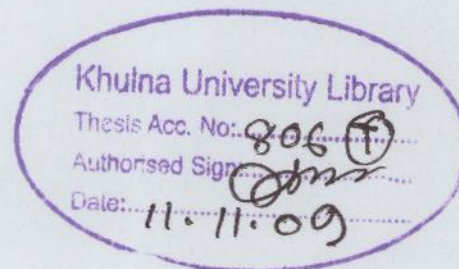


CAUSES AND CONSEQUENCES OF CHANGING CROPPING PATTERN IN KHULNA DISTRICT

A THESIS
BY



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DEDICATED TO
ALL OF MY TEACHERS
AND
MY YOUNGER SISTERS (SUMA AND SAMAPTI)

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The Author

ABSTRACT

The main objective of the study was to identify the changes in cropping pattern that has been occurred during the last 40 years as well as the farmers' perceptions regarding the causes and consequences of changing cropping patterns. The relationships between some of the selected characteristics of the farmers' and their perception regarding the causes and consequences of changing cropping patterns were explored. To fulfill the objectives data were collected from randomly selected 130 farmers of Batiaghata and Dumuri Upazilla of Khulna district. Data were collected during 01 May, to 07 July, 2008 by the researcher himself following several methods like personal interview, focus group discussion, field observation and systematic study of available records and browsing internet.

A remarkable change in cropping pattern during the last five decades was observed. In the study area, a total of 15 cropping patterns were identified over the times out of which 2 cropping patterns were 4-cropped, 3 were 3-cropped, 8 were 2-cropped and 2 were single cropped cropping patterns. Most dominant cropping pattern was single T. Aman – fallow. About 40 years ago, in the study area as observed, a total of 5 cropping patterns was practised. From the year 1967 – 1975 the polderization/embankment was made. From that time the number of cropping patterns was increased gradually. Before 30 years ago, a total of 6 cropping patterns were practised. About 15 years ago, *gher* was started in most of the study area and after that time a dramatical change was taken place in changing cropping pattern was observed in the study area. After starting *gher*, a total of 14 cropping patterns were practised in 15 years ago. But now-a-days, with a slight decrease i.e., 13 cropping patterns were observed to be continued. In both case, most of the observed cropping patterns were found in low land (11 cropping patterns in 15 years ago

and 9 cropping patterns in present status) and a majority was observed in medium high land and very low land. In both cases, a 1 – cropped cropping pattern (fallow – aman – fallow) was found to be the most dominant in all types of land topography and a 4 – cropped cropping pattern [*gher* (vegetables) – fallow – aman – boro] the second dominant mainly in medium high land and low land. In the study area, yield of different crops was found to increase with temporal variation. Farmers were generally found to practise traditional cultivation and post harvest technologies.

Most of farmers had high perception (83%) followed by medium perception (17%) regarding the causes of changing cropping pattern as well as high perception (90%) followed by medium perception (10%) regarding consequences of changing cropping pattern. Among the selected 14 causes of changing cropping patterns, the most important one was dependence on staple food while the least important one was starting of orchard as addressed by the respondents. Among the selected 7 consequences of changing cropping patterns, the most important one was the livelihood of people is increase due to high income from unit area of land while the least important one was introduction of mechanized cultivation. Among the selected characteristics of the respondents, none of the selected characteristics showed any significant relationship with the perception regarding causes of changing cropping patterns while only education showed a positive and significant relationship with the perception regarding consequences of changing cropping patterns.

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CHAPTER – I

INTRODUCTION

1.1 Background of the Study

During the last five decades the agriculture sector in Southwestern region of Bangladesh has undergone wide-ranging changes in terms of ownership of land, cropping pattern, cultivation practices, productivity, and intensity of cultivation. Bangladesh has an

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(United Nations, 1993), especially among the 87% of the population below the poverty line (International Fund for Agricultural Development, 1995).

Understanding the relationships among population, technology, and resources embedded in interpretations of such crises remains a fundamental problem confronting the human sciences (Kates, 1995), one viewed through many interpretive lenses (Turner, 1997). These relationships are critical to questions of agricultural change in Bangladesh and throughout the less-developed world in general, with serious implications for food production, nutrition and health, economic development, and sustainability.

The major cropping pattern in Bangladesh agriculture mostly consist of rice based cereal crops (Haque 1998). More than 60% of the total cropped area covered by Boro-T.aman rice cropping pattern in Bangladesh (FRG 1997). This is the dominant cropping pattern in medium high land area of Khulna region under high Ganges River floodplain (AEZ 13). The area and production of HYV Boro rice in Khulna region was 111134 ha and 342470 tones; meanwhile HYV T. aman rice was 184673 ha and 465840 tones, respectively (BBS 2004). Soil fertility and productivity changes over time and this change is towards negative direction because of intensive cropping with modern varieties, improper and imbalance use of fertilizer and manure (BARC, 2005).

There has been a massive change in the traditional cropping patterns of Bangladesh following the modernization of agriculture. In this paper an attempt has been made to analyse the nature of traditional cropping patterns and their subsequent changes in a selected area of Northern region of the country after the introduction of modern technologies in agriculture. The findings of the study suggest that prior to the introduction of modern technologies the area under study were mainly an aman mono-cropping area. The cropping patterns, however, were of two kinds: local T. aman - follow and local T. aman - rainfed Aus. The study further reveals a gradual changes in the cropping patterns

which the cropping pattern had been changed in several times. The study helped to identify the adverse effect that might be checked.

1.4 Objectives

The study was conducted to fulfill the following objectives:

1. to identify the cropping patterns in last 40 years,
2. to identify the causes of change in cropping patterns,
3. to identify the consequences of changing cropping patterns.
4. to explore the relationship between some of the selected characteristics of the respondents and their perception regarding the causes and consequences of changing cropping pattern.

1.5 Scope and limitation of the study

The study might help to identify our indigenous technology for crop cultivation as well as the conservation of the beneficial technologies. After identifying the causes and consequences, adaptation of new crops, their technology of production, preservation might be possible. Besides these, the negative effects of the changes on agriculture, environment, society, economy of the country might be checked.

There were some limitations of the study which have been described below:

- The study was confined to a selected one union of Batiaghata and two unions of Dumuria upazila under Khulna district. So the findings of the research have limitations for the applications particularly in other areas of the district as well as other region of the country.
- The resource availability and time constraints limited the coverage of investigation.

- The researcher was depended on the data that were furnished by the respondents, focus group discussants during the interview as well as the data of secondary sources.

1.6 Hypothesis

The following null hypotheses were put forward for this study:

1. There is no change of cropping pattern in the study area.
2. There is no cause and consequence of changing cropping pattern.

CHAPTER – II

REVIEW OF LITERATURE

The literature review is primarily directed to an overview of coastal embankment and land use pattern in Khulna district, cropping patterns, change in cropping patterns, causes and consequences of changing cropping patterns.

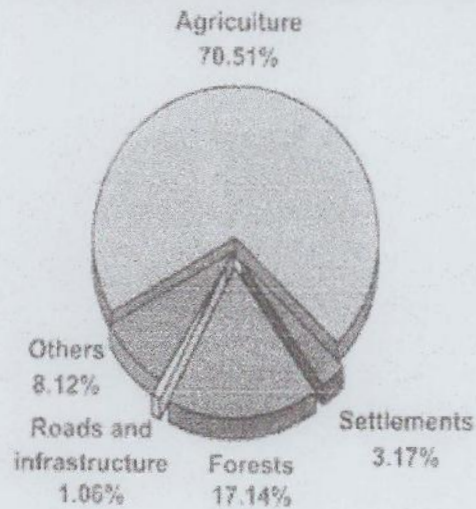
2.1 Coastal embankment and land use patterns in Khulna district

The coastal area of Bangladesh is located in the greater Khulna, Barisal, Patuakhali, Noakhali and Chittagong. It is the vast plain at the apex of the Bay of Bengal bounded with India and Myanmar. The area includes the world's largest continuous mangrove forest, estuarine marshlands and numerous rivers, canals and their tributaries (Viju, 1995; Giri and Shrestha, 1996). The coastal area is subjected to regular or periodic incursions of saline water from the Bay of Bengal, resulting in serious damage to crops and land fertility. Construction of small dyke or embankments around individual land plots separated by numerous tidal creeks and inlets have been practiced since the seventeenth century by *Zamindars* or landlords (who served as principal revenue agents to the Government) to limit saline water overflow. With the abolition of the *Zamindari* system in 1947, the construction of embankments by local efforts practically ceased and the condition of the existing embankments deteriorated due to lack of proper maintenance (Uddin and Islam, 1982).

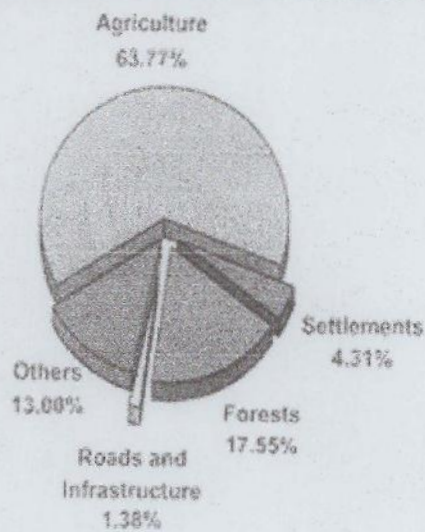
The need to protect the coastal area was recognized by the then East Pakistan Government soon and reconstruction and development of the embankments was started in 1961. In 1967, CEP (Coastal Embankment Project) was taken to provide flood control works by constructing new embankments or repairing and strengthening existing ones

On the other hand, trend of land use pattern can be shown by the following Figure 2.2.

Proportions of Area under Different Land Use (1983/84)



Proportions of Area under Different Land Use (1996/97)



Source: www.sdnpdb.org

Figure 2.2. Trend of land use pattern of Bangladesh

2.2 Cropping patterns

Local T. aman paddy is the single major crop grown extensively in the Khulna region (Razia and Iqbal, 1988). The effect of salt water intrusion both through surface and ground water have long been recognized as a limiting factor to the sustainable development of agriculture in southern region of the country Karim *et. al*, 1990). Nuruzzaman (1990) showed in his study that shrimp cultivation has reduced both percentage of land under paddy cultivation and yield of paddy per unit area where soil salinity has been increased.

In the absence of any other significant natural resources, the economy of Bangladesh has essentially evolved as agriculture oriented over country and agriculture in turn is critically on land and water both of which are scare at one time or other. Every cultivable inch of land is under cultivation and no new land is available to produce more food for an increasing population. On the contrary, the available arable land is shrinking every day for new settlements and physical infrastructure (Ahmed and Samsuddula, 2000).

Farming everywhere followed similar cropping schedules, corresponding to the seasons noted above if not impeded by environmental problems. Land was raised and lowered over time to deal with local flood regimes and was prepared largely with "traditional" tillage technologies. Rice cultivation involved considerable field preparation, including leveling and bunding. Local and high-yielding varieties (HYV) of rice were used, as were fertilizers and pesticides (Asaduzzman, 1979). In the northwestern and winter seasons, HYV rice required irrigation water supplied through special projects or by way of low-lift pumps. Rice yields were low by global and Asian standards, created by poor access to and inefficient use of inputs, the impacts of flooding on them, and inadequate irrigation (Khan, 1972). Jute was the next most important crop to rice, grown totally for an international market (Akiyama, 1985). Dwarf wheat increased among farmers in the mid-

1980s as did mustard, rape, pulses, and sundry vegetables. Market gardening and off-farm activities were increasing in peri-urban locales (Ali, 1980). The sheer marginality of most farm households, however, required that they produce the majority of their own food, which was only sold under conditions of normal surplus (rare) or duress (e.g., debt).

2.3 Changes of cropping pattern

Recently a growing number of farmers have placed more emphasis on dike crops and fish, and decreased the focus on the prawn component. This change has been partly the result of external factors that have strongly affected prawn production in 1997-98 and which increased the vulnerability of 'gher' operator. In 1997, a threatened import ban on prawns from Bangladesh led to lower selling prices for producers. In 1998, the cost of post-larvae was four times that of 1997 due to a poor wild-catch of post-larvae. Prawn farming mainly takes place in the district of Sathkhira, Khulna, Bagerhat in the Southwestern region of Bangladesh (Ahmed and Samsuddula, 2000).

During the past three decades the agriculture sector of Kerala has undergone wide-ranging changes in terms of ownership of land, cropping pattern, cultivation practices, productivity, and intensity of cultivation. Unlike the other regions in India, the farm front of Kerala is characterised by extreme diversity in its bio-physical resource base and agro-climatic endowments providing multiple opportunities for raising a variety of crops. In earlier periods, the choice of cropping pattern was guided by agronomic considerations and consumption needs of farmers; but it seems that mainly market forces determine the emerging trend. Official figures show that agricultural income in Kerala which showed a steady growth up to the mid-seventies, began to decline thereafter and showed a vacillating trend in the eighties. This change is mainly attributed to the shift in area from seasonal/annual crops to high-value-yielding perennial cash crops having a long gestation

period. By the end of the eighties, cash crops started generating higher income to the farm sector. Therefore, during the past five years agricultural income has started rising. However, the questions whether this performance is sustainable and the emerging cropping pattern is in the best interest of the State, require serious consideration (Mahesh, 1999).

Manavalan *et al.* (1995) detected change in cropping patterns in two successive campaigns by developing an image differencing algorithm involving the near infrared and red bands (IRS-LISS 2 data).

Analysis of changes in the cropping pattern in Himachal Pradesh revealed that during the period 1970-90 the area under fruit crops registered an increase of 6% per annum, followed by wheat (1.5%), vegetables (1.31%), maize (1.19%) and spices (1.07%). On the other hand, the area under non-green revolution crops--pulses, barley, paddy and oilseed--decreased at the annual rates of 3.90, 1.47, 0.57 and 0.12% respectively (Dahiya *et al.*, 1991).

In this phase, field trials with cropping patterns, new crop varieties, and agronomic techniques continued. It was noted that farmers (especially small-scale farmers) had made major changes in their crop production methods. Results showed that yields could be increased by 30% and income by 50% from the main rice crop. As well, new cropping patterns were developed and adopted by farmers on research sites (Projects in Bangladesh: <http://www.idrc.ca/en>).

2.4 Causes of changing cropping pattern

Mahesh (1999) found out some promising causes of changing cropping patterns which were i) Demand for land for non-agricultural purposes, ii) State-intervention, iii) Technological changes, iv) Increase in pressure on land and v) Neighbourhood aspects.

The major cropping pattern in Bangladesh agriculture mostly consist of rice based cereal crops (Haque, 1998). More than 60% of the total cropped area covered by Boro-T.aman rice cropping pattern in Bangladesh (FRG, 1997). This is the dominant cropping pattern in medium high land area of Khulna region under high Ganges River floodplain (AEZ 13). The area and production of HYV Boro rice in Khulna region was 111134 ha and 342470 tones; meanwhile HYV T. aman rice was 184673 ha and 465840 tones, respectively (BBS, 2004). Soil fertility and productivity changes over time and this change is towards negative direction because of intensive cropping with modern varieties, improper and imbalance use of fertilizer and manure (BARC, 2005). Again crops grown in different cropping patterns and environment responded differently to fertilizer nutrients. Mineral fertilizer inputs are the crucial factors to the overall nutrient balance in intensive cropping systems (Islam and Haque, 1998).

Mallick (2008) reported that a range of climate change consequences such as extreme weather, ecosystem changes, cropping pattern changes, inundation, migration, disease, food and livelihood security.

Changes in the thermal climate due to inter-annual climatic variability can potentially modify existing cropping pattern by forcing farmers to rearrange transplanting and harvesting dates. The study finds that under abnormally cool conditions transplanting dates will be pushed well into February to avoid plant injury and harvesting dates will be moved into the monsoon. The growing seasons will be longer under cooler than normal thermal conditions. Under abnormally warm conditions harvesting dates will be established well into March and will cause reduction of yield due to a shorter growing season. These conditions will also cause spatial shift in crop potential and changes in the cropping pattern. Due to a longer Boro rice growing season farmers will lose a significant amount of cropping land which is usually used for low and deep water rice cultivation.

New crops will need to be introduced during the beginning of a year to overcome the loss of production under abnormally cool conditions. Wheat and potato can be good options for the farmers for such conditions. New aus rice variety needs to be introduced after the boro harvesting under warmer than the normal conditions to overcome the loss of yield due to a shorter growing season (Mahmood, 1998).

Turner and Ali (1996) reported changes in agricultural intensity and, by implication, changes in the technology and management of cultivation. It employs an understanding of small-holder farming behavior in which variations exist in the production goals and rules of manipulating labor and capital toward those goals. This variation follows from the proportion of cultivation for subsistence and market and draws on behavior detailed in two ideal models.

Environmental constraints on agricultural change were profound, increasing the six village explained variance for cropping frequency to 68% (2A) of which 51% followed from the constraint index alone and for land productivity to 73% (2B). The low-performing villages, which were highly constrained by flooding and inadequate water, accounted for most of this outcome. Virtually no improvement in the explained variance in intensity was found for the high-performing villages by considering environmental variables (Turner and Ali, 1996).

Agricultural production critically depends on suitable climate and soil conditions, as well as direct human management. Although technology – including irrigation and fertilizer use – has extended the boundaries of cultivation, many large regions of the world are still unsuitable for crops. Using land use datasets and ecological modeling tools, we examine the links between land use practices, agricultural production, and the underlying patterns of climate and soil quality. Some of our initial results indicate a disturbing trend: the regions of the world with the least suitable agricultural lands are likely to be the ones hit

hardest by increasing population and possible changes in climate (Agricultural System: <http://www.sage.wisc.edu/pages/agriculture.html>).

2.5 Consequences of changing cropping pattern

The immediate result of the change in the crop pattern is the reduction in rice production. The annual production came down to 9.53 lakh tonnes in 1995-96 from 13.65 lakh tonnes in 1975-76 despite the increase in productivity of rice cultivation. Consequently, dependence of Kerala on other States for rice has increased. Rice-based farming system and cattle-rearing are inter-dependent activities. Sharp decline in the area under rice reduced the availability of straw which, in turn led to reduction in the number of draught animals and working bullocks in the farm sector, and to replacement of local variety of milch animals by high-yielding cross breed varieties. This development led to decline in the availability of farmyard manure and break down of the traditional farming sector. Since most of the farmers prefer to keep rice lands fallow during summer, production of pulses, sesame, sweet potatoes, etc have come down significantly. This change, together with reduction of area under tapioca, which is a cereal substitute, has affected the food availability for the poor adversely. While increase in the area under cash crops like coconut, rubber, and pepper helped to increase farm income, changes in cropping-pattern in favour of perennial crops have an immediate and direct impact on the employment pattern in the rural area. The shrinkage of rice cultivation and other seasonal crops has displaced agricultural labour especially women from the farm sector. Although cultivation of perennial crops like coconut and rubber provided work to large numbers in the initial stages, it has not absorbed any sizeable portion of the farm labour displaced from rice cultivation. The change in the seasonal pattern of work has affected the rhythm of village life. The change in cropping pattern has lowered the bio-diversity in the rural

area. Not only does it affect the environment; it worsens the living conditions of the rural masses that depend on natural resources for their survival as well. Moreover, in the context of globalisation of the economy and trade liberalisation, cash crops will have to face severe competition in the global as well as international markets. As the emerging crop-pattern is dominated by export-oriented cash crops spread over thousands of small holdings, getting effective control over the market forces will be a difficult problem for them (Mahesh, 1999).

