.50 percent), Fruit rot (20 percent), and Twig blight (20 percent) (15percent).

Table 23. Distribution of respondents according to disease infestation in mango orchard

Name of the diseases	Responses of farmers	
	Number of respondents	Percent
Dieback	34	42.50
Sooty molds	38	47.50
Scab	34	42.50
Powdery mildew	45	56.25
Pink disease	5	6.25
Anthracnose	25	31.25
Fruit rot	16	20.00
Black banded disease	5	6.25
Black mildew	6	7.50
Twig blight	12	15.00

4.3.12 Insect infestation

Fruit piercing moths, mango seed weevil, mango shoot caterpillar, mango leafhopper, mango stem miner, Queensland fruit fly, red-banded trips, spiraling whitefly, fruit-spotting bug, and mango tip borer were among the insects identified in the study area (Table 24). The results showed that 43.75 percent of respondents thought mango leafhoppers attacked mango trees seriously, followed by mango shoot caterpillars (35 percent) and spiraling whiteflies (31.25 percent), mango stem miner (22.50 percent), mango tip borer (20.00 percent), mango seed weevil (18.75 percent), and Queensland

fruit fly (17.50 percent), with the least number of respondents (7.5 percent) opposing fruit piercing moths.

Table 24. Distribution of respondents according to insects' infestation in mango orchard

Insect infestation	Responses of farmers	
	Number of respondents	Percent
Fruit piercing moths	6	7.5
Mango seed weevil	15	18.75
Mango shoot caterpillar	28	35
Mango leafhopper	35	43.75
Mango stem miner	18	22.50
Queensland fruit fly	14	17.50
Red-banded trips	12	15.00
Spiraling whitefly	25	31.25
Fruit-spotting bug	8	10.00
Mango tip borer	16	20.00

4.3.13 Control measures

Farmers in the study area were seen that they use a variety of pest and disease control techniques. The investigation revealed that 80.00 percent of respondents used control measures against diseases and pests, whereas 20 percent did not use any control measures at all.

Table 25. Distribution of respondents according to control measure against pest and diseases

Responses of farmers	Number of respondents	Percent
Yes	64	80
No	16	20
Total	80	100

4.3.14 Age of mango plant for higher production

Mango trees begin fruiting at a younger age of four years and can produce fruit for up to 30 years (Table 26). Each year of plant age was assigned a score of one. The observed score range for increased output was based on the age of the mango tree, with mean values of 8.87 years and a standard deviation of 2.91. All of the farmers who responded said that a mango tree that was 1 to 3 years old was not suited for commercial mango production. The majority of respondents (72.50 percent) believed that the most productive mango trees are those that are 5 to 9 years old, followed by those that are 10 to 13 years old, and that as the age of the tree grows older, the mango yield decreases.

Table 26. Distribution of respondents according to age of mango tree for maximum production

Age category (year)	Responses of farmers			
	Number of respondents	Percent	Mean	SD
2- 4 year	0	0.00	8.87	2.91
5- 9 year	58	72.5		
10- 13 year	26	32.5		
Above 13 year	6	7.5		
Total	80	100		

4.3.15 Marketing problems of mango

Three kinds of marketing challenges were determined as low, medium, and high based on information provided by respondents on a lack of communication facilities, middle man interference, a lack of storage facilities, a lack of marketing infrastructure, and a lack of processing industries. Total score attained was 750, with a mean of 8.50 and a standard deviation of 3.84. (Table 27). According to the investigation, 40.00 percent of total respondent farmers had medium marketing difficulties, 22.50 percent faced low marketing difficulties, and 37.50 percent faced severe marketing difficulties. The study area's findings revealed that each respondent's farmers had some form of marketing difficulty.

