Analysis of Changing Agricultural Pattern in Jessore: Environmental and Social Aspects

Ph.D. THESIS

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Dedicated to my

Departed Beloved Parents

CERTIFICATE

I hereby certify that the work reported here was carried out by Md. Abdur Raufe under my guidance and supervision. It is further certified that the work presented here is original and suitable for submission as a Ph.D. Thesis.

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ABSTRACT

Bangladesh is a highly populated country and majority of the population depends on agriculture. The objective of the study is to assess the changing agricultural pattern and production in last three decades in Jessore (1981-2010) which is being influenced by environment and social parameters. For this research work, the related data and information have been collected from both primary and secondary sources.

There was a massive change in agriculture pattern influenced by various parameters including soil character, rainfall, temperature, relative humidity, groundwater level, as well as availability and use of various agricultural inputs, modernization of cultivation method, improvement in transport and marketing system in last three decades. Result revealed that the soil nutrient, soil organic matter, and soil pH have been decreasing but increasing the arsenic contamination and water contamination due to over use of land, chemical fertilizers and pesticides during 1981-2010.

The results also showed that there was a significant transformation of agricultural pattern. Per unit area and yield of cereal crops such as transplanted Aus & Aman, Boro, and vegetables had been increasing gradually while decreasing the broadcast Aus, Aman and Banana. Rabi crop area is decreasing which was 0.45 ha per household in 1981-90 and decreased 0.29 ha in 2001-10 but yield is increasing for better management and use of good seed quality. From 1981-2010, per unit yield of non cereal crops such as jute, flower and cotton has been increasing although area has been decreasing except flower. Per unit area of wheat, sugarcane and fruit has decreased but timber tree has found to be increased during this period. The forest sub sector such as commercially used lichi, mango and *baukool* cultivation has largely increased after 1990. Average number of date tree cultivation per household has rapidly declined which was 26 in 1981-90 and 4 in 2001-10. Unit area and yield of fish cultivation are increasing gradually which was 0.17 ha in 1981-90 and 0.48 ha in 2001-10. Livestock raising has been increasing with change of purposes, from domestic to commercial and which was 2873 million in 1984 and 3853 million in 2001-10. Use of local seed in cultivating all the cereal and non-cereal crops has been decreasing gradually. Increase yield per unit of land has risen for improved water control, better soil preparation, better seed quality and better harvesting and post-harvesting processing. Therefore, these practices have great influenced increasing in

the cropping intensity in Jessore from 168% to 185% in 1984 and 2008 respectively. Cost of cultivation has reduced for use of modern appliances.

Educational status, age and gender of farmers, secondary occupation, training on agriculture from GoB and NGO influenced the agricultural pattern in last three decades in Jessore. Opportunity to receive credit from GoB and NGO has increased during 1981-2010. Receiving training on agriculture has improved farmer's quality to utilize input materials optimally. Marketing system, supply chain linking, transport management and communication have remarkably changed. The farmer has got fair price of their products which has great influence on changing agricultural pattern.

Use of chemical fertilizer has increased from 14% to 95% while organic fertilizers has decreased from 86% to 5% from 1981-1990 to 2001-10 respectively. For irrigation purpose, traditional methods are replaced by modern methods over decades. Swallow tubewell and deep tubewell were used by 10% and 3% household in 1981-90 and 85% and 8% in 2001-10 respectively. Modern cultivation method has become popular and traditional method has declined gradually. Pesticide use has been increasing rapidly which was 12% in 1981-90 and then 51% in 2001-10.

The overall transport system including roads and vehicle has developed in Jessore like other places of Bangladesh. Pickup, truck, *trolley* and *nocimon* have become popular transport to the farmers to carry agriculture products instead of traditional vehicles. Uses of pickup and truck were absent in 1981-90 and it was 57% and 49% in 2001-10 respectively. Bullcart and headload have declined rapidly in the study area which was 94% and 90% in 1981-90 and reduced to 3% and 1% in 2001-10 respectively.

Therefore, the present study concluded that agricultural pattern in Jessore has changed over period for multi factorial elements including environmental aspects such as soil nutrients, rainfall, temperature, relative humidity, groundwater; and social aspects such as education level, getting training on agriculture by the farmer and availability and use of chemical fertilizer, pesticides, transport and marketing system, communication and credit facilities.