Over the past two decades the principal sources of growth came predominantly from irrigated boro rice, followed by aman (wet season) rice and, to a small extent, wheat. The success in accelerating rice production in the 1980s can be attributed almost entirely to the conversion of local varieties to modern HYVs and, as a result of changes in the policy environment, the adoption of irrigation and fertilizer technologies, which has enabled intensive use of the boro months. As a result of the heavy emphasis on rice production, yields of other non-cereal crops such as pulses, potatoes, oilseeds and vegetables have stagnated. Land used previously for pulses has been converted for rice production. There have been modest increases in the yields of local rice but the average local yields have been only half of those of the HYV rice. However, of late, it is the yield of modern varieties that is showing signs of stagnation. With rice occupying almost 75 percent of the cropped area, followed by wheat which occupies approximately 4 percent and jute which occupies approximately 3 percent, less than 20 percent of the cropped area is devoted to a range of other crops. It appears that the benefits of crop diversification in the country are well known and have been recognized for a long time. (SOFA, 1997).

CHAPTER – III

METHODOLOGY

In any scientific research methodology plays an important role. Research methodology is a systematic way to solve any research problem. Appropriate methodology enables the researcher to collect valid and reliable information and to analyze the information properly in order to achieve a correct conclusion. The methods and procedures followed in conducting this study have been described in this chapter.

3.1 Design of the study

In the study, two approaches have been used: (i) a statistical survey to assess the existing as well as previous cropping patterns in the area, and (ii) a study carried out with participation of local people using Participatory Learning Methods to understand how the local population perceives the changes in cropping pattern.

3.2 Locale of the study

The study was conducted at four villages (Chakrakhali, Sachibunia, Bashbaria and Hogladanga) of Jalma union under Batiaghata and three villages (Banda, Ghona and Taltala) of Vandarpara union and three villages (Gutudia, Bardanga and Jhilerdanga) of Gutudia union under Dumuria Upazila of Khulna District. A short description Batiaghata and Dumuria Upazila has been given below:

3.2.1 Batiaghata upazila

Batiaghata Upazila (Khulna district) with an area of 248.33 sq km, is bounded by Kotwali (Khulna), Dumuria and Rupsa upazilas and Sonadanga thana on the north; Dumuria upazila and Paikgacha upazila on the west; Dacope, Paikgacha and Rampal upazilas on

the south; Rampal, Fakirhat and Rupsa upazilas on the east. The main rivers are Kazibachha, Shoilmari, Salta, Jhopjhopia, Pasur, Sibsa, Rupsa and Nalua.

Batiaghata (Town) is situated on the banks of the river Kazibachha, 10 km. south from Khulna city and on the west of Khulna-Chalna road. It consists of 2 mouzas. It has an area of 8.3 sq km. The town has a population of 6224; male 52.06%, female 47.94%; density of population is 1750 per sq km (Banglapedia).

Administration

Batiaghata Thana was established in 1863 and was turned into an upazila in 1984. The upazila consists of 7 union, 158 mouzas and 121 villages (Banglapedia).

Land use

Total cultivable land 18494.53 hectares, fallow land 60.70 hectares; single cropped area 87.74%, double cropped area 11.27%, tripple cropped area 0.99%. Average cultivable land per head is 0.15 hectares (Banglapedia).

Land control

Among the peasants 32% are landless, 30% small, 25% medium and 13% large farm holders (Banglapedia).

Value of land

The market value of the land of the first grade is around Tk 5000 per 0.01 hectare (Banglapedia).

Main crops: Paddy, sesame, oil seed, onion, and garlic (Banglapedia).

Endangered crops: Jute (Banglapedia).

Main fruits: Coconut, betel nut, mango (Banglapedia).

Fisheries, dairies, poultries: Fishery 644, prawn gher 501 (golda), shrimp gher 143 (bagda), dairy farms 19, hatchery 1, poultry farms 48 (Banglapedia).

3.2.2 Dumuria upazila

Dumuria Upazila (khulna district) with an area of 454.23 sq km. is bounded by Manirampur, Abhaynagar and Phultala upazilas on the north; Batiaghata and Paikgachha upazilas on the south; Khan Jahan Ali, Khalishpur and Sonadanga thanas and Batiaghata upazila on the east; Tala and Keshabpur upazilas on the west. Main rivers are Shibsa and Shengrail; Beel Dakatia is notable.

Dumuria (Town) consists of 4 mouzas with an area of 6.93 sq km. It has a population of 14189; male 52.09%, female 47.91%; density of population is 2047 per sq km.

Administration

Dumuria Thana was established in 1918 and was turned into an upazila in 1983. It consists of 14 union, 183 mouzas and 230 villages (Banglapedia).

Population

Total population 256503; male 51.12%, female 48.88%; Muslim 56.97%, Hindu 42.83%, Christian 0.01%, Buddhist 0.01%, and others 0.09% (Banglapedia).

Main occupations

Agriculture 46.29%, Agricultural labourer 16.77%, wage labourer 4.09%, commerce 12.85%, industry 2.01%, transport 3.24%, service 4.66% and others 10.08% (Banglapedia).

Land use

Total cultivable land 31340 hectares; fallow land 3240 hectares; single cropped area 36.52%, double cropped area 33.82% and tripple cropped area 29.66% (Banglapedia).

Land control

Among the peasants 20% are landless, 28% small, 32% medium, and 0.8% large farm holders; cultivable land per head 0.12 hectares (Banglapedia).

Value of land

The market value of the first grade agricultural land is around Tk.13000 per 0.01 hectare (Banglapedia).

Main crops: Paddy, jute, vegetables (Banglapedia).

Endangered crops: Sesame (Banglapedia).

Main fruits: Mango, jackfruit, coconut, betel nut (Banglapedia).

Fisheries, dairies, poultries: Hatchery 1, fishery 12000, poultry farms 285, dairy farms 88 (Banglapedia).

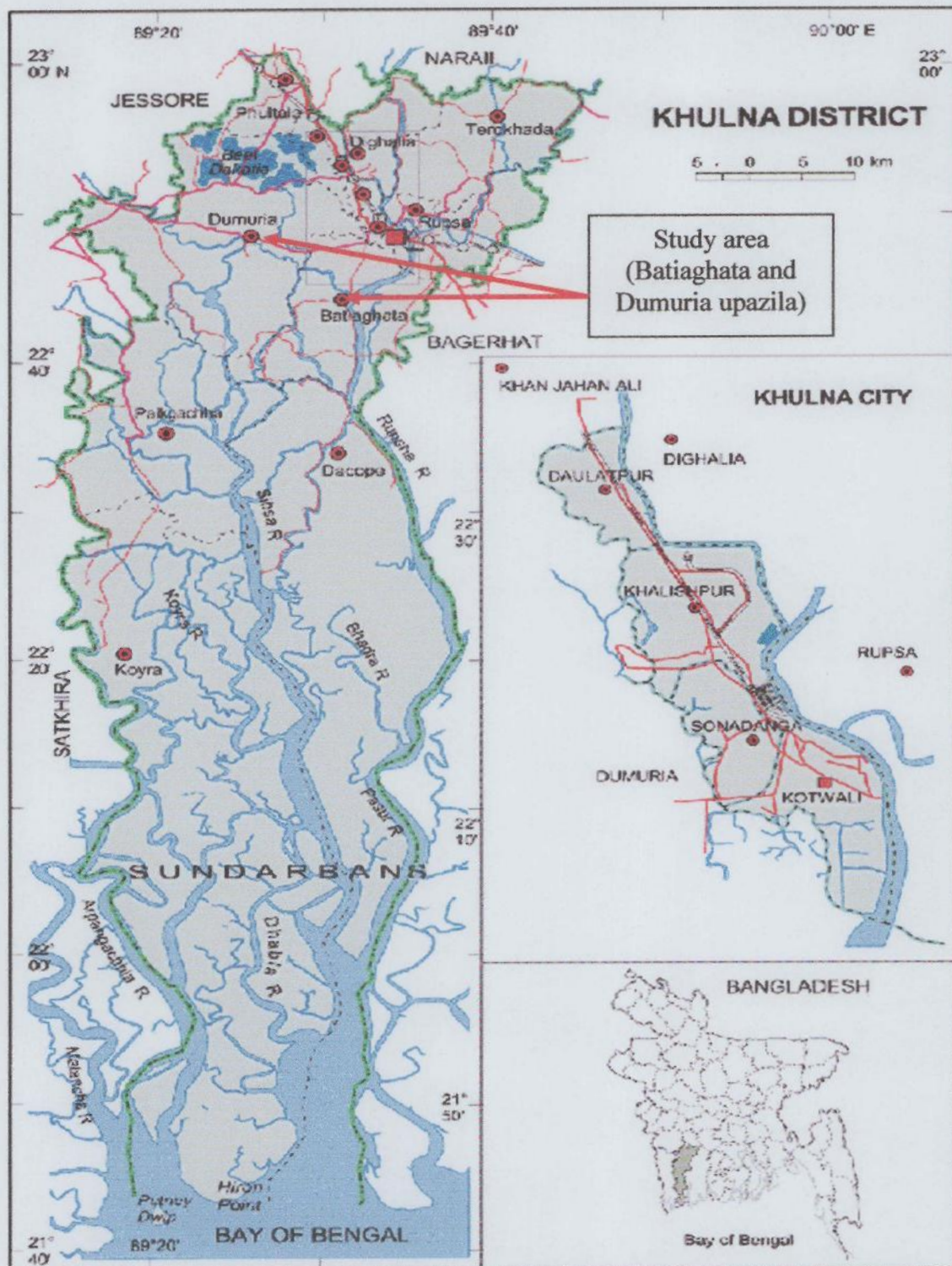


Figure 3.1. Map of Khulna district

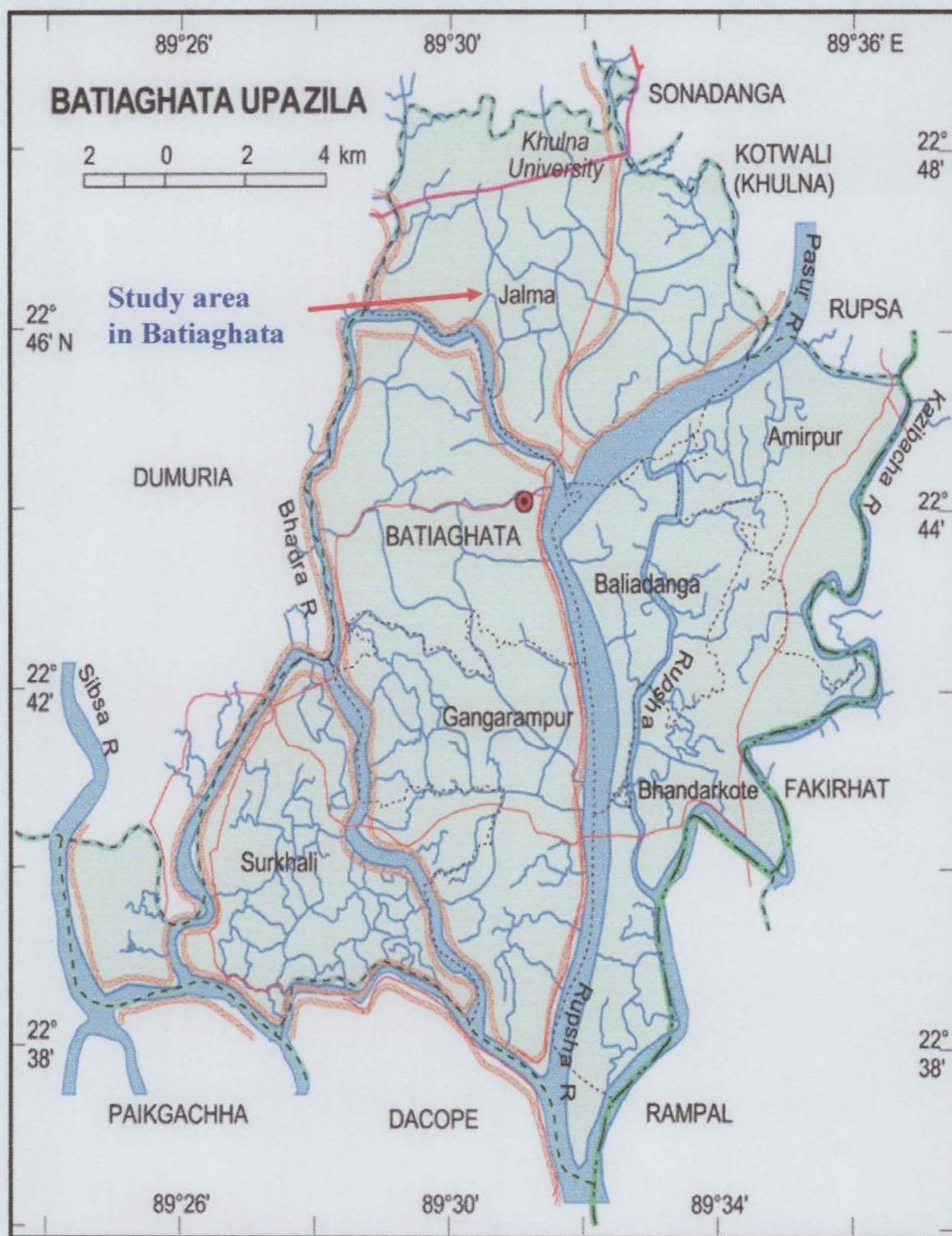


Figure 3.2. Map of Batiaghata Upazila



Figure 3.3. Map of Dumuria upazila

A flow chart showing step by step selection of the study area is presented below (Figure 3.4).

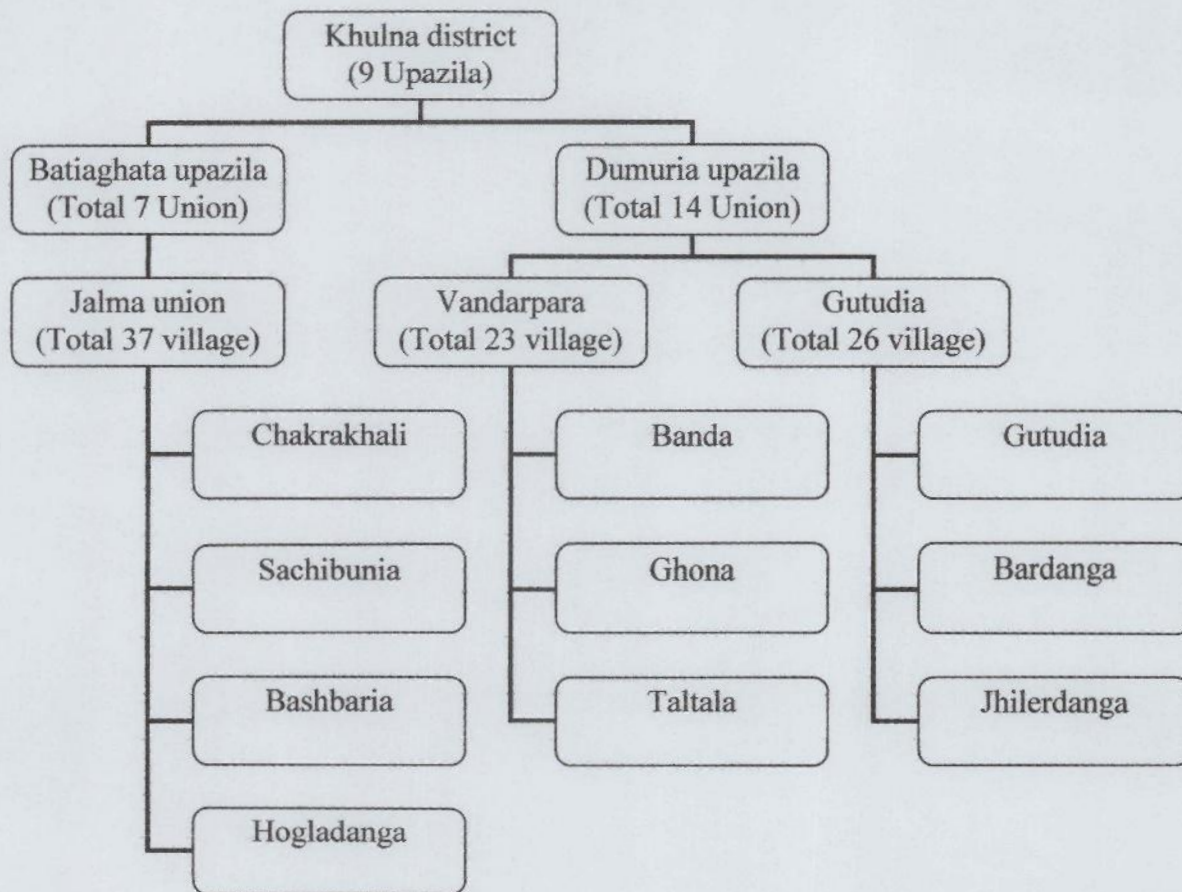


Figure 3.4. Flow chart showing step by step selection of the study area

3.3 Unit of analysis

The unit of analysis of this study was the farmers of the selected study area particularly who are more than 50 years of old.

3.4 Sampling design

For data collection, 20% upazilas out of total upazilas in Khulna district were selected and then 10% union from each upazila and 10% villages in each union were selected. From 10 (10% of total) villages of two upazilas, a total of 130 farmers were selected randomly. The farmers were selected on the basis of age i.e., the farmers who were found

to be more than 50 years of old to fulfill the objectives of the study. Among all the above 50 years old farmers more than 40% farmers in each village of the study area were selected to be interviewed. The distribution of the respondents is shown in the Table 3.1.

Table 3.1. Distribution of the sampled farmers

Study area			Population (above 50years old)	Number of sampled farmers	Total sampled farmers
Khulna District					
Batiaghata Upazila	Jalma Union	Sachibunia	40	16	54
		Chakrakhali	36	15	
		Bashbaria	22	9	
		Hogladanga	33	14	
Dumuria Upazila	Vandarpara Union	Banda	42	17	76
		Taltala	30	13	
		Ghona	27	11	
	Gutudia Union	Gutudia	31	13	
		Jhilerdanga	35	14	
		Bardanga	18	8	
Total			314		130

3.5 Instrument for data collection

An interview schedule was used as the research instrument in order to collect relevant information from the respondents. The interview schedule was prepared (Appendix 1) considering the objectives of the study and it was used to collect valid and reliable information from the respondents. The schedule contained both open and closed form of question. Most easy, simple, direct questions and different scales were used to collect information. The schedule was pretested and necessary correction and modification were made before final collection of data.

3.6 Data collection

Data collection for the study was done by the researcher himself mainly through face to face interview using the interview schedule. The researcher made all possible efforts to establish desired rapport with the respondents in order to get valid and pertinent information from the respondents. The other relevant data were collected by several methods such as focus group discussion, field observation, and systematic study of available records, and browsing internet.

After completion of interview each statement was checked and verified for proper recording of data. Good cooperation was received from all of the respondents during interview. To make the data reliable, primary collected for the respondents were checked and verified with secondary data regarding cropping pattern available at BBS, Bhumi Nirdeshika etc. Data were collected during May 01 to July 07, 2008 by the researcher himself.

3.7 Specification and measurement of variables

A variable is any characteristic, which can assume varying or different values in successive individual cases (Ezekiel and Fox, 1959). A well organized piece of research usually contains at least two important elements, viz. an independent variable and a dependent variable. An independent variable is that variable which is manipulated by the researcher in his attempt to ascertain its relationships to an observed phenomenon. A dependent variable is that variable which appears, disappears or varies as the researcher introduces, removes or varies the independent variables (Townsend, 1953). In a scientific research the selection and measurement of variables constitutes a significant task. In this connection, the researcher reviewed literature to widen his understanding about the nature and scope of the variables relevant to this piece of research.

3.7.1 Measurement of independent variables

In case of perception study, the independent variables of the study were the selected characteristics of the farmers. It is very difficult to identify all possible characteristics related to farmers. Also it is not particularly possible to include and investigate all possible independent variables. Therefore, only 4 important characteristics of the respondents such as age, education, family size and farm size were studied. For clarify of understanding, the procedures for measurement of these independent variables are furnished below.