Table 27. Problems of mango marketing faced by the farmers

Marketing problems	Score range	Obtained score	Responses of farmers		Mean	SD
			Number	Percent		
Low	0 - 5	72	18	22.50	8.5	3.84
Medium	5 - 10	288	32	40.00		
High	11 - 15	390	30	37.50		
Total	0 - 15	750	80	100.00		

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

4.3.16 Farmers' suggestion for improving mango orchard

Respondent farmers gave a variety of suggestions for making mango orchard practices more productive. Communication facilities, market infrastructure, pest and disease control, usage of optimal fertilizer, management methods, planting materials, technical support, product quality, maintenance system, HYV, and mechanization were among the

ideas made by respondents (Table 28). According to the findings, the majority of farmers (81.25 percent) recommended upgrading marketing infrastructure, and it was ranked first. Suggestions for improving management practices, communication facilities, planting materials, pest and disease control practices, product quality, use of optimal fertilizer, technical facilities, maintenance system, mechanization, and improved HYV were ranked second, third, fourth, fifth, sixth, seventh, eighth, ninth, tenth, and eleventh, respectively. The findings revealed that the designated area's market infrastructures were not sufficiently established and advanced to support good mango-based agroforestry practices.

Table 28. Farmers suggestions to improve production in mango orchard

Suggestions to improve	Number of respondents	Percent	Rank
Communication facilities	57	71.25	3
Market infrastructure	65	81.25	1
Pest and disease control	42	52.50	5
Use of optimum fertilizer	31	38.75	7
Management practices	63	78.75	2
Planting materials	49	61.25	4
Technical support	28	35	8
Product quality	39	48.75	6
Maintenance system	24	30	9
HYV	19	23.75	11
Mechanization	23	28.75	10

Table 29. Year wise different cost and return per hectare (Tk./ha) of mango production of 13 year

Age of Mango	Seedling Cost		Land Preparation					Interest on operating capital	Total cost	Gross Benefit	Net Return
Initial	14400		5000					2328	21728		
	Fertilizer cost	Fertilizer application Cost	Pesticide cost	Inter. Operational. Cost	Harvesting cost	Marketing cost	Land use Cost				
1	7500	400	2500	2550	0	0	30000	5152	48102	0	-48102
2	8000	400	2500	2550	0	0	30000	5214	48664	0	-48664
3	8500	500	3000	2800	1200	1200	35000	6264	58464	10000	-48464
4	8500	500	3000	2800	1200	1200	35000	6264	58464	15000	-43464
5	8500	500	3000	2800	1500	1200	35000	6300	58800	75000	16200
6	10500	600	4000	3500	2000	1800	40000	7488	69888	100000	30112
7	10500	600	4000	3500	3000	2000	40000	7632	71232	100000	28768
8	10500	600	4000	4500	4000	2000	40000	7872	73472	200000	126528
9	10500	600	4000	4500	4000	2000	40000	7872	73472	250000	176528
10	10500	600	4500	4500	4500	2500	50000	9192	85792	500000	414208
11	13500	1000	5000	6000	4500	2500	60000	11040	103040	500000	396960
12	13500	1000	5000	6000	4500	3000	60000	11100	103600	500000	396400
13	13500	1000	5000	6000	4500	3000	60000	11100	103600	550000	446400
Total	134000	8300	49500	52000	34900	22400	555000	104818	978318	2800000	1843410
BCR=1.88											

4.3.17. Economic benefit from Mango Orchard

Data were collected from 4 upazilas of Khagrachari district. Randomly selected 20 respondents from each union as a total 80 respondents was interviewed through similar questionnaires. An English version of the questionnaire is given in Appendix I. From the compiled data in Appendix II. Earning cash from mango orchard is comparatively higher when practicing this system, which is shown in table 12 and 29. The relationship between the selected characteristics of the respondent farmers and their income, correlation co-efficient 'r' has been determined and presented in Table 30.