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ABBREVIATION

ADB : Asian Development Bank
AEZ : Agroecological Zone
Agri : Agriculture
ASI : Agro Services International
B. Aman : Broadcast Aman Rice
B. Aus : Broadcast Aus Rice
BADC : Bangladesh Agriculture Development Corporation
BARC : Bangladesh Agriculture Research Council
BARI : Bangladesh Agriculture Research Institute
BAU : Bangladesh Agriculture University
BBS : Bangladesh Bureau of Statistics
BCAS : Bangladesh Center for Advanced Studies
BFVAPEA : Bangladesh Fruits, Vegetables & Allied Products Exporters' Association
BINA : Bangladesh Institute of Nuclear Agriculture
BRRI : Bangladesh Rice Research Institute
BWDB : Bangladesh Water Development Board
CBOs : Community Based Organization
CCC : Climate Change Cell
CDMP : Comprehensive Disaster Management Program
CEGIS : Center for Environment and Geographical Services
DAE : Department of Agriculture Extension
DoE : Department of Environment
DOF : Department of Fisheries
DOF : Department of Forest
DPHE : Department of Public Health Engineering
DTW : Deep Tube-Well
EIA : Environment Impact Assessment
FAO : Food and Agriculture Organization
FGD : Focus Group Discussion
GDP : Gross Domestic Products
GoB : Government of Bangladesh
H.Hs : Household
HIES : Households Income and Expenditure Survey
HTW : Hand Tube Well

HYV : High Yielding Varieties
IFAD : International Fund for Agriculture Development
IPCC : Intergovernmental Panel on Climate Change
IPM : Integrated Pest Management
IUCN : International Union for Conversation and Nature
LGED : Local Government Engineering Department
MIS : Management Information System
MOEF : Ministry of Environment and Forests
MoFDM : Ministry of Food and Disaster Management
MP : Murat of Potash
MT/M.ton : Metric Ton
NAP : National Agricultural Policy
NFP : National Food Policy
PRA : Participatory Rapid Appraisal
PPS : Probability Proportionate to Size
SIA : Social Impact Assessment
SLR : Sea Level Rise
SRDI : Soil Research Development Institute
STW : Shallow Tube-Well
T. Aman : Transplanted Aman Rice
T. Aus : Transplanted Aus Rice
TA : Technical Assistance
TSP : Triple Super Phosphate
UNDP : United Nations Development Program
USAID : United States Agency for International Development
WB : World Bank
WFP : World Food Programme

Chapter 1

INTRODUCTION

1. Introduction

Agriculture is the deliberate effort to modify a portion of Earth's surface through cultivation of crops and raising livestock & poultry, fisheries and plantation for subsistence or economic gain. It is the key implement in the rise of sedentary human civilization, whereby farming of domesticated species created food surpluses that nurtured the development of cultivation. It has influenced the growth of areas and human society.

Bangladesh, the agricultural based country is the 7th largest populated countries in the world, land size of 90th in the world where 142 (Population Census 2011) million people are virtually elbowing each other in a land that is 147,570 sq km in area. According to Population Census 2011, 964 inhabitants live per square kilometer and in 1901, it was 216. At present average annual growth rate is 1.34%. Compared to the enumerated population in 2001, about 18 million people are added in last decade.

Agriculture in Bangladesh is constrained every year by challenges, such as loss of arable land, rapid population growth, climate changes, inadequate management practices, unfair price of produces, lack of quality seeds and inadequate and inefficient credit support to farmers. Agriculture in Bangladesh has become regularly vulnerable to the hazards of climate change, flood, drought and salinity in particular. In addition, poor management practices, especially those of pests and diseases, fertilizer, water and irrigation have largely contributed to significant change in cropping pattern. In view of the above, diversification of agricultural activities is considered important for enhancing agricultural production and productivity in Bangladesh.