3.7.1.1 Age

The age of an individual is one of the most important factors pertaining to his personality make up (Ahmed, 2003) which may play an important role in his perception. The age of a respondent was measured in terms of years at the time of interviewing. The respondents were asked directly about their age. Item number 3 in the interview schedule (Appendix 1) indicates age of the respondent.

3.7.1.2 Education

The education of an individual helps him in acquiring information and knowledge from reading books, newspapers, leaflets and other printed materials to solve multifarious problems in everyday life. It broadens the capacity of unerderstanding and judgement. The education of respondent was measured in terms of years of schooling. For example, a respondent has passed class V, his education score was 5. Item number 4 in the interview schedule (Appendix 1) indicates the education of the respondent.

3.7.1.3 Family size

Family size of the respondent was defined as the number of individuals in the family including himself, his wife, children and other dependent members who live under same

roof and share same kitchen. The total number of family members was considered as the family size score of the respondent. Item number 3 in the interview schedule (Appendix 1) indicates family size.

3.7.1.4 Farm size

Land is the most important resource to a farmer and farm size has influence on many personal characteristics of a farmer. It can be one of the important factors, which may influence the perception of an individual. Since differences in farm size may necessitate different types and quantities of information. Total land (Appendix – I, item number 6) of the respondent was measured in hectare according the following formula:

$$\text{Total land } A = A_1 + A_2 + \frac{1}{2}(A_3 + A_4) + A_5$$

Where, A = Total land

A_1 = Homestead area

A_2 = Own land under own cultivation

A_3 = Land under share cropping in

A_4 = Land under share cropping out

A_5 = Land leased in

3.7.2 Measurement of dependent variables

In case of perception study, the perception of the respondent regarding the causes of changing cropping patterns and the consequences of changing cropping patterns were treated as dependent variables.

3.7.2.1 The causes of changing cropping patterns

A statement with 14-item was used to determine the respondent's perception regarding the causes of changing cropping patterns. A 3-point Likert's type scale such as agree, undecided and disagree were employed against each of 14 statements (Appendix 1; item

24) to determine the perception of the respondent regarding the causes of changing cropping patterns. A score of 3, 2 and 1 were assigned against the scales agree, undecided and disagree, respectively.

14-item statements used to determine the respondents' perception regarding the causes of changing cropping patterns are as follows.

1 = Dependence on staple food

2 = Income from unit area for cultivation of staple food is high

3 = Lack of knowledge about balanced nutrition from other crops

4 = Lack of availability of high yielding rabi crop varieties

5 = Low yield of rabi crops

6 = Introduction of shrimp/prawn farming as a high return

7 = Land leased out for shrimp cultivation

8 = For cultivation of finfish

9 = For starting orchard

10 = For tree plantation

11 = Change in utilization patterns of agricultural implements

12 = Demand of land for non-agricultural process (commerce, industry, Transport)

13 = Increasing pressure on land (Mainly for population)

14 = Neighbourhood aspects: Changes in the farming practices and crop

The perception score regarding the causes of changing cropping patterns were determined by summing up all the scores obtained against each of the 14-statements.

3.7.2.2 Consequences of changing cropping patterns

A 7-item statement was used to determine the respondents' perception regarding the consequences of changing cropping patterns. A 3-point Likert's type scale such as agree, undecided and disagree were employed against each of 7 statements (Appendix 1; item

26) to determine the perception of the respondent regarding the consequences of changing cropping patterns. A score of 3, 2 and 1 were assigned against the scales agree, undecided and disagree respectively.

7-item statements used to determine the respondents' perception regarding the consequences of changing cropping patterns are as follows.

1 = The year – round distribution of labors

2 = The livelihood of people is increasing due to high income from unit area of land

3 = Health hazard/imbalance or malnutrition

4 = Introduction of mechanized cultivation

5 = Change in utilization patterns of agricultural implements

6 = Lowering bio-diversity

7 = Decreasing dairy farming.

The perception scores regarding the consequences of changing cropping patterns were determined by summing up all the scores obtained against each of the 7-statement.

Besides, the data were also collected regarding the cropping patterns in different years, yield of different crops in different years as well as production and post-harvest technology (technology used in land preparation, seed technology, fertilizer and manure application practices, intercultural operations, pesticidal application practices, harvesting and post-harvest practices).

Cropping patterns in different years

Cropping pattern is the yearly sequence and spatial arrangement of crops or of crops and fallow on a given area of land. The cropping patterns that are being practiced by the respondents for different years were recorded. Item number 9, 11, 13 and 15 in the interview schedule (Appendix 1) represent the cropping patterns.

Yield of different crops in different years

Yield of different crops that the farmers have been cultivating under different cropping patterns was recorded and calculated in ton/hectare. Item number 10, 12, 14 and 16 in the interview schedule (Appendix 1) represent yield of crops.

Technology used in land preparation

Different technologies are being practiced by the respondents for several years and these technologies were recorded. Item number 17 in the interview schedule (Appendix 1) represents technology used in land preparation.

Seed technology

What types of seed technologies the farmers have been practiced in several years were recorded and item number 18 in the interview schedule (Appendix 1) represents the seed technology.

Fertilizer and manure application practices

Fertilizer and manure application practices that the farmers have been using for several years were recorded. Item number 19 in the interview schedule (Appendix 1) represents the fertilizer and manure application practices.

Intercultural operations

Different types of intercultural operations, their methods and implements used by the farmers in different time were recorded and item number 20 in the interview schedule (Appendix 1) represents the intercultural operations.

Pesticidal application practices

Pesticidal application practices that practiced by the farmers in several years were recorded. Item number 21 in the interview schedule (Appendix 1) represents the pesticidal application practices.

Harvesting and post-harvest practices

Different methods and implements/devices have been being used harvesting and post harvest practices in several years and were recorded. Item number 22 in the interview schedule (Appendix 1) represents the harvesting and post-harvest practices.

3.8 Data processing

The data obtained through interview schedule were coded and tabulated in a data sheet. In some cases, qualitative data were converted to quantitative data by means of suitable scoring to facilitate interpretation. Local units were converted into standard unit scales.

3.9 Statistical analysis of data

After processing, data were entered in statistical software (SPSS) for further analysis. The SPSS program is quite good and useful for recording, categorizing, tabulation and computing various simple statistics. All personal traits were categorized and arranged in simple tables for description. The respondents were also categorized based on their perception scores. MS Excel, statistical software was also used for graphical presentation of data. For presentation of data statistical treatments such as number, percent, mean, and standard deviation were used. To test the relationship between two variables, Pearson Product correlation co-efficient was employed.

CHAPTER – IV

RESULTS AND DISCUSSION

Presented in this chapter are the findings of the study and interpretation of results. These are conveniently presented according to the objectives of the study even sections of this chapter. The study investigated the causes and consequences of changing cropping patterns. The study also explored the relationship between 4 characteristics of the respondents and their perception of causes and consequences.

4.1 Socio-economic profile of the respondents

Behavior of an individual is largely determined by his characteristics. These characteristics were age, education, family size and farm size.

4.1.1 Age

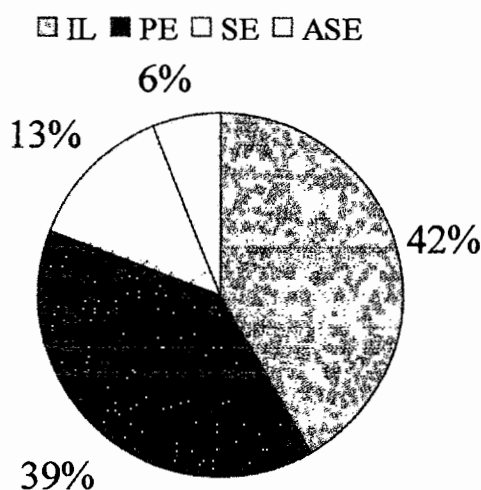
The age of the respondents ranged from 51 – 76 with an average and standard deviation of 61.29 and 6.62, respectively (Table 4.1). The respondents were classified into three categories as shown in the Table 4.1. This classification has the agreement with Ahmed (2003). Most of the respondents were younger old (51 – 60 years) and the lowest were older old (> 70 years). This was because to fulfill the objectives of the research though the data were collected from the respondents of the age above 50 years the respondents above 70 years old were found rarely as the national average life time is 67 years.

Table 4.1. Age of the respondents

Characteristics	Categories (Scores)	Number of respondents	Distribution of respondents (%)	Obtained score (Possible score)	Mean	Standard Deviation
Age	Younger old (51 – 59 years)	68	52.31			
	Medium old (61 – 70 years)	49	37.69	51 – 76	61.29	6.62
	Older old (> 70 years)	13	10			
	Total	130	100			

4.1.2 Education

On the basis of data, the respondents were classified into four categories as shown in the Figure 4.1. More than 41% respondents belonged to illiterate group followed by primary (39.23%), secondary (13.08%) and above secondary (6.15%). The range, average and standard deviation regarding education of the respondents were 0 – 14, 2.52 and 3.78, respectively (Supp. Table 4.1).



Note: IL = Illiterate, PE = Primary Education, SE = Secondary education and ASE = Above secondary education

Figure 4.1. Educational status of the respondents

4.1.3 Family size

The family size of the respondents ranged from 3 – 13 with an average and standard deviation of 6.47 and 2.30, respectively (Supp. Table 1). The respondents were classified into 3 categories as shown in the Figure 4.2. Majority (45%) of the respondents was in the large group (above 6 family members) followed by medium group (4 -5 family members) 38% and small (upto 4 family members) 17% as shown in the Figure 4.2. It indicates that majority of the respondents are fond of joint family though in some cases, it was found that they were not conscious about family size and population growth.

■ Small ■ Medium □ Large

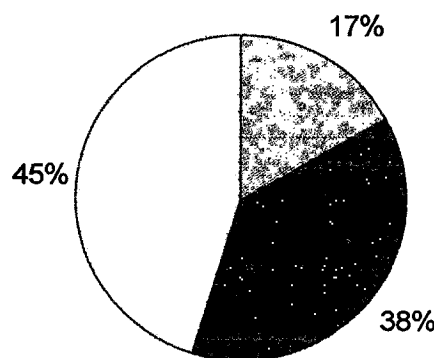


Figure 4.2. Distribution of respondents according to their family size

After conducting a study, Begum (2004) reported that the size of the family was observed as 4.59 persons where nearly half of the respondents (48%) having less than five members. Age of the respondent, number of children, age of the first and last child, average monthly income, number of rooms in the house, persons living in the main dwelling houses, number of earning persons having audio-visual assets had statistically significant association with the size of the family and all were with higher percentage in

big family. But in the study area, as most of the respondents had been found to have large family because of their age of the respondents, their educational status, farm size, socio-economic condition of the respondents. Moreover, majority of the respondents were observed to be fond of joint family though in some cases, it was found that they were not conscious about family size and population growth.

4.1.4 Farm size

The range, average and standard deviation regarding farm size of the respondents was 0.1 – 6.07 ha, 1.01 and 1.01, respectively (Supp. Table 1). The respondents were classified into 5 categories according to BBS (1993) on the basis of their farm size shown in the Figure 4.3. The results indicate that the respondents on an average possessed larger size of farms (1.01 ha) than the national average 0.891 ha. In Bangladesh, most of the farmers (95.06%) have small to medium farm holdings (Anon., 1993) i.e., only 4.94% have large size of farm. As against 7% of the respondents in the study area have large size of farm where as 7%, 23%, 30% and 33% of the respondents were in landless, marginal, small and medium farm holdings group, respectively.

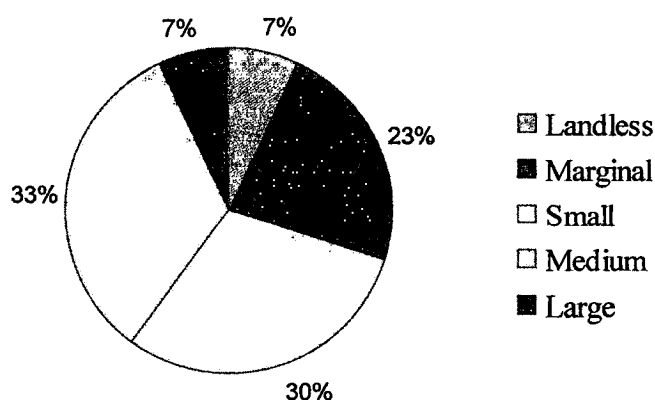
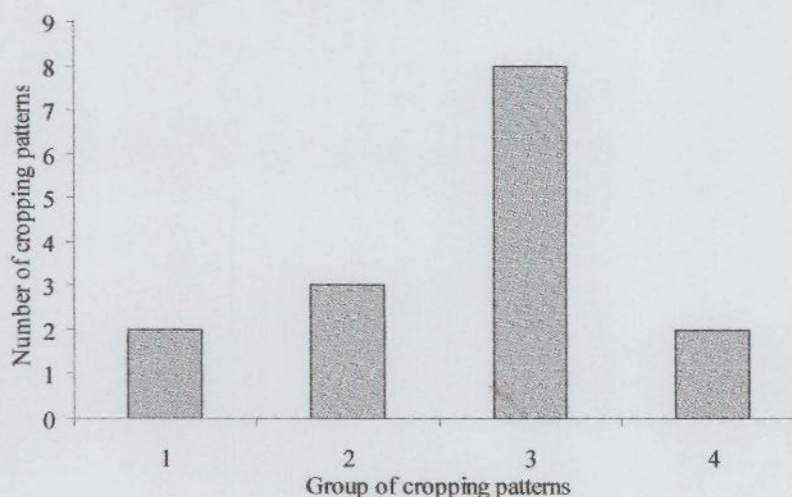


Figure 4.3. Different groups of respondents according their farm size

4.2 Identification of Cropping patterns in different years

In the study area, a total of 15 cropping patterns were identified (Supp. Table 2) over the times among which 2 cropping patterns were 4-cropped, 3 were 3-cropped, 8 were 2-cropped and 2 were single cropped cropping patterns (Figure 4.4). Shahidullah *et. al* (2006) reported that he found a total of 18 major cropping patterns after conducting an experiment to identify the cropping patterns in East coastal region of Bangladesh in the year 2001-02. Most dominant cropping pattern, single T. Aman alone occupied 35% land of net cropped area. The next three, Boro-Fallow-T. Aman, Fallow-B.Aus-T. Aman and single Boro represents 14, 11 and 11%, respectively of the net cropped area. A sharp variation was observed in cropping patterns among the different upazillas of the study area.



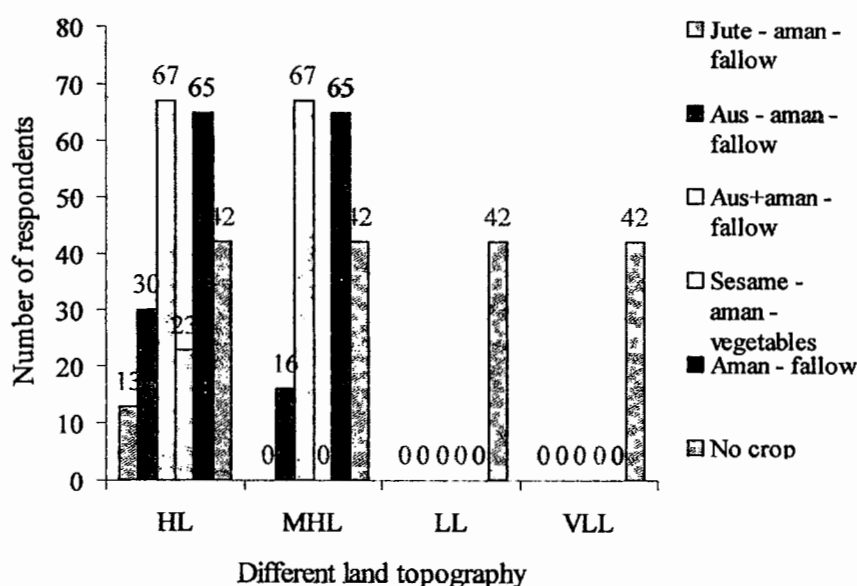
Note: 1 = 4 – cropped cropping pattern, 2 = 3 – cropping patterns, 3 = 2 – cropped cropping pattern and 4 = 1 – cropped cropping pattern

Figure 4.4. Different types of cropping patterns

About 50 years ago, in the study area a total of 5 cropping patterns (Figure 4.5) was found. Majority of respondents mentioned that crop production was mainly related to high land where all mentioned 5 cropping patterns were practised and to some extent in medium high land where 3 cropping patterns were practised. At that time, it was found

that mainly 2 – cropped (Aus + aman – fallow) and 1 – cropped (Aman – fallow) type cropping patterns with a minor proportion of 3 – cropped cropping patterns were practised. A major portion of the respondents mentioned that no crop was grown at that time due to the water inundation condition and the regular tidal effect. From the year 1967 – 1975 the polderization/embankment was established. From that time, the number of cropping patterns was increased gradually.

At that time, among all the respondents, Aus+aman – fallow was noticed to practised by 67 respondents both in high land and medium high land, Aman – fallow by 65 respondents both in high land and medium high land, Aus – aman – fallow by 30 respondents in high land and 16 respondents in medium high land, Sesame – aman – vegetables by 23 respondents in high land, Jute – aman – fallow by 13 respondents in high land but 42 noticed for no cropping pattern i.e., no crop was grown in any type of land topography (Figure 4.5).

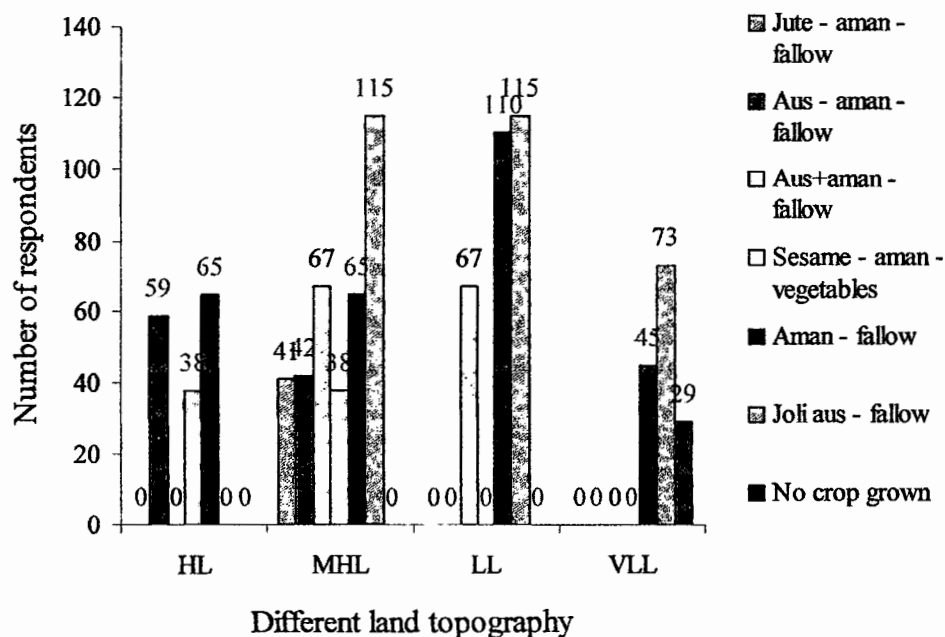


Note: HL = High land, MHL = Medium high land, LL = Low land and VLL = Very low land

Figure 4.5. Cropping patterns of 50 years ago

Before 30 years ago, there a total of 6 cropping patterns were practised all of which were practised only in medium high land, 3 cropping patterns were related to high land and low land, and 2 cropping patterns were found in very low land (Figure 4.6). At that time, it was found that 1 – cropped cropping pattern (aman – fallow) was practised in all type of land topography but another 1 – cropped cropping pattern (joli aus – fallow) was practised by the majority of the respondents in medium high land, low land and very low land but it was not practised in high land. Besides these, only one 3 – cropped cropping patterns (Sesame – aman – vegetables) was found to be practised in high land and medium high land, jute – aman – fallow was practised only in medium high land and a small portion of respondents mentioned that in no crop was grown in very low land of some area at all. It was due was inundation in this type of soil.