Table 30. Correlation between selected characteristics of respondents with their income from mango orchard

Dependent variables	Independent variables	Tabulated value at 79 df		Values of coefficient of correlation
		0.05 level	0.01 level	
Income of the respondents	Farm size	0.217	0.283	0.9769**
	Education			0.7426**
	Tree age			0.6807**

****** Correlation is significant at 0.01 and 0.05 level.

The co-efficient of correlation (r) between the concerned variables was computed and found to be 0.9769, 0.7426 and 0.6807. Computed value and tabulated value of "r" was presented in the table 30. The computed value of "r" (0.9769, 0.7426 and 0.6807) was found to be greater than the tabulated value of "r" (0.217) with 79 degrees of freedom at 1% level of probability. The coefficient of correlation between the concerned variable was significant at 1% and 5% level of probability. The finding implies that farm size, education and tree age had significant positive relationship with their income from mango orchard

4.4. Comparison of Mango orchard and Jhum cultivation

Table 31. Cost and return analysis of Mango orchard and Jhum cultivation

Sl no.	Name	Gross income (Tk./ha)	Total cost of production (Tk./ha)	Net income (Tk./ha)
1	Mango orchard(13Years)	2800000	978318	1843410
2	Jhum cultivation	94000	57311	36689

Data in the table 31 shows that for mango orchard cost of production and gross income are 978318 and 2800000 Tk so Net income is 1843410.In jhum cultivation cost of production and gross income are 57311 and 94000 Tk so Net income is 36689.Benefit cost ratio is the amount we are used and the amount we got as return. If we arrange the value of benefit cost ratio (BCR) get in table 18 from higher to lower (1.88>1.64), we will be seen the mango orchard is more profitable than jhum cultivation. So, the highest benefit cost ratio is obtained from mango orchard. It means that if, a farmer invests 1 taka in Mango orchard in a unit land, he will get 1.88 taka as a return from it. Chittagong Hill Tracts comprise 10% of country's landmass. Area is mild to very steep ranging from 15% to over 70% slope. Among three districts khagracharri has 2,749.16 km^2 areas and it has both plain and hilly area. People are trying to focus on profit maximization which is no longer possible through jhum cultivation. Crop productivity in jhum has declined due to soil erosion and associated reduction in essential soil nutrients. The existing cropping pattern in Bangladesh's hilly areas should be changed to adopt a better pattern. In order to achieve higher yields respective to higher returns, farmers in the hilly area are now concentrating on mango production. Mango production has become extremely profitable as it requires small amount of and compared to jhum cultivation. Privatization of land system again pushed them to alter the cultivation pattern.

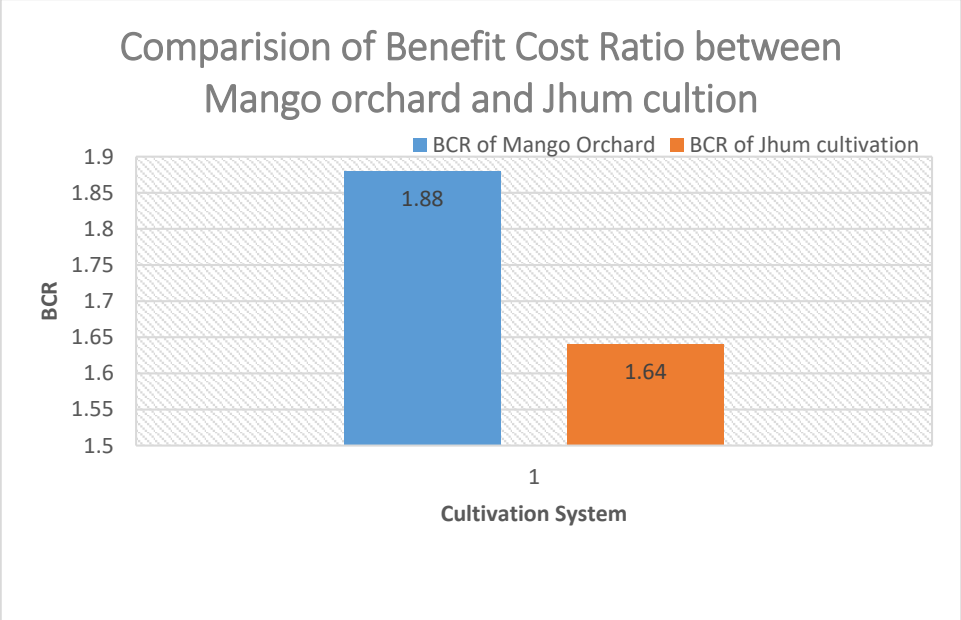


Figure 13. Benefit cost ratio of Mango orchard and Jhum cultivation in Khagrachari