At that time, among all the respondents, Joli aus – fallow was noticed to practised by 115 respondents in medium high land and low land and 73 respondents in very low land. Aus+aman – fallow was noticed by 67 respondents both in high land and medium high land. Aman – fallow was noticed by 65 respondents both in high land and medium high land, 110 respondents in low land and 45 respondents in very low land. Aus – aman – fallow was noticed by 59 respondents in high land and 42 respondents in medium high land. Sesame – aman – vegetables was noticed by 38 respondents in high land and medium high land. Jute – aman – fallow was noticed by 41 respondents in high land. 42 respondents noticed for no cropping pattern i.e., no crop was grown in any type of land topography (Figure 4.6).

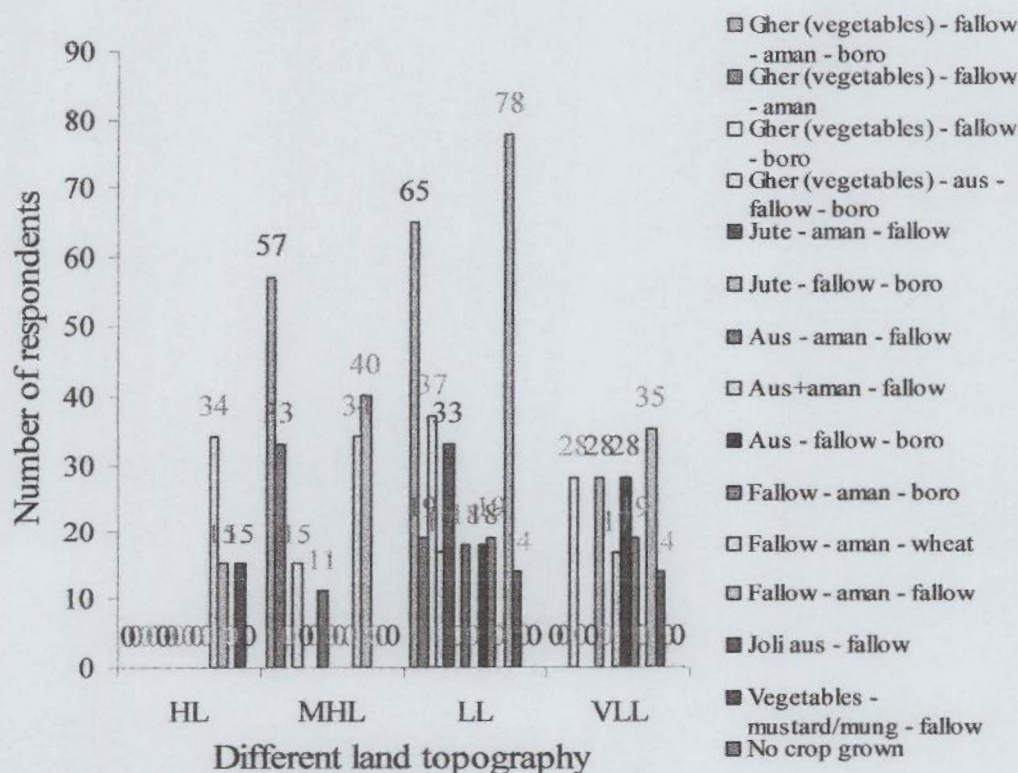


Note: HL = High land, MHL = Medium high land, LL = Low land and VLL = Very low land

Figure 4.6. Cropping patterns of 30 years ago

About 15 years ago, *gher* was started in most of the study area and after that time a dramatical increase was taken place in changing cropping pattern as mentioned in the study area. After starting *gher* in the study area, a total of 14 cropping patterns (Figure 4.7) were practised in 15 years ago. But now-a-days, with a slight decrease 13 cropping patterns were found to be continued (Figure 4.8). In both cases, most of the identified cropping patterns were found in low land (11 cropping patterns in 15 years ago and 9 cropping patterns in present status) and a majority was observed in medium high land and very low land. In both cases, a 1 – cropped cropping pattern (fallow – aman – fallow) was found to be the most dominant in all types of land topography and a 4 – cropped cropping pattern [*gher* (vegetables) – fallow – aman – boro] the second dominant mainly in medium high land and low land. Besides these, 3 – cropped cropping patterns [*gher* (vegetables) – aman – fallow in medium high land and low land, and *Gher* (vegetables) –

fallow – boro in low land and very low land], 2 – cropped cropping patterns (fallow – aman – wheat in medium high land and low land in 15 years ago and high land and medium high land at present, fallow – aman – boro in low land and very low land, aus – fallow – boro in low land and very low land, and fallow – vegetables – mustard/mung in high land and medium high land) were found to be noticeable.

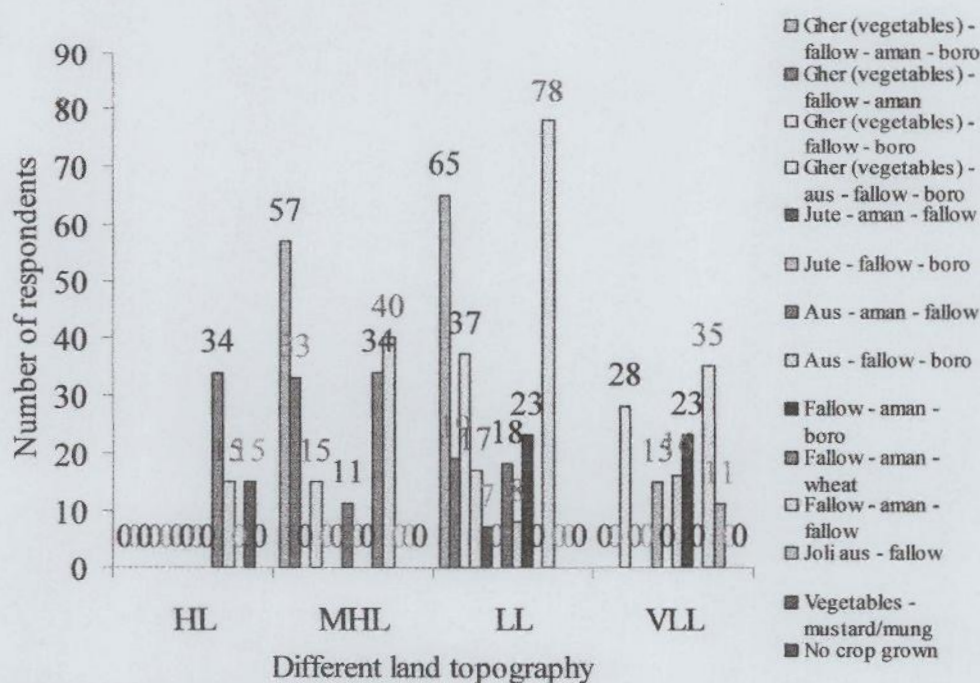


Note: HL = High land, MHL = Medium high land, LL = Low land and VLL = Very low land

Figure 4.7. Cropping patterns of 15 years ago

At 15 years ago as shown in the Figure 4.7, among all the respondents, Fallow – aman – fallow was noticed to be practised by 15 respondents in high land, 40 respondents in medium high land, 78 respondents in low land and 35 respondents in very low land. *Gher* (vegetables) – fallow – aman – boro was noticed by 57 respondents in medium high land, 65 respondents in low land. Fallow – aman – wheat was noticed by 34 respondents both in high land and medium high land. *Gher* (vegetables) – fallow – aman was noticed by 33

respondents in medium high land and 19 respondents in low land. *Gher* (vegetables) – fallow – boro was noticed to be practised by 37 in low land and 28 in very low land. *Gher* (vegetables) – aus – fallow – boro was noticed by 15 respondents in medium high land and 17 respondents in low land. Jute – aman – fallow was found to be practised only by 33 respondents in low land. Jute – fallow – boro was observed to be practised only by 28 respondents in very low land. Aus – aman – fallow was noticed to be practised by 11 respondents in medium high land and 18 respondents in low land. Aus – fallow – boro was found to be practised by 18 respondents in low land and 28 respondents in very low land. Fallow – aman – boro was observed to be practised by 19 respondents in both low land and medium high land. Joli aus – fallow was found to be practised by 14 respondents both in low land and very low land. Vegetables – mustard/mung – fallow was found to be practised by 15 respondents only in high land.



Note: HL = High land, MHL = Medium high land, LL = Low land and VLL = Very low land

Figure 4.8. Present cropping patterns

At present as shown in the Figure 4.7, among all the respondents, Fallow – aman – fallow was noticed to be practised by 15 respondents in high land, 40 respondents in medium high land, 78 respondents in low land and 35 respondents in very low land. *Gher* (vegetables) – fallow – aman – boro was noticed to be practised by 57 respondents in medium high land, 65 respondents in low land. *Gher* (vegetables) – fallow – aman was noticed by 33 respondents in medium high land and 19 respondents in low land. *Gher* (vegetables) – fallow – boro was noticed to be practised by 37 in low land and 28 in very low land. *Gher* (Vegetables) – aus – fallow – boro was noticed by 15 respondents in medium high land and 17 respondents in low land. Jute – aman – fallow was found to be practised only by 7 respondents in low land. Jute – fallow boro was observed to be practised only by 15 respondents in very low land. Aus – aman – fallow was noticed to be practised by 11 respondents in medium high land and 18 respondents in low land. Aus – fallow – boro was found to be practised by 8 respondents in low land and 16 respondents in very low land. Fallow – aman – boro was observed to be practised by 23 respondents in both low land and medium high land. Fallow – aman – wheat was noticed by 34 respondents in high land and 40 respondents in medium high land. Joli aus – fallow was found to be practised by only 11 respondents in and very low land. Vegetables – mustard/mung – fallow was found to be practised by 15 respondents only in high land.

The results as described above clearly indicate that there was a great change but gradual (Rasid and Ando, 1990) in cropping patterns. From 50 years ago it was found in the study area as well as in whole Bangladesh (Haque 1998) that most of the cropping pattern was consisted of rice based cereal crops. Gradual change in dominance in the cropping patterns took places from 50 years ago when the most dominant pattern was fallow – aman – fallow as well as aus + aman – fallow in high land and medium high land, in 30

years ago the most dominant was aman in all types of land and jori aus – fallow in all types except high land.

4.3 Yield ($t\ ha^{-1}$) of different crops

In some places of the study area, due to salinity and most cases due to water logging, crop yield is generally hampered. According to Karim (2000), rice production suffers 10% yield reduction when the salinity tolerance limit of 2000 micro-mohs is exceeded and when water salinity exceeds 48000 micro-mohs, yield is reduced by 50%. At 50 years ago average yield of some selected crops was found very low due to tidal effect of saline water; but it is monitored that production of that crops has been increased in dynamic way (Table 4.2). Increase in yield of different crops took place mainly for introduction of HYV, no tidal effect due to embankment of the region. It was found that yield of HYV of rice was much more than the local varieties in the study area. Though the yield of rice, mustard and mungbean was found to be increased in the study area, the yield of jute and sesame was found to be decreased with temporal variation (Table 4.2).

Table 4.2. Yield ($t\ ha^{-1}$) of different crops in different times

Years (Before)	Rice (t ha ⁻¹)							Wheat (t ha ⁻¹)	Jute (t ha ⁻¹)	Mung bean (t ha ⁻¹)	Mustard (t ha ⁻¹)	Sesame (t ha ⁻¹)
	Aus	Aman			Boro							
		Local	HYV	Average	Local	HYV	Average					
50	2.25	2.70	-	2.70	-	-	-	-	1.81	1.12	-	1.84
30	2.25	2.70	-	2.70	-	-	-	-	1.81	1.12	1.00	1.84
15	2.28	3.01	4.77	3.89	3.54	5.21	4.36	2.5	1.69	1.76	1.21	1.81
Present	2.28	3.01	4.77	3.89	3.54	5.21	4.36	2.5	1.69	1.76	1.21	1.81

Note: - = Not found

Average yield of aus, aman, boro, wheat and jute in present status as calculated in the study area was found 2.28 t ha⁻¹, 3.89 t ha⁻¹, 4.36 t ha⁻¹, 2.5 t ha⁻¹ and 1.69 t ha⁻¹ respectively where as the average national yield (BBS, 2007) of these crops in the fiscal year 2005 – 06 was 1.69 t ha⁻¹, 1.99 t ha⁻¹, 3.43 t ha⁻¹, 1.53 t ha⁻¹ and 2.04 t ha⁻¹, respectively. Increase in yield in the study areas was found due to cultivation of HYVs of crops, increasing fertilizer and pesticide application and having no tidal effect.

4.4 Production and post harvest technology

4.4.1 Technology in land preparation

In the study area, all respondents were found to practise both primary tillage (ploughing, leveling) and secondary tillage operations (leveling) in traditional way of cultivation procedure. There was no change in the land preparation procedure as monitored in the study area with temporal variation (Table 4.3). It was observed that all the farmers in the study area used to utilize country plough, ladder and spade for primary tillage operation before 15 years and from 15 years ago most of the respondents also have been utilized power tiller along with these implements which was introduced in Bangladesh after 1988 (Kabir and Ahmed, 2005), due to the shortage of draft power after death of a huge number of bullocks during the devastating flood of 1988. On the other hand, in case of secondary tillage operation generally ladder and spade have been being utilized since about 50 years ago by the farmers and recently i.e., since 15 years ago they have been utilized power tiller.

Table 4.3. Technology used in land preparation

Tillage operations		Number of respondents used different technologies in land preparation at different times			
		50 years ago	30 years ago	15 years ago	Present status
Primary tillage	Yes	130	130	130	130
	No	0	0	0	0
	Implements	1, 2, 3	1, 2, 3	1, 2, 3, 4	1, 2, 3, 4
Secondary tillage	Yes	130	130	130	130
	No	0	0	0	0
	Implements	2, 3	2, 3	2, 3, 4	2, 3, 4

Note: 1 = Country plough, 2 = Ladder, 3 = Spade, 4 = Power tiller

4.4.2 Seed technology

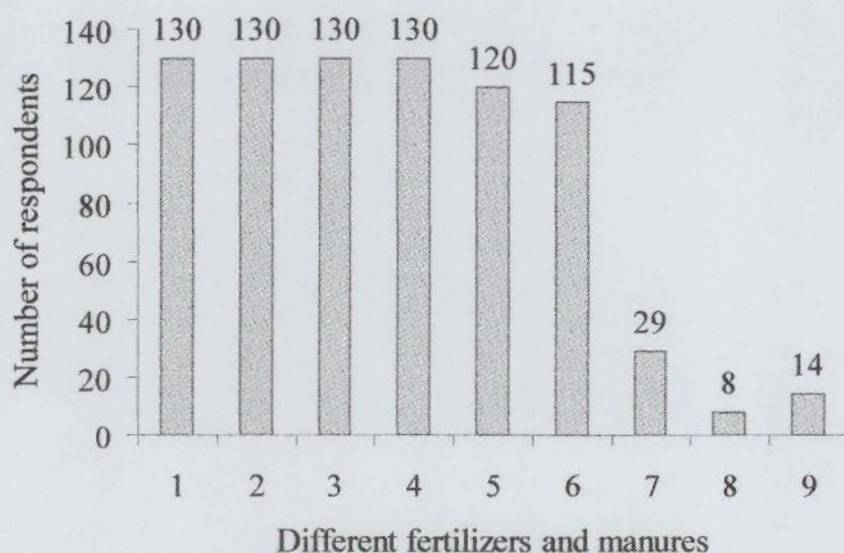
In the study area, it was observed that no respondent was conscious about seed treatment and seed inoculation. Seed treatment and seed inoculation were not found to be practised by any respondents in the study area (Table 4.4). In case of seed sowing, only broadcasting was practised but no line sowing or transplanting were practised before 15 years ago and broadcasting and transplanting have been being practised after 15 years ago. Line sowing was not found to be practised in the study area in case of field crops production. Seed sowing as well as transplanting has been being done fully manually in all cases; no mechanical device was observed to be used for it though recently manually operated seed and fertilizer applicator was developed which was yet to become popular (Kabir and Ahmed, 2005).

Table 4.4. Seed technology

Seed technology			Number of respondents used different seed technologies at different times			
			50 years ago	30 years ago	15 years ago	Present status
Seed treatment	Methods	No treatment	130	130	130	130
		Mechanical method	0	0	0	0
		Chemical method	0	0	0	0
Seed sowing	Methods	Broadcasting	130	130		
		Line sowing	0	0	0	0
		Transplanting	0	0		130
	Implements used		Manually			
Seed inoculation		Yes	0	0	0	0
		No	130	130	130	130

4.4.3 Fertilizer and manure application practices

Before 15 years no fertilizer and manure were observed to be applied by the farmers in the study area. Fertilizer application was started mainly from 15 years ago when *gher* was started and HYVs of rice were commonly cultivated. All the respondents used to apply only urea, TSP (triple super phosphate), MoP (Muriate of potash) and gypsum but no other fertilizer or manure (Supp. Table 3). But at present several fertilizers and manures were observed to be applied by the farmers in the study area. It was monitored that all the respondents applied urea, TSP (triple super phosphate), MoP (Muriate of potash) and gypsum, and a majority applied Zink and boron fertilizer where application of manure such as cowdung, compost and FYM (farm yard manure) was negligible compared to chemical fertilizers (Figure 4.9). No bio-fertilizer was observed to apply in any time by the farmers of study area.



Note: 1 = Urea, 2 = TSP (Triple super phosphate), 3 = MoP (Muriate of potash), 4 = Gypsum, 5 = Zink, 6 = Boron, 7 = Cowdung, 8 = Compost and 9 = FYM (Farm yard manure)

Figure 4.9. Present status of using fertilizers and manures

4.4.4 Intercultural operations

Different intercultural operations were observed to be taken traditionally till present. Weeding and thinning was observed to be done manually by all (Table 4.5) respondents in the study area where they were found to use traditional implements like sickle, hoe, small spade, *khupri*, rake, single rake etc. and no modern implement like Japanese rice weeder was found to be utilized.

Table 4.5. Intercultural operations taken by the respondents

Operations and methods		Number of respondents used different intercultural operations at different times			
		50 years ago	30 years ago	15 years ago	Present status
Weeding	Manual	130	130	130	130
	Implements used	Sickle, hoe, small spade, <i>khupri</i> , rake, single rake			
	Mechanical	0	0	0	0
Irrigation	No irrigation	130	130	0	0
	Flood irrigation	0	0	130	130
	Others	0	0	0	0
	Devices used	Shallow pump			
Thinning	Manual	130	130	130	130
	Implements used	Sickle, hoe, small spade, <i>khupri</i> , rake, single rake			
	Mechanical	0	0	0	0
Gap filling	Yes	0	0	0	0
	No	130	130	130	130
Top dressing	No	130	130		
	Manual	0	0	130	130
	Mechanical	0	0	0	0
Earthing up	Yes	0	0	0	0
	No	130	130	130	130

No irrigation was found to be applied by the respondents before 15 years but since 15 years ago all the respondents were observed to provide only flood irrigation where mostly shallow pumps were noticed to be used for this purpose. Gap filling and earthing up as shown in the Table 5 were found no to be practised by the respondents at all. On the other hand, top dressing was started since 15 years ago and it was observed to be done fully manually.

4.4.5 Pesticidal application practices

No fungicide, insecticide or any other types of pesticide was applied by the respondents of the study area upto 15 years ago. But since 15 years ago, all respondents were found to apply fungicide and insecticide but no other pesticides (Table 4.6). They were found to apply those fungicides and insecticides which are common in the market such as fungicides like Tilt, Savin, Dithane M – 45, Thiovit and insecticides like Melathion, Nogos, Sumithion, Dimecron, Furadan, Ripcord etc. For application of these fungicides and insecticides sprayers of different models and types were found to be used in the study areas.

Table 4.6. Pesticidal application practices in different times

Types of pesticide		Number of respondents used different pesticides at different times			
		50 years ago	30 years ago	15 years ago	Present status
Fungicide application	No application	130	130	0	0
	Yes	0	0	130	130
	Name of fungicide commonly used			Tilt, Savin, Dithane M – 45, Thiovit,	
	Implements used			Sprayer	
Insecticide application	No application	130	130	0	0
	Yes	0	0	130	130
	Name of insecticide commonly used			Melathion, Nogos, Sumithion, Dimecron, Furadan, Ripcord,	
	Implements used			Sprayer	
Others	Yes	0	0	0	0
	No	130	130	130	130

4.4.6 Harvesting and post harvest practices

Harvesting, threshing, cleaning, drying and storage were found to be practised in traditional way and there no major change was found in the study areas except threshing (Table 4.7).

Harvesting, threshing and cleaning in all cases were found to be done manually but only in threshing operation, most of the respondents were observed to do mechanical as well as manual threshing at present. In case of harvesting mainly sickle was monitored to be used, in case of mechanical threshing power tiller, paddle threshers were found to be used. Only sun drying was observed for drying of grains and after drying grains were found to be stored mostly in *gola* (round and rectangular); besides this plastic container, sacks, earthen pot etc. were also used.

Table 4.7. Harvesting and post harvest practices in different times

Operations and methods		Number of respondents used harvest and post harvest practices at different times			
		50 years ago	30 years ago	15 years ago	Present status
Harvesting	Manual	130	130	130	130
	Implements used	Sickle			
	Mechanical	0	0	0	0
Threshing	Manual	130	130	130	130
	Mechanical	0	0	0	123
	Implements used	Power tiller, paddle thresher etc.			
Cleaning	Manual	130	130	130	130
	Implements used				
	Mechanical	0	0	0	0
Drying	Sun drying	130	130	130	130
Storage	<i>Gola</i> (round and rectangular), plastic container, sacks, earthen pot				

4.5 The causes of changing cropping patterns

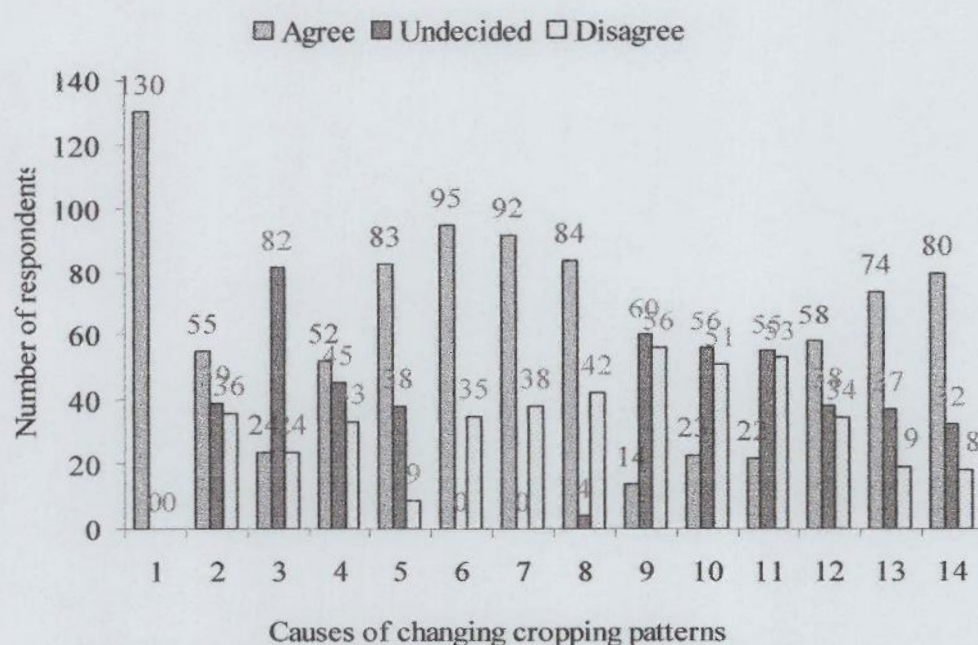
In the study area, it was clearly found that there is great variation in cropping patterns as discussed earlier. As there were variations in cropping patterns there prevail some causes and consequences of changing cropping patterns. The changes were related mainly to environmental factors and man made factors. No environmental factor was considered in this research work as the changes due to environmental factors are slower compared to other factors and in most cases natural. The causes and perceptions of the respondents as observed about these causes have been described below.

The respondents' perceptions were tested on the basis of analysis of selected 14 causes, which are detailed out in the methodology chapter. In this session the respondents' perception are analyzed for interpretation and understanding chronologically. Firstly, the distribution of the respondents was done based on their perception against each of the 14-statements i.e., the causes as well as the overall perception regarding the causes of changing cropping patterns.

It is very difficult to determine the perception of an individual regarding anything because perception varies from individual to individual. Same thing could be perceived differently/different ways by different individual. However, the respondents were asked to express their perception by indicating agreement against each of the selected 14 statements related to the causes of changing cropping patterns and based on the agreements (opinions), the respondents were distributed in different agreement categories as shown in Supp. Table 4.

All the respondents (130) under the study area expressed their agreement about the dependence on the staple food (Figure 4.10). Majority of the respondents expressed their agreement about low yield of rabi crops (83 respondents out of 130), introduction of shrimp/prawn farming as a high return enterprise (95 respondents out of 130), land leased

out for shrimp cultivation (92 respondents out of 130), for cultivation of finfish (84 respondents out of 130), increasing pressure on land (Mainly for population) (74 respondents out of 130) and neighbourhood aspects: changes in the farming practices and crop (80 respondents out of 130). A majority of the respondents expressed their agreement about income from unit area for cultivation of staple food is high (55 respondents out of 130), lack of availability of high yielding rabi crop varieties (52 respondents out of 130) and demand of land for non-agricultural process (commerce, industry, Transport) (58 respondents out of 130).



Note: 1 = Dependence on staple food, 2 = Income from unit area for cultivation of staple food is high, 3 = Lack of knowledge about balanced nutrition from other crops, 4 = Lack of availability of high yielding rabi crop varieties, 5 = Low yield of rabi crops, 6 = Introduction of shrimp/prawn farming as a high return enterprise, 7 = Land leased out for shrimp/prawn cultivation, 8 = For cultivation of finfish, 9 = For starting orchard, 10 = For tree plantation, 11 = Change in utilization patterns of agricultural implements, 12 = Demand of land for non-agricultural process (commerce, industry, Transport), 13 = Increasing pressure on land (Mainly for population), 14 = Neighbourhood aspects: Changes in the farming practises and crop

Figure 4.10. Perception of the respondents for causes of changing cropping patterns

Most of the respondents were undecided to express their perception about lack of knowledge about balanced nutrition from other crops (82 respondents out of 130) while a significant proportion of the respondents were undecided to expressed their opinion about 'for starting orchard' (60 respondents out of 130), for tree plantation (56 respondents out of 130) and change in utilization patterns of agricultural implements (55 respondents out of 130). A little number of respondents (9 – 56 respondents out of 130) expressed their disagreement regarding the causes of changing cropping pattern under serial number 2 – 14. None of the respondent expressed their disagreement and indecision regarding dependence on staple food as the cause of changing cropping pattern.

Dependence on staple food

All the respondents agreed with the cause of the dependence on staple food. In Bangladesh, rice is the staple food. The rapid growth of population impedes the agricultural development and food grains mostly rice predominantly lead agriculture here. Although acceleration of rice production resulted in an increase in per capita availability and led to self sufficiency in rice by the early 1990s, agricultural growth became under some strains since then. This raised concerns about sustainability of rice-led cropping pattern (Ahmed *et. al*, 2001). A major portion in the study area was found to be occupied by *gher* and mainly aman – boro – vegetables, aman – vegetables, boro – vegetables and aus – boro – vegetables were observed to be practised in *gher* where no other crop grow well.

Income from unit area for cultivation of staple food is high

In the study area, it was found that a majority of the respondents agreed to this cause. Though the income from unit area for cultivation of staple food i.e., rice was less than many other crops in previous years but now-a-days as the price of rice is to be risen up

and yield of HYV is higher, income from unit area for cultivation of staple food also became high (Ahmed, 2003).

Lack of knowledge about balanced nutrition from other crops

In the study area it was found that a majority of the respondents was undecided to this cause. In the study area most of the respondents belonged to illiterate and primary education level and consequently they might have lack of knowledge about balanced nutrition from other crops which might help in mainly rice led cropping patterns.

Lack of availability of high yielding rabi crop varieties

Most of the farmers was undecided to express their perception about lack of availability of high yielding rabi crop varieties as a cause of changing cropping patterns. It was found that the farmers in the study areas were not used to practise the rabi crop cultivation due to low yield of rabi crops, lack of availability of irrigation water.

Low yield of rabi crops

Yield of different rabi crops as shown in the study area was less than that of kharif crops (Table 4.2) and the results also similar to average national yield where the average of aus, aman, boro, wheat and jute in present status as calculated in the study area was found 2.28 t ha⁻¹, 3.89 t ha⁻¹, 4.36 t ha⁻¹, 2.5 t ha⁻¹ and 1.69 t ha⁻¹, respectively where as the average national yield (BBS, 2007) of these crops in the fiscal year 2005 – 06 is 1.69 t ha⁻¹, 1.99 t ha⁻¹, 3.43 t ha⁻¹, 1.53 t ha⁻¹ and 2.04 t ha⁻¹, respectively. Low yield of rabi crops might have to influence in changing cropping pattern in the study area. Low yield of different rabi crops was found due to soil salinity in some area, irrigation water supply scarcity in some area, interest of farmers to grow boro rice instead of other rabi crops.

Introduction of shrimp/prawn farming as a high return enterprise

One of the most important factors found to change cropping patterns was introduction of shrimp/prawn farming as a high return enterprise in the study area as well as in the whole

Southwestern region of Bangladesh. Marine and freshwater shrimp and prawn farming is an age-old practice in many countries of Asia. Though Bangladesh discovered this as an economic activity during early 70's, even a decade ago, higher earnings than the principal crops e.g. rice, jute and wheat) shrimp ponds were instructed in the coastal belt of Greater Khulna Region. History of shrimp cultivation is very old in the coastal areas of Bangladesh. Farmers used to cultivate shrimp in small scale for a long time especially in Khulna region. With the rise in international demand and high price, brackish water shrimp cultivation in the coastal areas has become popular. Currently, brackish water shrimp is not practised only in Khulna region in the southwest but also in the Cox's Bazar area (Nuruzzaman, 1993).

Land leased out for shrimp/prawn cultivation

Most of the farmers lease their lands to others for shrimp/prawn cultivation for riskless return from the land. Lands are leased out extensively in the area where *gher* culture is practised. As a result, the leased owner practise only shrimp/prawn for high return rather followed other cropping patterns.

For cultivation of finfish

Beside shrimp/prawn, the *ghers* are also used for cultivation of finfish for more income which helps in change in cropping patterns in the study area.

For starting orchard

For fulfillment of the domestic demand and market demand due to higher price a lot of agricultural land has been converted into orchard. Fruit trees are also planted on the bank of *gher*. This phenomenon prompted in changing cropping patterns in the study areas.

For tree plantation

To meet up timber requirement, control of environmental hazard a lot of land both agricultural and non-agricultural are being used for tree plantation in the recent years which affected the cropping patterns.

Change in utilization patterns of agricultural implements

Farmers in the study area were found to practise their agricultural operations traditionally in most cases with the indigenous farm implements. A very little change was found in utilization of modern implements. So in the study area, the change in utilization patterns of agricultural implements has no or negligible influence on changing cropping patterns.

Demand of land for non-agricultural process (commerce, industry, Transport)

The activities in commerce, industry, transport, etc have risen with increase in population and changes in the socio-economic conditions of the people. This increase has lead to rise in demand for land for construction of residential houses, shops, establishments, roads, etc (Mahesh, 1999). Since almost the entire available land in the study area was already under some economic uses, the land required for non-agricultural activities had to be taken from cultivable areas.

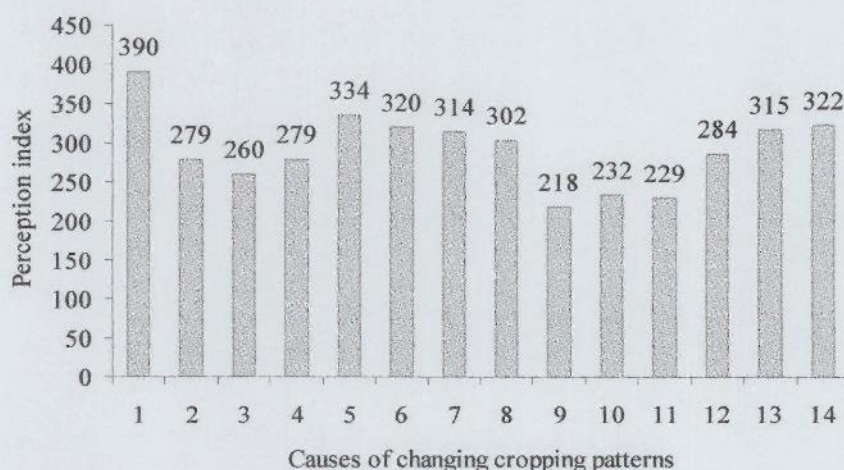
Increasing pressure on land (Mainly for population)

Due to increase in population, agricultural farms got subdivided and very small-sized farms became the order of the day. Since small-sized farms are not viable, the owners of these farms turned to other occupations for their livelihood. For such cultivators farming is only a subsidiary activity (Mahesh, 1999). They preferred to cultivate crops that require less personal attention.

Neighbourhood aspects: changes in the farming practices and crop

Changes in the farming practices and cropping patterns in the neighbouring areas induce other farmers to adapt to the changes (Mahesh, 1999). However, underlying all these has been the people's attitude to agriculture. For the older generation agriculture was a way of life; while for the present generation it is a commercial activity. The latter therefore, utilizes it to earn as much money as possible at the minimum cost and in the shortest time possible.

Perception index of all causes of changing cropping patterns was also calculated where it was highest in case of dependence on the staple food (PI 390) while it was lowest for starting orchard with PI 218 (Figure 4.11). From the individual statements point of view the observed score of the individual statements ranged from 218 – 390 against the possible range 130 – 390 with an average and standard deviation of 291.29 and 46.93, respectively (Supp Table 5). Most of the individual statements (64%) were highly perceived and the rest (36%) was moderately perceived by the respondents about the causes of changing cropping patterns while no individual statement was found to have low perception (Figure 4.12).



Note: 1 = Dependence on staple food, 2 = Income from unit area for cultivation of staple food is high, 3 = Lack of knowledge about balanced nutrition from other crops, 4 = Lack of availability of high yielding rabi crop varieties, 5 = Low yield of rabi crops, 6 = Introduction of shrimp/prawn farming as a high return enterprise, 7 = Land leased out for shrimp cultivation, 8 = For cultivation of finfish, 9 = For starting orchard, 10 = For tree plantation, 11 = Change in utilization patterns of agricultural implements, 12 = Demand of land for non-agricultural process (commerce, industry, Transport), 13 = Increasing pressure on land (Mainly for population), 14 = Neighbourhood aspects: Changes in the farming practises and crop

Figure 4.11. Perception index of causes of changing cropping patterns

☐ Low perception (Upto 130) ☒ Medium perception (131 - 260)
☐ High perception (> 260)

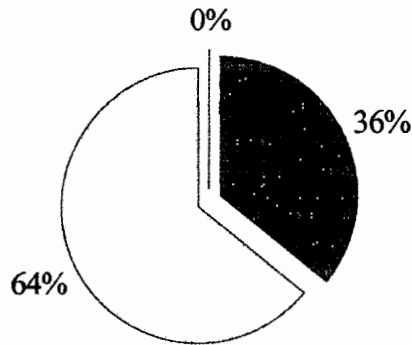


Figure 4.12. Distribution of the individual statement according to their perception for causes of changing cropping patterns

The overall perception scores of the respondents for the causes of changing cropping patterns varied from 25 – 38 against all possible range of 14 – 42 having an average and standard deviation 31.37 and 3.03, respectively. Based on the obtained score regarding perception, the respondents were classified into three categories as shown in the Supp. Table 6. Most of the respondents (83%) had high perception and the rest (17%) had medium perception about the causes of changing cropping patterns while no respondent was found to have low perception (Figure 4.13).

☒ Low perception up to 14 ☐ Medium perception 15 – 28
☐ High perception > 28

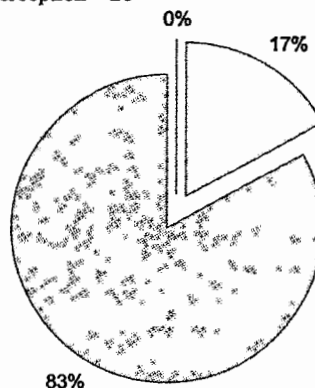


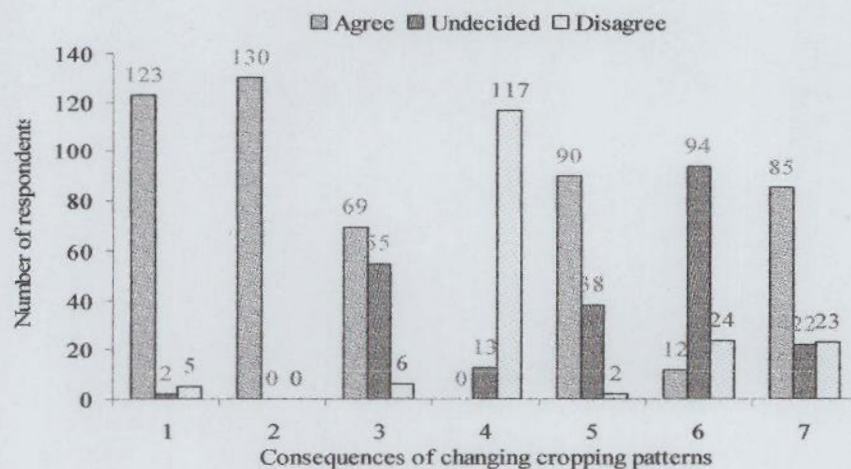
Figure 4.13. Distribution of the respondents according to their perception for causes of changing cropping patterns

4.6 The consequences of changing cropping patterns

The respondents' perceptions were tested on the basis of analysis of selected 7 consequences, which are detailed out in the methodology chapter. In this session the respondents' perception are analyzed for interpretation and understanding chronologically. Firstly, the distribution of the respondents was done based on their perception against each of the 7-statements i.e., the consequence as well as the overall perception regarding the consequences of changing cropping patterns.

It is very difficult to determine the perception of an individual regarding anything because perception varies from individual to individual. Same thing could be perceived differently/different ways by different individual. However, the respondents were asked to express their perception by indicating agreement against each of the selected 7 statements related to the consequences of changing cropping patterns and based on the agreements (opinions), the respondents were distributed in different agreement categories as shown in Supp. Table 7.

All the respondents (130) under the study area expressed their agreement with the livelihood of people is increasing due to high income from unit area of land (Figure 4.14). Most of the respondents had expressed their agreement about the year round distribution of labors (123 respondents out of 130) but majority had expressed their agreement about health hazard/imbalance or malnutrition (69 respondents out of 130), change in utilization patterns of agricultural implements (90 respondents out of 130) and lowering dairy farming (85 respondents out of 130). Most of the respondents were undecided to express their perception about lowering biodiversity (94 respondents out of 130) where as most of the respondents disagreed related to the consequence due to introduction of mechanized cultivation (117 respondents out of 130).