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

The study was conducted at Khagrachhari sadar, Mahalchhari, Panchari and Dighinala Upazilla under Chattogram Division. The zila's yearly average temperature ranges from 13 °C to 34.6 °C, with an average annual rainfall of 3031 mm. In Jhum area rice, maize, millet, cucumber, pumpkin, melon, cotton, banana, ginger, turmeric, etc are mainly cultivated. The study was carried out from April to September, 2020, and it included field testing of the interview schedule, direct interviews with respondents, field visits and observations. Using a random number table, (6.67%) percent of the population was proportionately chosen as the study's sample. The benefit-cost ratio (BCR) is calculated by dividing the discounted benefit by the discounted cost. It represents the value derived from a single unit of cost.

The study divided land ownership into five categories: landless (0-49 decimal), marginal (50-149 decimal), small (150-249 decimal), medium (250-749 decimal) (above 750 decimal). The average land ownership percentage was 214.99 decimal, with a standard deviation of 199.44. Farmers' experience with mango production was extensive in the research area ranging from 1 to above13 years. The age of the seedling is important for the fruit plant's growth and long-term production of mango. The majority of respondents (51.25 percent) used 6 months to 1-year-old seedlings in their mango gardens. The analysis determined that June-July is the optimal planting season for mango seedlings. Farmers apply a range of different types of fertilizers at varying rates for various mango tree ages. Pruning is an important part of mango production since it reduces insect and disease infestation while also promoting balanced growth and development of the fruit and tree. Mango trees were pruned twice a year by farmers in the research region: once before blossoming and again after harvesting. Powdery mildew was ranked as the most dangerous illness by the majority of respondents (56.25 percent), followed by sooty molds (47.50 percent) and dieback (42.50%). Mango trees begin fruiting at a younger age of four years and can produce fruit for up to 30 years. The majority of respondents believed that the most productive mango trees are those that are 5 to 9 years old. 80.00 percent of respondents used control measures against diseases and pests, whereas 20 percent did not use any control measures at all. The

average cost of land preparation for jhum cultivation was found to be Tk. 2800 per hectare, representing 4.8 percent of total cost.

In Jhum cultivation for land preparation slash, burn and other activities required to prepare the soil. The average amount of hired human labor employed in jhum production is less than any other production system. Most of the time jhum farmers stored their own seed as a result it required less money for seeds. Sometimes they collect seeds from local market. Cost of seed varied widely depending on its quality and availability. Jhum cultivation is a totally rain fed. Due to lack of irrigation facilities cultivars didn't apply any irrigation. Cost of irrigation is nearly zero in this cultivation process. Average cost of insecticides for jhum cultivation was found to be Tk. 1550 which was 2.70 percent of the total cost. The average amount of family supply labor used in jhum production was discovered to be approximately 90 man-days per hectare. The average output of Jhum per hectare rice was 2500 kg at an average price of Tk. 18, whereas the average yield of other crops was 1400 kg at an average price of Tk35.The net return or profit was determined by subtracting the whole cost of production from the gross return. The benefit-cost ratio (BCR) was determined to be 1.64, indicating that a taka invested in Jhum production generated Tk1.64. According to the following calculation, Jhum cultivation is profitable in Bangladesh. It is most essential to use modern inputs such as seeds, fertilizers and human labor efficiently.

Mango orchard is more profitable than jhum cultivation. It means that if, a farmer invests 1 taka in mango orchard, he will get 1.88 taka as a return from it. If we arrange the value of benefit cost ratio (BCR) high to low (1.88>1.64), we will see the difference.