Note: 1 = The year – round distribution of labors, 2 = The livelihood of people is increasing due to high income from unit area of land, 3 = Health hazard/imbalance or malnutrition, 4 = Introduction of mechanized cultivation, 5 = Change in utilization patterns of agricultural implements, 6 = Lowering bio-diversity, 7 = Decreasing dairy farming.

Figure 4.14. Perception of the respondents regarding the consequences of changing cropping patterns

The year – round distribution of labors

Increasing labor intensity due to shrimp (Ahmed, 2003) as well as prawn or finfish culture which was found to increase farm income, changes in cropping-pattern have an immediate and direct impact on the employment pattern in the rural area (Mahesh, 1999).

The livelihood of people is increasing due to high income from unit area of land

The livelihood of people is increasing due to high income from unit area of land. At present income from per unit land has been increased through which livelihood patterns is also improving day by day. Increasing income by HYVs, vegetables and of course shrimp/prawn (*gher*) helps in bettering standard of life through the increasing use of mobile phone, vehicle, sanitary toilet, medicare, entertainment media, electricity (Ahmed, 2003) as well as increasing of education level, change in food habit and improved housing (Ali, 2007).

Health hazard/imbalance or malnutrition

In the study area it was found that the respondents agreed to the health hazard/imbalance or malnutrition due to the consequences of changing cropping pattern. The respondents blamed frequently use of chemical fertilizers, pesticides, HYVs of different crops as well as no consciousness of the illiterate people about health.

Introduction of mechanized cultivation

Mechanization has been taken place in Bangladesh agriculture in the backdrop and fragmented farm size recently. Mechanization in the agricultural production system has been recognized as a potential contributor for rural development through rural income generation. Moreover, under higher income and literacy rate, drudgery reduction became important issue towards mechanization (Kabir and Ahmed, 2005). Though mechanized agriculture is increasing in many part of the country, was found in poor condition in the study area. Here mainly due to *gher* culture as well as poor economic condition of the farmers, less crop diversification did not help to introduce mechanized cultivation.

Change in utilization patterns of agricultural implements

For increasing farm mechanization, selective farm mechanization is a must. Though 62% work forces are engaged in agriculture, acute labor shortage occurs during some of the agricultural operations like sowing/ transplanting, harvesting and threshing. Due to labor shortage, timeliness of operations cannot be maintained, resulting in bad impact on crop production, rural employment and poverty alleviation (Kabir and Ahmed, 2005). As intensive agriculture have been practised in recent years, for proper management of agricultural production procedure there has been a change in utilization patterns of agricultural implements.

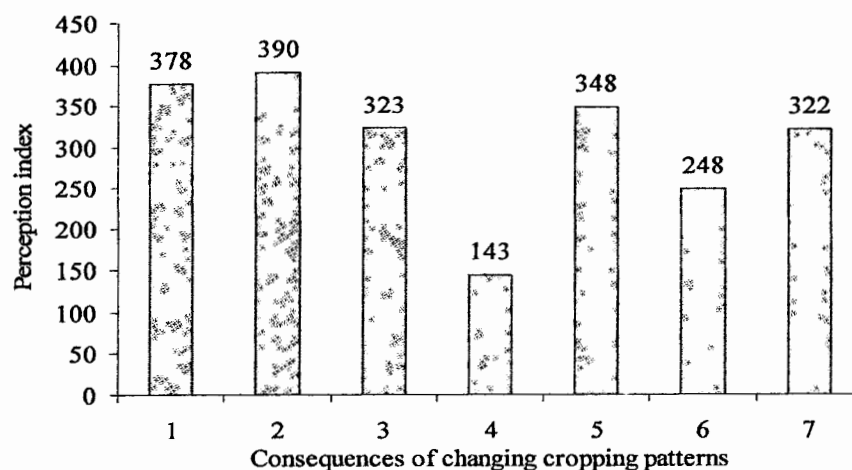
Lowering bio-diversity

The change in cropping pattern has lowered the bio-diversity in the rural area (Mahesh, 1999). Not only does it affect the environment; it worsens the living conditions of the rural masses that depend on natural resources for their survival as well. Intensive agricultural production of shrimp/prawn i.e., the *gher* as well as field crops threatened different indigenous crop varieties as and species of fish.

Decreasing dairy farming

Rice-based farming system and cattle-rearing are inter-dependent activities. Reduced the availability of straw which, in turn led to reduction in the number of draught animals and working bullocks in the farm sector, and to replacement of local variety of milch animals by high-yielding cross breed varieties. This development led to decline in the availability of farmyard manure and break down of the traditional farming sector (Mahesh, 1999).

Perception index of all consequences of changing cropping patterns was also calculated where it was highest in case of The livelihood of people is increasing due to high income from unit area of land (PI 390) while it was lowest for introduction of mechanized cultivation with PI 143 (Figure 4.15). From the individual statements point of view the observed score of the individual statements ranged from 143 – 390 against the possible range 130 – 390 with an average and standard deviation of 307.43 and 86.09, respectively (Supp. Table 8). Most of the individual statements (71%) were highly perceived and the rest (29%) was moderately perceived by the respondents about the consequences of changing cropping patterns, while no individual statement was found to have low perception (Figure 4.16).



Note: 1 = The year – round distribution of labors, 2 = The livelihood of people is increasing due to high income from unit area of land, 3 = Health hazard/imbalance or malnutrition, 4 = Introduction of mechanized cultivation, 5 = Change in use of agricultural implements, 6 = Lowering bio-diversity, 7 = Decreasing dairy farming.

Figure 4.15. Perception index regarding consequences of changing cropping patterns

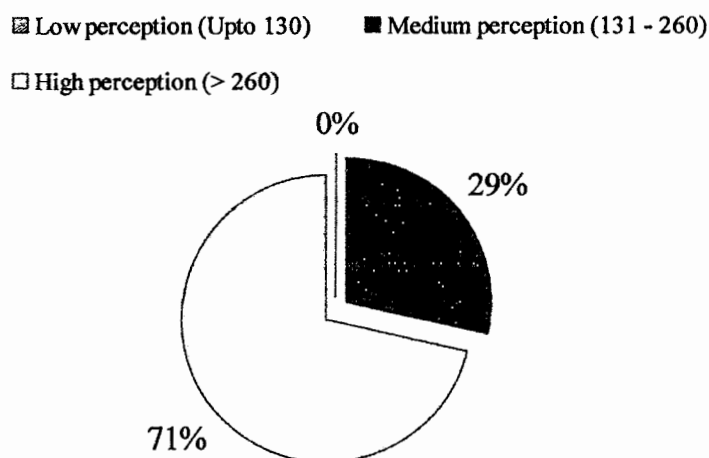


Figure 4.16. Distribution of the individual statement according to their perception for consequences of changing cropping patterns

The overall perception scores of the respondents for the consequences of changing cropping patterns varied from 12 – 19 against all possible range of 7 – 14 having an average and standard deviation 16.62 and 1.53, respectively. Based on the obtained score regarding perception, the respondents were classified into three categories as shown in the Supp. Table 9. Most of the respondents (90%) had high perception and the rest (10%) had

medium perception about the consequences of changing cropping patterns while no respondent was found to have low perception (Figure 4.17).

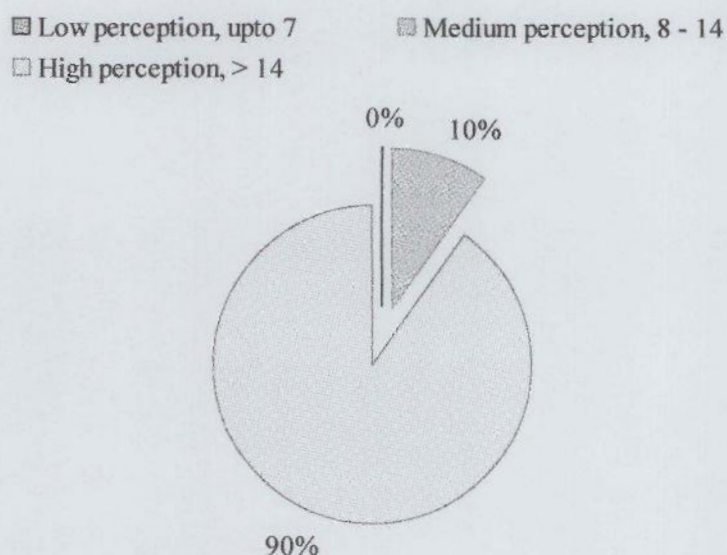


Figure 4.17. Distribution of the respondents according to their perception regarding consequences of changing cropping patterns

4.7 Relationship between the selected characteristics of the respondents and their perception

To test the relationship between the selected characteristics of the respondents and their perception, Pearson's product correlation coefficient was employed (at 01 and 5% level of significance). The results of the relationship tests are presented below.

4.7.1 Age and perception about causes and consequences of changing cropping pattern

There is no significant relationship between the age of the respondents and their perception regarding causes and consequences of changing cropping patterns. Though age had positive trend of relationship with the causes, but negative trend of relationship with the consequences of changing cropping patterns (Table 4.8).

4.7.2 Education and perception about causes and consequences of changing cropping pattern

Education had significant role ($r = 0.194^*$) with the perception of farmers regarding consequences as well as positive trend of relationship with causes of changing cropping patterns (Table 4.8). It means that higher is the level of education, the higher is the perception regarding the consequences of changing cropping patterns. This might be due to that education broadens the ideas/knowledge of the people to understand the effect of changing cropping pattern.

4.7.3 Family size and perception about causes and consequences of changing cropping pattern

Family size had nonsignificant negative relationship with the perception of the respondents regarding causes but had nonsignificant positive relationship with the perception of the respondents regarding consequences of changing cropping patterns where family size had positive trend of relationship with the consequences but negative trend of relationship with the causes of changing cropping patterns (Table 4.8).

4.7.4 Farm size and perception about causes and consequences of changing cropping pattern

Farm size had nonsignificant positive relationship with the perception of the respondents regarding causes and consequences of changing cropping patterns. But it had positive trend of relationship with perception regarding the causes and consequences (Table 4.8).

Table 4.8. Correlation between the selected characters of the farmers and their perception regarding causes and consequences of changing cropping pattern

Characters	r – value	
	'r' for causes	'r' for consequences
Age	0.117	- 0.168
Education	0.081	0.194*
Family size	- 0.037	0.088
Farm size	0.050	0.023

Note: * = Significant at 0.05 level.

CHAPTER – V

SUMMARY, CONCLUSION AND IMPLICATIONS

5.1 Summary

During the past five decades the agriculture sector in Southwestern region of Bangladesh has undergone wide-ranging changes in terms of ownership of land, cropping pattern, cultivation practices, productivity, and intensity of cultivation. Bangladesh has an agrarian economy, although the share of agriculture to GDP has been decreasing over the last few years. Yet it dominates the economy accommodating major labour force living in the rural areas. The spatial representation of crops rotations, since it basically adds the reference to the spatial distribution of crop rotations in an area to the definition of crop rotation itself: “yearly sequence and spatial arrangement of crops or of crops and fallow of a given area”.

The main objective of the study was to identify the changes in cropping pattern that has been occurred during the last five decades as well as the causes and consequences of changing cropping pattern. The specific objectives of the study were: 1. to identify the cropping patterns last 40 years, 2. to identify the causes of changing cropping patterns, 3. to identify the consequences of changing cropping patterns and 4. to explore the relationship between some of the selected characteristics and their perception regarding the causes and consequences of changing cropping pattern.

In the study, two approaches have been used: (i) a statistical survey to assess the existing as well as previous cropping patterns in the area, and (ii) a study carried out with participation of local people using Participatory Learning Methods to understand how the local population perceives the changes in cropping pattern. The study was conducted at four villages (Chakrakhali, Sachibunia, Bashbaria and Hogladanga) of Jalma union under

Batiaghata and three villages (Banda, Ghona and Taltala) of Vandarpara union and three villages (Gutudia, Bardanga and Jhilerdanga) of Gutudia union under Dumuria Upazila of Khulna District. To fulfill the objectives, the study was carried out and data were collected during 01 May, to 07 July, 2008 by the researcher himself following several methods like personal interview, focus group discussion, field observation and systematic study of available record. The primary data were collected from the respondents directly while secondary data were collected from different records available at different office, internet, and journals by the researcher himself.

Data analysis design and major findings were divided into two steps. First, the data related to selected variables were analyzed and their relationships with each other were determined. Second, the data concerning the causes and consequences of changing cropping patterns were analyzed.

After completion the field survey and data analysis the following results could be found.

All of the respondents were above 50 years old. More than 41% respondents belonged to illiterate group followed by primary (39.23%) level.

Majority (45%) of the respondents was in the large family (above 6 family members) followed by medium group (4 -5 family members) 38%.

The highest proportion of the respondents (33%) was in medium group of farm size followed by 30% small farm size.

In the study area, a total of 15 cropping patterns were identified over the times out of which 8 were 2-cropped followed by 3 were 3-cropped.

About 40 years ago, in the study area as observed, a total of 5 cropping patterns was determined among which majority of respondents mentioning those cropping patterns indicated that crop production was mainly related to high land where all mentioned 5 cropping patterns were practised and to some extent in medium high land where 3

cropping patterns were practised. At that time, it was observed that mainly 2 – cropped (Aus + aman – fallow) and 1 – cropped (Aman – fallow) type cropping patterns. A major portion of the respondents mentioned that no crop was grown at that time. From the year 1967 – 1975 the polderization/embankment was established. From that time the number of cropping patterns was increased gradually. At that time, among all the respondents, Aus+aman – fallow was noticed to be practised by 67 respondents both in high land and medium high land, Aman – fallow by 65 respondents both in high land but 42 respondents noticed for no cropping pattern i.e., no crop was grown in any type of land topography.

Before 30 years ago, there a total of 6 cropping patterns were practised all of which were practised mainly in medium high land. At that time, it was found that 1 – cropped cropping pattern (aman – fallow) was practised in all type of land topography but another 1 – cropped cropping pattern (joli aus – fallow) was practised by the majority of the respondents in medium high land, low land and very low land. At that time, among all the respondents, Joli aus – fallow was noticed to be practised by 115 respondents in medium high land and low land and 73 respondents in very low land. Aman – fallow was noticed by 65 respondents both in high land and medium high land, 110 respondents in low land and 45 respondents in very low land.

About 15 years ago, *gher* was started in most of the study area and after that time a dramatical increase was taken place in changing cropping pattern as monitored in the study area. After starting *gher* in the study area, a total of 14 cropping patterns were practised in 15 years ago. But now-a-days, with a slight decrease, 13 cropping patterns were observed to be continued. In both case, most of the observed cropping patterns was found in low land (11 cropping patterns in 15 years ago and 9 cropping patterns in present status). In both cases, a 1 – cropped cropping pattern (fallow – aman – fallow) was found

to be the most dominant in all types of land topography and a 4 – cropped cropping pattern [*gher* (vegetables) – fallow – aman – boro] the second dominant mainly in medium high land and low land.

At 15 years ago, among all the respondents, Fallow – aman – fallow was noticed to practised by 15 respondents in high land, 40 respondents in medium high land, 78 respondents in low land and 35 respondents in very low land. *Gher* (vegetables) – fallow – aman – boro was noticed by 57 respondents in medium high land, 65 respondents in low land. Fallow – aman – wheat was noticed by 34 respondents both in high land and medium high land. On the other hand, at present among all the respondents, Fallow – aman – fallow was noticed to practised by 15 respondents in high land, 40 respondents in medium high land, 78 respondents in low land and 35 respondents in very low land. *Gher* (vegetables) – fallow – aman – boro was noticed to be practised by 57 respondents in medium high land, 65 respondents in low land. *Gher* (vegetables) – fallow – aman was noticed by 33 respondents in medium high land and 19 respondents in low land.

At 50 years ago average yield of some selected crops was found very low; but it is monitored that production of that crops has been increased. It was found yield of HYV of rice was much more than the local varieties in the study area. Though the yield of rice, mustard and mung was found to increase in the study area, the yield of jute and sesame was found to decrease with temporal variation. Average of aus, aman, boro, wheat and jute in present status as calculated in the study area was found 2.28 t ha⁻¹, 3.89 t ha⁻¹, 4.36 t ha⁻¹, 2.5 t ha⁻¹ and 1.69 t ha⁻¹ respectively.

In the study area, all respondents were found to practise both primary tillage (ploughing, leveling) and secondary tillage operations (leveling) in traditional way of cultivation procedure. There was no change in the land preparation procedure as monitored in the study area with temporal variation. It was observed that all the farmers in the study area

used to utilize country plough, ladder and spade for primary tillage operation before 15 years and from 15 ago years most of the respondents also have been utilizing power tiller along with these implements. On the other hand, in case of secondary tillage operation generally ladder and spade have been being utilized since about 50 years ago by the farmers and recently i.e., since 15 years ago they have been utilized power tiller.

In the study area, it was observed that no respondent is conscious about seed treatment, seed inoculation. Seed treatment and seed inoculation were not found to be practised by any respondents in the study area. In case of seed sowing, only broadcasting was practised but no line sowing or transplanting before 15 years ago and broadcasting and transplanting have been being practised after 15 years ago. Line sowing was not found to be practised in the study area in case of field crops production. Seed sowing as well as transplanting has been being done fully manually in all cases; no mechanical device was observed to be used for it.

Before 15 years no fertilizer and manure were observed to be applied by the farmers in the study area. All the respondents used to apply only urea, TSP (triple super phosphate), MoP and gypsum but no other fertilizer or manure. But at present several fertilizers and manures were observed to be applied by the farmers in the study area. It was monitored that all the respondents applied urea, TSP (triple super phosphate), K_2O and gypsum, and a majority applied zink and boron fertilizer where application of manure such as cowdung, compost and FYM (farm yard manure) was negligible compared to chemical fertilizers. No bio-fertilizer was observed to apply in any time by the farmers of study area.

Different intercultural operations were observed to be taken traditionally till present. Weeding and thinning was observed to be done manually by all respondents in the study area where they were found to use traditional implements like sickle, hoe, small spade,

khupri, rake, single rake etc. and no modern implement like Japanese rice weeder was found to be utilized. No irrigation was found to be applied by the respondents before 15 years but after from 15 years ago all the respondents were observed to provide only flood irrigation where mostly shallow pumps were noticed to be used for this purpose. Gap filling and earthing up were not found to be practised by the respondents at all. On the other hand, top dressing was started after 15 years ago and it was observed to be done fully manually.

No fungicide, insecticide or any other types of pesticide was applied by the respondents of the study area upto 15 years ago. But from 15 years ago, all respondents were observed to apply fungicide and insecticide but no other pesticides. They were found to apply those fungicides and insecticides which are common in the market such as fungicides like Tilt, Savin, Dithane M – 45, Thiovit and insecticides like Melathion, Nogos, Sumithion, Dimecron, Furadan, Ripcord etc. For application of these fungicides and insecticides sprayers of different models and types were found to be used.

Harvesting, threshing cleaning, drying and storage were found to be practised in traditional way and there no major change was found in the study area except threshing. Harvesting, threshing and cleaning in all cases were found to be done manually but only in threshing operation, most of the respondents were observed to do mechanical as well as manual threshing at present. In case of harvesting mainly sickle was monitored to be used, in case of mechanical threshing power tiller, paddle threshers were found to be used. Only sun drying was observed for drying of grains and after drying grains were found to be stored mostly in *gola* (round and rectangular); besides this plastic container, sacks, earthen pot etc. were also used.

The respondents' perceptions were tested on the basis of analysis of selected 14 causes where all the respondents (130) under the study area expressed their agreement about the

dependence on the staple food. Most of the respondents expressed their agreement about low yield of rabi crops (83 respondents out of 130), introduction of shrimp farming as a high return (95 respondents out of 130), land leased out for shrimp cultivation (92 respondents out of 130), for cultivation of finfish (84 respondents out of 130). Most of the respondents were undecided to express their perception about lack of knowledge about balanced nutrition from other crops (82 respondents out of 130) No cause was found to be disagreed by majority of the respondents.