CONCLUSIONS

Based on findings of the study, the following conclusions were drawn:

- The experience of jhum cultivation among the farmers are higher in jhum cultivation. In jhum cultivation experienced was found above 20 years but in mango orchard above 13 years experienced was found only 11.25 % of total respondents. The mango orchard farmers are educated and wealthy.
- Jhum farmers are poor as a result they can't able to invest much in their jhum. Most of the jhum farmers grown crops for their own consumption. Only little amount of crops are sold in the market to fulfill their other basic needs. Due to high population pressure day by day jhum cultivation is reducing.
- For mango orchard Net income was 1843410 Tk and in jhum cultivation 36689 Tk. The benefit-cost ratio (BCR) of mango orchard was determined to be 1.88 and for jhum1.64. Mango production has become extremely profitable as it requires small amount compared to jhum cultivation.
- Problems like mango powdery mildew, low price of jhum crops and mango, high price of inputs, attack of mango shoot caterpillar, mango leafhopper on mango orchard etc. are jeopardizing the farmers to practice this system. There is a need to take measures to solve the problems as a priority basis and training on mango orchards is needed to increase total profit.

Recommendations

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

1. Hence, the present study area was at Khagrachhari sadar, Mahalchhari, Panchhari, Dighinala Upazilla under Khagrachhari District, the number of location along with sample size and observed view should be increased to attain more information and for better interpretation about the objectives of the study.
2. Research program should be conducted to identify the best one between mango orchard and jhum cultivation and to imply them for practicing.
3. A good marketing system is hampered due to some severe problems. A considerable damage was occurred due to lack of marketing facilities and price return was not also desirable as their demand. So, marketing problems should be removed by improving marketing infrastructure and communication.
4. Agricultural extension programme should be increased to provide best support among jhum and Mango farmers.

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CHAPTERVIII

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

Measuring the Agro-economic Potential of Conversion of Jhum Cultivation Area to Mango Orchards

A. Personal Details

1. Identification of the Respondent:

Name:
……..
Father's name:
……..
Mother's 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. Jhum Area details of farmer:

.

Homestead	Lease in	Lease out	Agreement	Total land

7. Please inform your yearly production from jhum area

Rice	Maize	Pepper	Marpha	Pumpkin	Turmaric	Ginger	Melon	another	Total

8. Please inform your yearly income from Jhum area

Rice	Maize	Pepper	Marpha	Pummkin	Turmaric	Ginger	Melon	Another	Total

9. How many years you were practiced jhum Cultivation?

……

10. Jhum cultivation Pattern?

……

B. Location Details:

1. Soil:

i. Fertility level: L/M/H

ii. Soil Type: Sandy/Loamy/Sandy-loamy/Clay

a. **Land Type:** Hilly/Plain/Low land/Others

C. Detail history and purpose of conversion from Jhum Cultivation to Mango Orchards:

1. From when and how have you related with Mango gardening?

.....Years

2. Why do you choose Mango plantation in your jhum area?

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

2. How long have you been practicing Mango gardening?

……Years.

3.What types of cultivars/varieties have you cultivated in your Mango Garden?

Cultivar/Variety	Origin	Duration (yrs)

4. What types of land will you prefer for Mango Cultivation?

5. Which location that you prefer to collect Mango Seedlings?

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

7. Please informed us about fertilizer application before plantation:

Name of fertilizers	Amount	Time	Methods

8. Please inform the following information regarding methods of Mango gardening that you follow:

Planting Materials	**Planting Method**	**Spacing**	**Precautions**

9. Please inform the application of different fertilizers in your Mango garden

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

11. Please mention the age of the tree, which gives the higher production ……. years

12. How can you identify the appropriate harvesting time (maturity time) of Mango

……
……
……
……

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

14. Please inform year wise production of Mango with age of plants:

Age category of Mango tree	Production
4-7 years	
8-13 years	

15. Please mention the following information about mango marketing

- Where and how you sell your product

- Do you get desired return? Yes/No

Please specify the reasons-

- Please advise the marketing infrastructures that is needed to improve marketing system that will help you to get maximum return

16. Do you think that your production is increasing day by day during previous 5 years' production status? Yes/ No

If Yes/ No, please notify……

17. Do you take any training from Agricultural training institute?

…….