Perception index of all causes of changing cropping patterns was also calculated where it was highest in case of dependence on the staple food.

Based on the obtained personal score regarding perception, the respondents were classified into three categories. Most of the respondents (83%) had high perception and the rest (17%) had medium perception about the causes of changing cropping patterns.

From the individual statements point of view most of the individual statements (64%) were highly perceived and the rest (36%) was moderately perceived by the respondents about the causes of changing cropping patterns while no individual statement was found to have low perception.

The respondents' perceptions were tested on the basis of analysis of selected 7 consequences. All the respondents (130) under the study area expressed their agreement about the livelihood of people is increasing due to high income from unit area of land. Most of the respondents expressed their agreement about the year round distribution of labors (123 respondents out of 130), change in utilization patterns of agricultural implements (90 respondents out of 130) and lowering dairy farming (85 respondents out of 130). Most of the respondents were undecided to express their perception about lowering biodiversity (94 respondents out of 130) where as most of the respondents

disagreed the consequence introduction of mechanized cultivation (117 respondents out of 130).

Perception index of all causes of changing cropping patterns was also calculated where it was highest in case of dependence on the staple food.

Based on the obtained personal score regarding perception about the consequences, most of the respondents (90%) had high perception and the rest (10%) had medium perception about the consequences of changing cropping patterns.

From the individual statements point of view most of the individual statements (71%) were highly perceived and the rest (29%) was moderately perceived by the respondents about the consequences of changing cropping patterns.

To test the relationship between the selected characteristics of the respondents and their perception, Pearson's product correlation coefficient was employed (at 1 and 5% level of significance) where only education had significant role on the perception of the farmers regarding consequences of changing cropping patterns.

Finally, it could be noted down that there are many causes and consequences of changing cropping patterns in the study area.

5.2 Conclusion

Based on the finding of the study and logical interpretation of the meaning the following conclusions are drawn:

1. There was a trend to increase in the total number of cropping patterns from the 50 years ago and onward but it was found to be decreased since 15 years ago.
2. The respondents had clearer perception regarding the causes and consequences of changing cropping patterns. Most of the farmers had high perception (83% for causes and 90% for consequences) and medium perception (17% for causes and 10% for consequences).
3. Among the selected 14 causes of changing cropping patterns, the most important one was dependence on staple food while the least important one was starting of orchard as addressed by the respondents.
4. Among the selected 7 consequences of changing cropping patterns, the most important one was The livelihood of people is increasing due to high income from unit area of land while the least important one was Introduction of mechanized cultivation as addressed by the respondents.
5. Among all the selected characteristics of the respondents only education showed a significant positive relationship with their perception regarding consequences of changing cropping patterns.

Finally, it could be concluded that there are a lot of causes that positively and negatively affected the cropping patterns and accelerated to change in cropping pattern and the consequences of this change had both positive and negative influence on the crop production, farmers' livelihood and farm income.

5.3 Implications

Findings of the study indicated that there is need for economic and financial analysis of the changes in cropping patterns that were found in Khulna district in which the changes could have a long-term impact with positive benefits for other uses. Analysis should also to be done for the causes and consequences of changing cropping pattern of the district as well as other parts of the country. Hence, proper planning and strategies should be taken to minimize the bad impact of changing cropping pattern if any for sustainable agricultural development. Finally, it could be mentioned that this study provides important inputs, useful insights and guidelines for planners and policy-makers to develop a viable plan for cropping patterns in Khulna district as well as for other parts of the country.

5.4 Suggested future research

- a) Researches of similar nature are suggested to be conducted covering more areas of the district as well as other parts of the country to have more comprehensive idea about the causes and consequences of changing cropping patterns.
- b) Field level agronomic research is suggested to be carried out for studying the impact of the change in cropping patterns.
- c) Physiological, soil and environmental researches should be conducted to study the causes of changing cropping patterns.
- d) Feasibility of the intervening response of improved technologies to mitigate the bad impact of changing cropping patterns may be studied and their implications to assessed with utmost care.

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APPENDIX – I

Agrotechnology Discipline
Khulna University
Khulna – 9208, Bangladesh

INTERVIEW SHCHEDULE

CAUSES AND CONSEQUENCES OF CHANGING CROPPING PATTERN IN KHULNA DISTRICT

1. Name:
2. Address: Village:..... Union:.....
Upazilla:.....
3. Age:..... Years
4. Educational qualification:

☐

Cannot read and write

☐

Can signature only

☐

Passed class

5. Background of the family members

Name	Relation	Sex		Age (year)	Education	Occupation	
		1	2			Major	Subsidiary

1 = Male

2 = Female

6. Information of land:

Ownership pattern	Quantity of land	
	Local unit	Hectare
Homestead area		
Own land under own cultivation		
Land under share cropping in		
Land under share cropping out		
Land leased in		
Total land		

7. Topography of different cultivated land:

- I) High Land
- II) Medium High land
- III) Low land
- IV) Very low land

8. Area under different crops -

- I. High Land _____
- II. Medium High land _____
- III. Low land _____
- IV. Very low land _____

9. Present cropping patterns:

Land topography	Cropping Pattern in different seasons			
	Kharif - 1	Kharif - 2	Rabi	
			Rabi - 1	Rabi - 2
High land				
Medium High land				
Low land				
Very low land				

10. Total yield (mound/bigha) of different crops at that time

Land topography	Rice			Wheat	Jute	Mung	Mustard	Sesame
	Aus	Aman	Boro					
High land								
Medium High land								
Low land								
Very low land								

11. Cropping patterns of about 50 years ago

Land topography	Cropping Pattern in different seasons			
	Kharif – 1	Kharif – 2	Rabi	
			Rabi – 1	Rabi – 2
High land				
Medium High land				
Low land				
Very low land				

12. Total yield from the field at that time:

Land topography	Rice			Wheat	Jute	Mung	Mustard	Sesame
	Aus	Aman	Boro					
High land								
Medium High land								
Low land								
Very low land								

13. Cropping patterns of about 30 years ago

Land topography	Cropping Pattern in different seasons			
	Kharif – 1	Kharif – 2	Rabi	
			Rabi – 1	Rabi – 2
High land				
Medium High land				
Low land				
Very low land				

14. Total yield, production cost and income from the field at that time:

Land topography	Rice			Wheat	Jute	Mung	Mustard	Sesame
	Aus	Aman	Boro					
High land								
Medium High land								
Low land								
Very low land								

15. Cropping patterns of about 15 years ago

Land topography	Cropping Pattern in different seasons			
	Kharif – 1	Kharif – 2	Rabi	
			Rabi – 1	Rabi – 2
High land				
Medium High land				
Low land				
Very low land				

16. Total yield from the field at that time

Land topography	Rice			Wheat	Jute	Mung	Mustard	Sesame
	Aus	Aman	Boro					
High land								
Medium High land								
Low land								
Very low land								

17. Technology used in land preparation

Tillage operations		Different times			
		50 years ago	30 years ago	15 years ago	Present status
Primary tillage	Yes				
	No				
	Implements				
Secondary tillage	Yes				
	No				
	Implements				

Note: 1 = Country plough, 2 = Ladder, 3 = Spade, 4 = Power tiller

18. Seed technology

Seed technology			Different times			
			50 years ago	30 years ago	15 years ago	Present status
Seed treatment	Methods	No treatment				
		Mechanical method				
		Chemical method				
Seed sowing	Methods	Broadcasting				
		Line sowing				
		Transplanting				
	Implements used					
Seed inoculation		Yes				
		No				

19. Fertilizer and manure application practices at different times:

Name of fertilizer and manure		Different times			
		50 years ago	30 years ago	15 years ago	Present status
Fertilizer	No fertilizer				
	Urea				
	TSP				
	K ₂ O				
	Gypsum				
	Zink				

	Continued				
	Boron				
	Others				
Manure	No Manure				
	Cowdung				
	Compost				
	FYM				
	Others				
Bio – fertilizer	No use				
	<i>Rhizobium</i>				
	BGA				

FYM = Farm Yard Manure

20. Intercultural operations taken

Operations and methods		Different times			
		50 years ago	30 years ago	15 years ago	Present status
Weeding	Manual				
	Implements used				
	Mechanical				
Irrigation	No irrigation				
	Flood irrigation				
	Others				
	Devices used				
Thinning	Manual				
	Implements used				
	Mechanical				
Gap filling	Yes				
	No				
Top dressing	No				
	Manual				
	Mechanical				
Earthing up	Yes				
	No				

21. Pesticidal application practices

Types of pesticide		Different time			
		50 years ago	30 years ago	15 years ago	Present status
Fungicide application	No application				
	Yes				
	Name of fungicide commonly used				
	Implements used				
Insecticide application	No application				
	Yes				
	Name of insecticide commonly used				
	Implements used				
Others	Yes				
	No				

22. Harvesting, threshing, cleaning, drying

Operations and methods		Different times			
		50 years ago	30 years ago	15 years ago	Present status
Harvesting	Manual				
	Implements used				
	Mechanical				
Threshing	Manual				
	Mechanical				
	Implements used				
Cleaning	Manual				
	Implements used				
	Mechanical				
Drying	Sun drying				
	Others				
Storage					

23. Do you think there is change in cropping patterns in different times?

Yes ☐

No ☐

24. If yes, the causes of changing cropping patterns that you think are –

Causes	Perceptions		
	1	2	3
Dependence on staple food			
Income from unit area for cultivation of staple food is high			
Lack of knowledge about balanced nutrition from other crops			
Lack of availability of high yielding rabi crop varieties			
Low yield of rabi crops			
Introduction of shrimp farming as a high return			
Land leased out for shrimp cultivation			
For cultivation of finfish			
For starting orchard			
For tree plantation			
Change in utilization patterns of agricultural implements			
Demand of land for non-agricultural process (commerce, industry, Transport)			
Increasing pressure on land (Mainly for population)			
Neighbourhood aspects: Changes in the farming practices and crop pattern in the neighbouring areas induce other farmers to adapt to the changes.			

25. Do you think there is any consequence of changing in cropping patterns in different times?

Yes ☐

No ☐

26. If yes, the consequences of changing cropping patterns that you think are –

Causes	Perceptions		
	1	2	3
The year – round distribution of labors			
The livelihood of people is increasing due to high income from unit area of land			
Health hazard/imbalance or malnutrition			
Introduction of mechanized cultivation			
Change in utilization patterns of agricultural implements			
Lowering bio-diversity			
Lowering dairy farming			

(Thank you for your kind cooperation)

Signature of the Enumerator

Date:

APPENDIX – II

Supp. Table 1. Facts on socio-economic profile of the respondents

Characteristics	Categories (Scores)	Number of respondents	Distribution of respondents (%)	Obtained score (Possible score)	Mean	Standard Deviation
Age	Younger old (51 – 59 years)	68	52.31			
	Medium old (61 – 70 years)	49	37.69	51 – 76	61.29	6.62
	Older old (> 70 years)	13	10			
	Total	130	100			
Education	No education (0)	54	41.54			
	Primary education (1 – 5)	51	39.23	0 – 14	2.52	3.78
	Secondary education (6 – 10)	17	13.08			
	Above secondary (> 10)	8	6.15			
	Total	130	100			
Family size	Small (upto 4)	22	16.92			
	Medium (5-6)	49	37.70	3 – 13	6.47	2.30
	Large (> 6)	59	45.38			
	Total	130	100			

Continued						
Farm size	Landless (< 0.20 ha)	9	6.92			
	Marginal (0.21 – 0.40 ha)	30	23.08			
	Small (0.41 – 0.99 ha)	39	30.00	0.1 – 6.07	1.01	1.01
	Medium (1 – 3 ha)	43	33.08			
	Large (> 3 ha)	9	6.92			
Total		130	100			

Supp. Table 2. Cropping pattern in different years

Cropping patterns	Number of respondents according to time and land topography													
	50 years ago				30 years ago				15 years ago				Present status	
	HL	MHL	LL	VLL	HL	MHL	LL	VLL	HL	MHL	LL	VLL	HL	VLL
Gher (vegetables) - Aman - Boro - Fallow	0	0	0		0	0	0	0	0	57	65	0	65	0
Gher (vegetables) - Aman - Fallow	0	0	0	0	0	0	0	0	0	33	19	0	33	0
Gher (vegetables) - Boro - Fallow	0	0	0	0	0	0	0	0	0	0	37	28	37	28
Gher (vegetables) - Aus - Boro - Fallow	0	0	0	0	0	0	0	0	0	15	17	0	15	0

Continued																	
Jute – Aman – Fallow	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jute – Fallow – Boro	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	15
Aus – Aman – Fallow	30	16	0	0	0	59	42	0	0	0	0	11	18	0	0	11	0
Aus+Aman – Fallow	67	67	0	0	0	0	67	67	0	0	0	0	0	17	0	0	0
Aus – Fallow – Boro	0	0	0	0	0	0	0	0	0	0	0	0	18	28	0	0	16
Fallow – Aman – Boro	0	0	0	0	0	0	0	0	0	0	0	0	19	19	0	0	23
Fallow – Aman – Wheat	0	0	0	0	0	0	0	0	0	34	34	0	0	0	34	34	0
Sesame – Aman – Vegetables	23	0	0	0	0	38	38	0	0	0	0	0	0	0	0	0	0
Aman – Fallow	65	65	0	0	0	65	110	110	45	15	40	78	35	15	40	78	35
Joli Aus – Fallow	52	52	0	0	0	0	115	115	73	0	0	14	14	0	0	0	11
Fallow – VegeSupp.	0	0	0	0	0	0	0	0	0	15	0	0	0	15	0	0	0
Tables – mustard/mung																	
No cropping pattern	42	42	42	42	0	0	0	0	29	0	0	0	0	0	0	0	0

Supp. Table 3. Fertilizer and manure application practices at different times

Name of fertilizer and manure		Different times			
		50 years ago	30 years ago	15 years ago	Present status
Fertilizer	No fertilizer	130	130	0	0
	Urea	0	0	130	130
	TSP	0	0	130	130
	K ₂ O	0	0	130	130
	Gypsum	0	0	130	130
	Zink	0	0	0	120
	Boron	0	0	0	115
	Others	0	0	0	0
Manure	No Manure	130	130	130	79
	Cowdung	0	0	0	29
	Compost	0	0	0	8
	FYM	0	0	0	14
	Others	0	0	0	0
Bio – fertilizer	No use	130	130	130	130
	<i>Rhizobium</i>	0	0	0	0
	BGA	0	0	0	0

FYM = Farm Yard Manure

GM = Green Manure

Supp. Table 4. Causes of changing cropping pattern with their perception index, rank

Causes	Perceptions			Perception index	Rank
	Agree	Undecided	Disagree		
Dependence on staple food	130	0	0	390	1
Income from unit area for cultivation of staple food is high	55	39	36	279	9
Lack of knowledge about balanced nutrition from other crops	24	82	24	260	10
Lack of availability of high yielding rabi crop varieties	52	45	33	279	9
Low yield of rabi crops	83	38	9	334	2
Introduction of shrimp farming as a high return	95	0	35	320	4
Land leased out for shrimp cultivation	92	0	38	314	6
For cultivation of finfish	84	4	42	302	7
For starting orchard	14	60	56	218	13
For tree plantation	23	56	51	232	11
Change in utilization patterns of agricultural implements	22	55	53	229	12
Demand of land for non-agricultural process (commerce, industry, Transport)	58	38	34	284	8
Increasing pressure on land (Mainly for population)	74	37	19	315	5
Neighbourhood aspects: Changes in the farming practices and crop pattern in the neighbouring areas induce other farmers to adapt to the changes.	80	32	18	322	3

Supp. Table 5. Distribution of the individual statement according their overall perception of causes of changing cropping pattern

Category	Score	Causes		R	$\bar{X}$	Sd
		Number	Percentage			
Low perception	Up to 130	0	0	218 – 390	291.29	46.93
Medium perception	131 – 260	5	36			
High perception	> 260	9	64			

Supp. Table 6. Distribution of the respondents according their overall perception of causes of changing cropping pattern

Category	Score	Respondents		R	$\bar{X}$	Sd
		Number	Percentage			
Low perception	Up to 14	0	0	25 – 38	31.37	3.03
Medium perception	15 – 28	22	16.92			
High perception	> 28	108	83.07			

Supp. Table 7. The consequences of changing cropping patterns

Causes	Perceptions			Perception index	Rank
	Agree	Undecided	Disagree		
The year – round distribution of labors	123	2	5	378	2
The livelihood of people is increasing due to high income from unit area of land	130	0	0	390	1
Health hazard/imbalance or malnutrition	69	55	6	323	4
Introduction of mechanized cultivation	0	13	117	143	7
Change in utilization patterns of agricultural implements	90	38	2	348	3
Lowering bio-diversity	12	94	24	248	6
Decreasing dairy farming	85	22	23	322	5

Supp. Table 8. Distribution of the individual statement according their overall perception of consequences of changing cropping pattern

Category	Score	Consequences		R	$\bar{X}$	Sd
		Number	Percentage			
Low perception	Up to 130	0	0	143 – 390	307.43	86.09
Medium perception	131 – 260	2	29			
High perception	> 260	5	71			

Supp. Table 9. Distribution of the respondents according their perception of consequences of changing cropping pattern

Category	Score	Respondents		R	$\bar{X}$	Sd
		Number	Percentage			
Low perception	Up to 7	0	0	12 – 19	16.32	1.53
Medium perception	8 – 14	13	10			
High perception	> 14	117	90			