D. Cost of Production and Net income (Jhum Crops):

1. Production cost

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

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

2. Net return/ Output

Item	**Rice**	Other crops
Sell price		
Own consumption		

.

E. Cost of Production and Net income (Mango):

3. Production cost

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

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

4. Net return/ Output

Item	Mango	Other crops
Sell price		
Own consumption		

(Thank You for Your Cooperation)

Date :…… **Signature :……...**

Appendix 2. Some Photographs Related to The Study

Plate 1. Data collection from farmer in Mahalchhari

Plate 2. Data collection from farmer in Panchhari

Plate 3.: Jhum cultivation plot in Dighinala

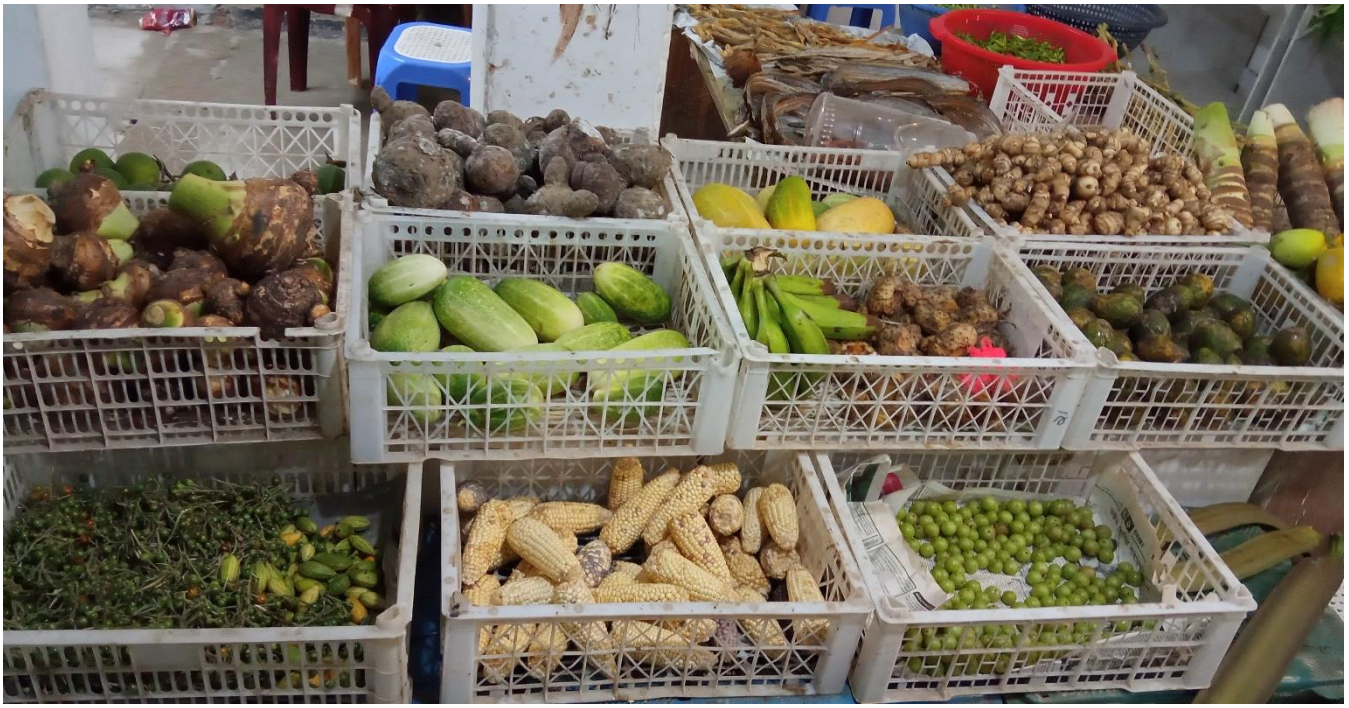

Plate 4: Jhum Crops

Plate 5: Jhum rice field in Dighinala

Plate 6: Mango Orchard in Khagrachari sadar

Plate 7. Jhum in Khagrachhari District

Plate 8. Burning down jhum area for jhum land preparation in Mahalchhari