APPENDIX - III

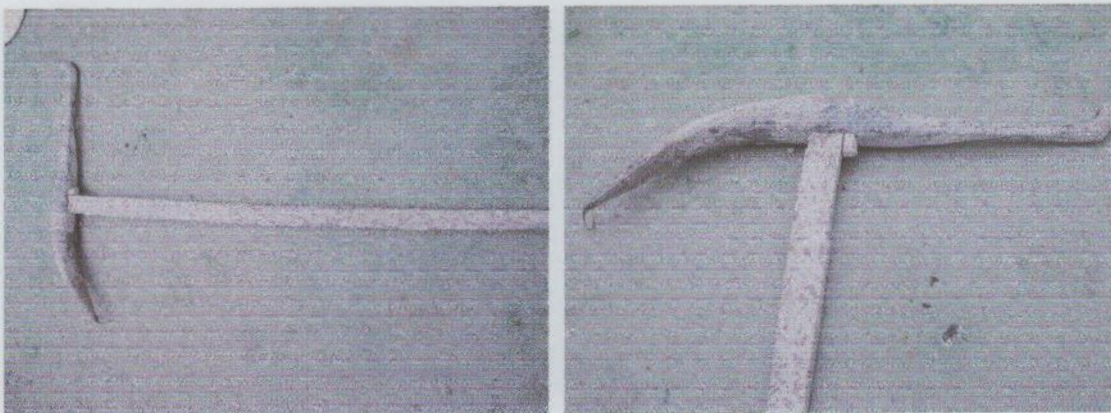


Plate 1. Country plough

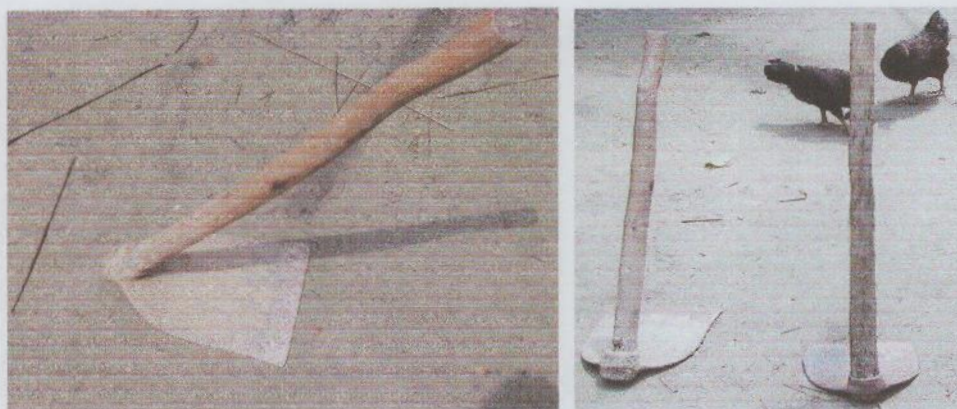


Plate 2. Spades



Plate 3. Power tiller

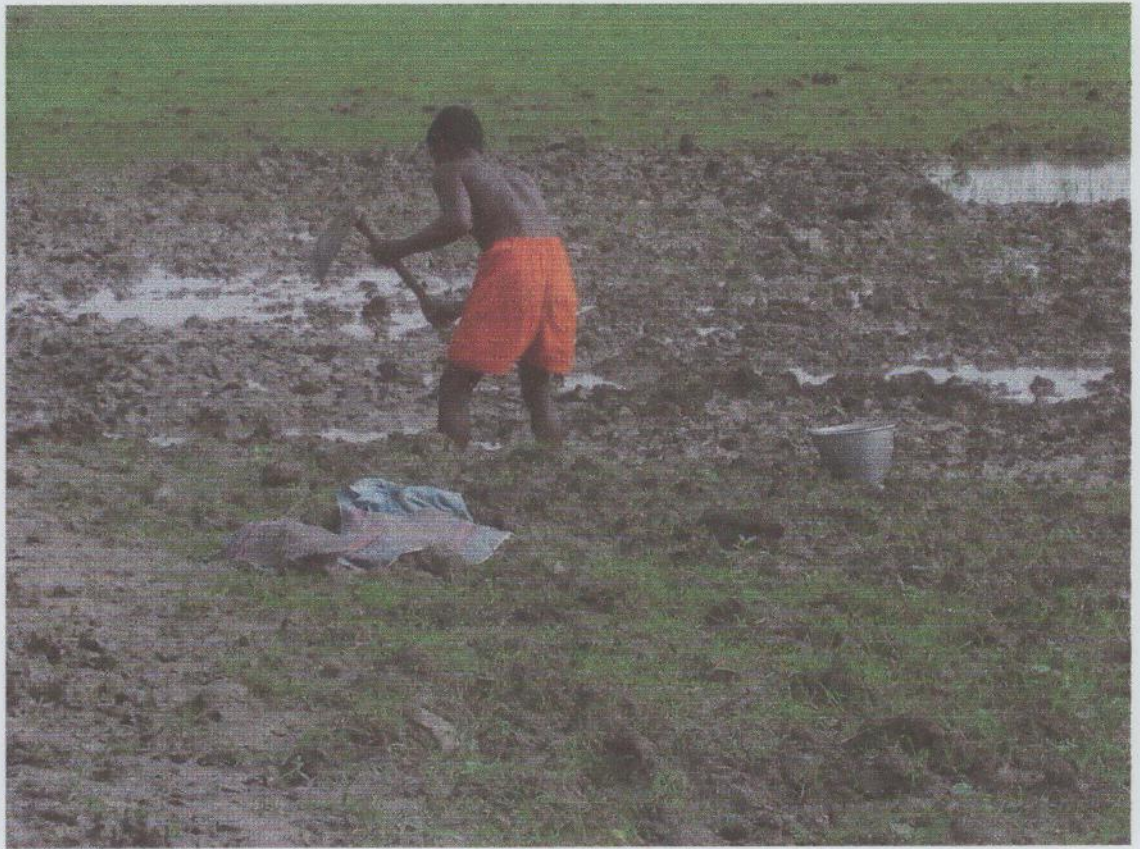


Plate 4. Land preparation with spade



Plate 5. Land preparation



Plate 6. Preparation of country plough for ploughing



Plate 7. Land preparation with country plough



Plate 8. Land preparation with country plough



Plate 9. Weeding for land preparation



Plate 10. Land preparation with power tiller



Plate 11. *Gher* with rice and vegetables



Plate 12. Vegetables on the bank of *gher*

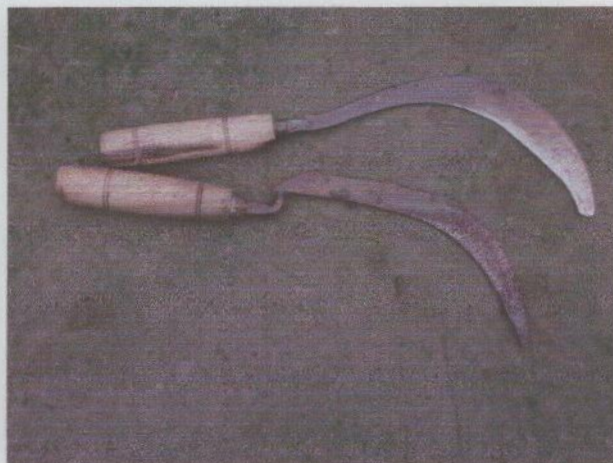
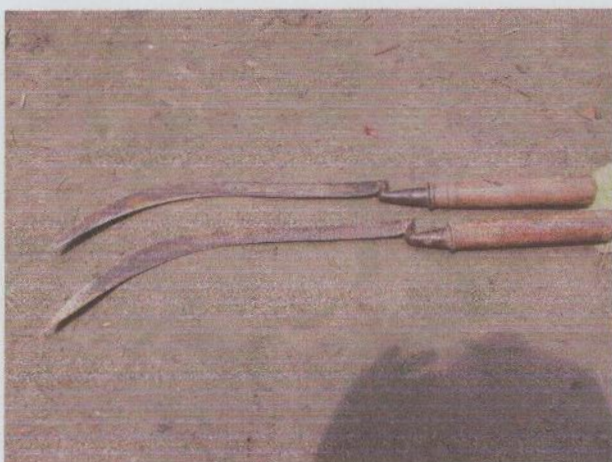


Plate 13. Different types of sickle used in weeding, harvesting



Plate 14. Different types of hoe used in weeding



Plate 15. Different types of small spade used in weeding, thinning



Plate 16. Rake used in weeding, thinning



Plate 17. Hoe and single rake used in weeding, thinning



Plate 18. *Khupri* used in weeding, thinning

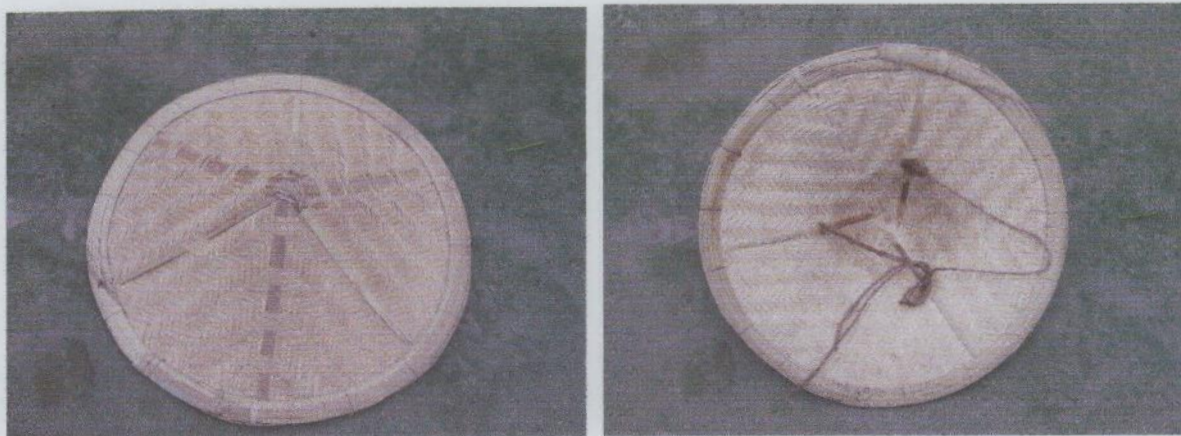


Plate 19. *Mathal* used as hat by the farmers



Plate 20. *Halolathi* used to control bullock at ploughing, transportation

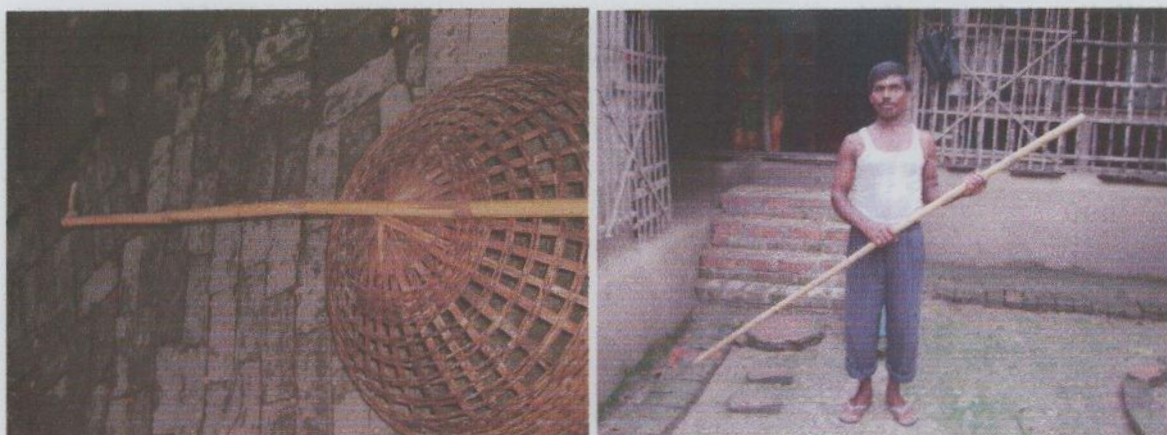


Plate 21. *Kandol* used in drying, threshing

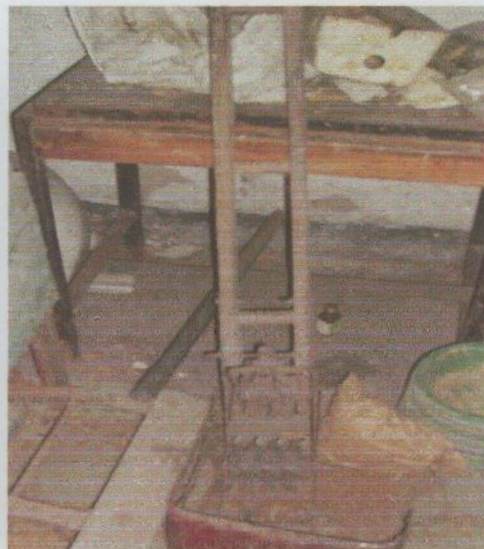


Plate 22. Seed drill (left) and Japanese rice weeder (right)



Plate 23. Shallow pump used for irrigation

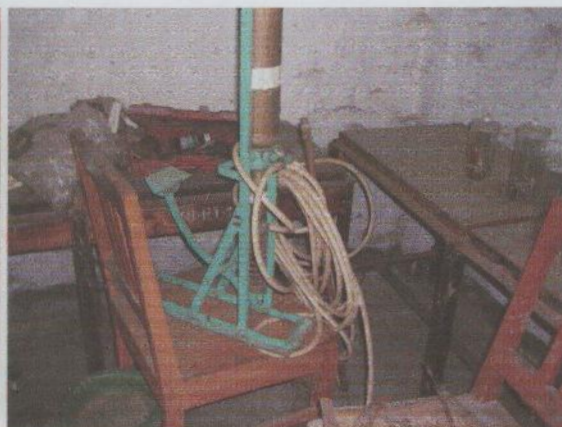
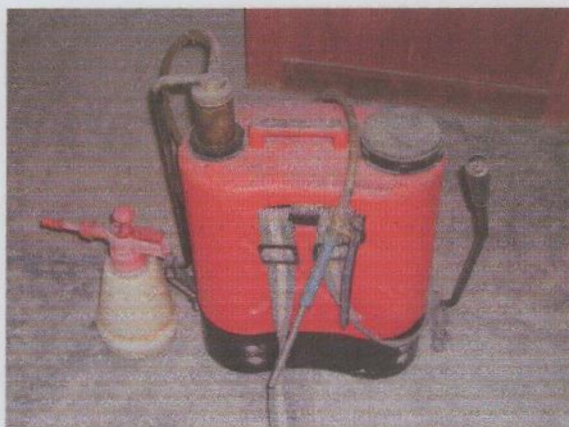


Plate 24. Different types of sprayer (Hand sprayer in left and foot pressure sprayer in right)



Plate 25. Paddle thresher



Plate 26. *Kular* used in cleaning

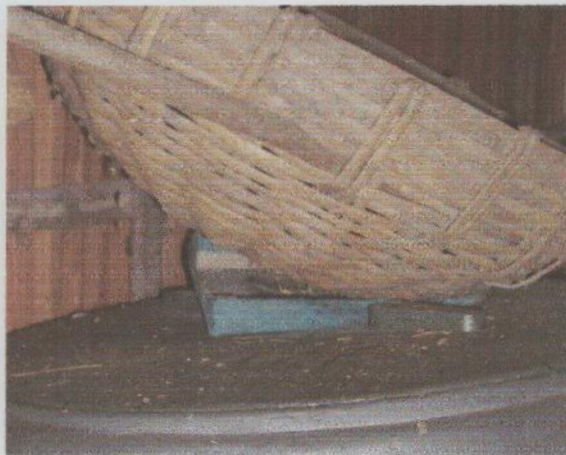
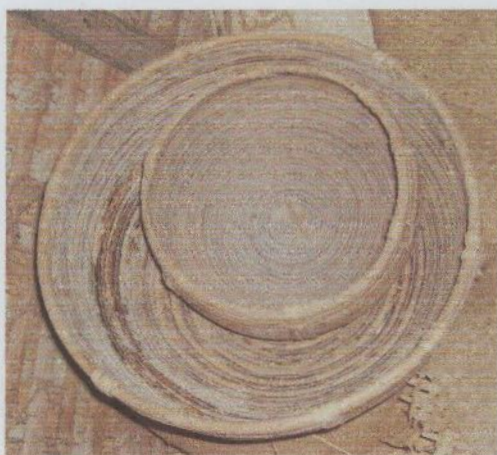


Plate 27. Different types of basket (*Dhama* in left and *Jhuri* in right)



Plate 28. Rectangular *gola* used for storage

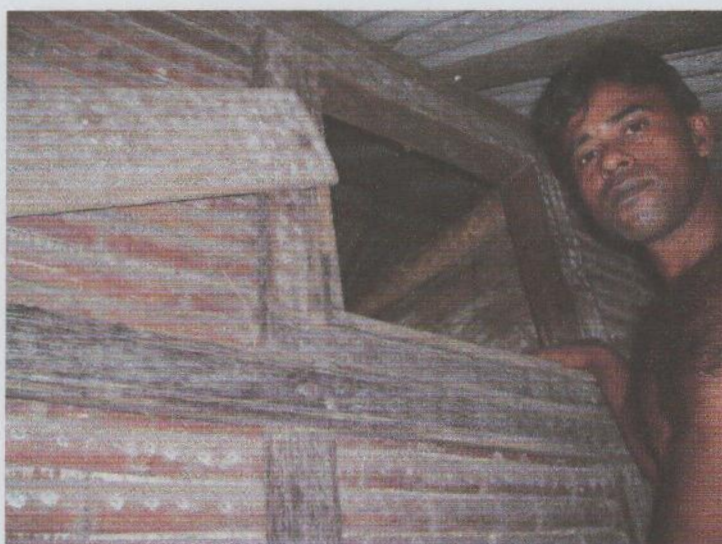


Plate 29. Door or entrance of the rectangular *gola*

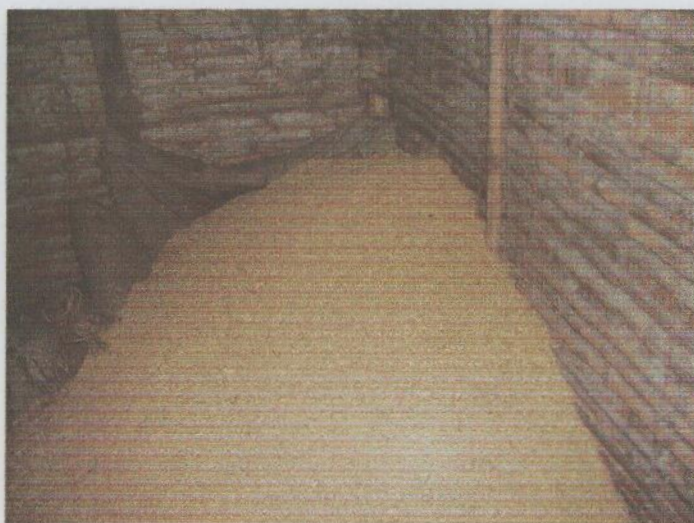


Plate 30. Rice (grain) stored in a rectangular *gola*



Plate 31. Round gola made by hogla (left) and tin (right)

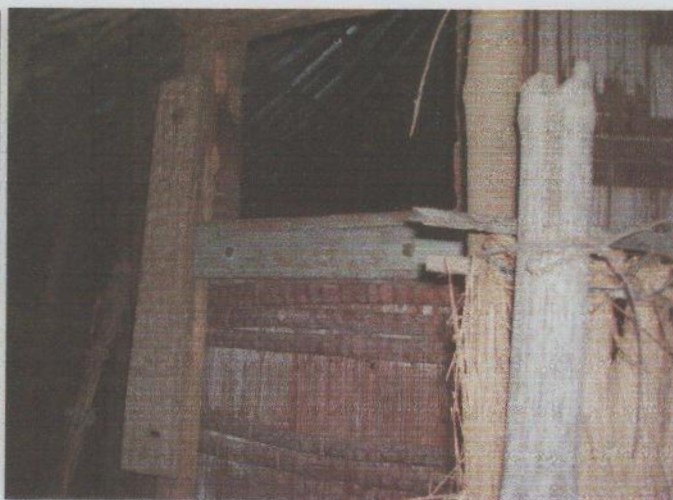
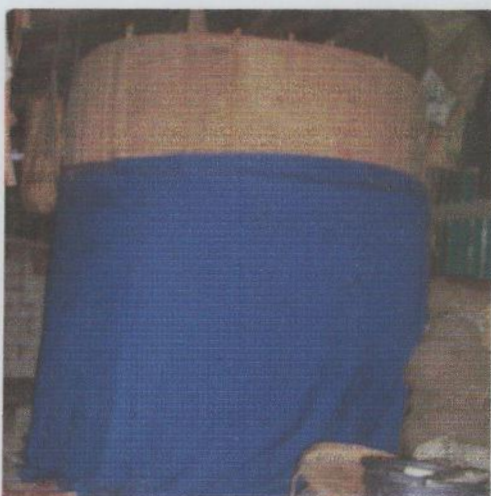


Plate 32. Round gola made by bamboo (left) and entrance of a round gola (right)

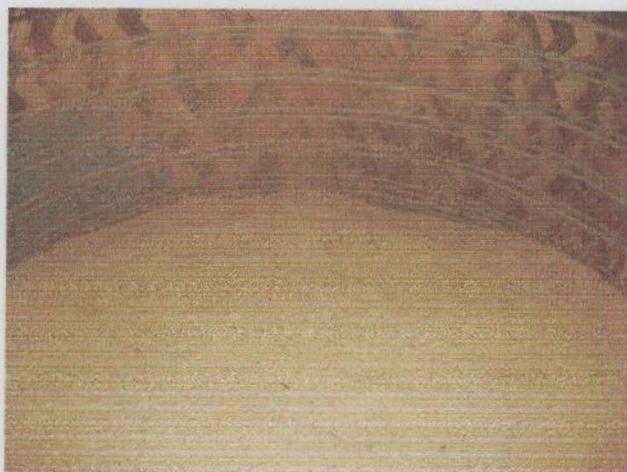


Plate 33. Rice grain in a round gola