The challenge to maintain food and population balance is great because practically all cultivable land is in use for different purposes. There is little scope to expand the land frontier in Bangladesh. The pressure of increasing population reduced the average size of farm holding from 0.69 to 0.60 hectare (ha) in the period 1996-2005 (BBS, 2006). The country also faces a difficult land distribution challenge to achieve

food security for all groups in society. About 20% of the rural households have no cultivable land and another 38% have less than 0.20 ha (BBS, 2006). Bangladesh has lost about one million ha of productive arable land from 1983 to 1996. That is about 80,000 ha of agricultural land per year are going out of crop production (BBS, 1999). In 1990, the agriculture land was 73.35% and in 2004, it has decreased to 69.3%. Major factors responsible for land loss are urbanization, human settlement, building of infrastructure and river erosion (Mondal, 2005).

1.1 General Background

Bangladesh economy draws its main strength from agriculture sector. The sector contributes a major share in the GDP, which is about 20.6% and employs about 48.10% of the working force. Again, among the sub-sectors contributions of agricultural GDP is dominated by crops (56.07%), followed by fisheries (22.18%) and livestock (13.25%) and the rest by forest and related services (8.50%) (BBS, 2010).

Climate change is a significant and lasting the change in the pattern of statistical distribution of weather related parameters over periods ranging from decades to millions of years. It may be a change in average weather conditions or the distribution of events around that average (e.g., more or fewer extreme weather events). Climate change may be limited to specific regions or may occur across the whole earth.

Climate is a vital factor for agriculture and at present climatic parameters has been changing gradually. According to the Intergovernmental Panel on Climate Change (IPCC 4th Assessment Report, 2007), Bangladesh will be one of the worst victims of climate change. At present groundwater contributes in irrigating 77% of total irrigated area in Bangladesh (BBS, 2008). The hydrological cycle of Bangladesh is influenced very much by the presence of the Himalayas in the north and the Bay of Bengal in the south. The major watersheds important for the country are the Brahmaputra, Meghna and the Ganges. About 93% of water that flows through the country comes from trans-boundary sources. The sector wise withdrawal of water is dominated by agriculture (86%) followed by domestic (12%) and industry (2%) (Divya, and Mehrotra, R.1995). The groundwater irrigation has increased with the expansion of High Yielding Variety (HYV) rice cultivation. About 80% of

groundwater is used for crop production of which Boro paddy alone consumes 73% of total irrigation (Rahman and Ahmed, 2008). Hence, Boro rice production is increasing at about 1% annually and contributes to 55% of the total rice production (BBS, 2007).

Proper irrigation plays a vital role in crop production in the country. Soils vary conspicuously with respect to moisture holding capacities, infiltration rates, and other related properties (Karim et al., 1990). In Bangladesh of the crop land irrigated area was 33.8% in 1990 and it has raised to 54.3% in 2002. Whereas in Jessore irrigation area was 15.34% in 1984 and in 2008 it covered 79.13 % of crop land (Agriculture Census 1986 and 2008).

Bangladesh has a total area of 148.4 million ha (Mha), 67% of which is arable (BBS, 2008). About 1% of the cultivable land is going out of agricultural use annually. The land-man ratio is decreasing at an alarming rate; the current estimated per capita arable land stands at 0.05 ha only. On the other hand, intensified agricultural land use accompanied with increased use of modern crop varieties has contributed to deterioration of soil health (Jahir et al, 2010). Land degradation and land quality change due to improper anthropogenic interventions. In Bangladesh, active land degradation processes are soil erosion and loss of fertility due to physico-chemical or biological degradation of soils. A good soil should have at least 2.5% organic matter but in Bangladesh most of the soil has less than 1.5%, and some soils have even less than 1% organic matter (BARC, 2005).

During 1994-95 to 2008-09, rice yield in the country has steadily increased from 16.83 to 34.22 million tones, though wheat yield declined slightly from 1.25 to 0.958 million tones. It indicates an overall increase in production of cereal crops. The area under rice cultivation and per capita availability of land has increased over periods, in 1990 it was 0.10 Mha and in 2004, it has increased 0.11 Mha (BBS-2004).

Jessore district area is 2,567 sq.kms (991.13 sq.miles) including riverine area which constitutes 1.74% of total area of the country. In respect of area, the district ranks 4th among the 10 districts of Khulna Division and 24th among the 64 districts of the country. This district is 8 meter high from sea level and plain land. Suitable climatic and physiographic condition, good soil, Jessore district is idle place for cultivation.

In 1990, the average rainfall in Jessore was 1,648 CM and in 2010, it is 1,371 CM. In 1990, maximum temperature was 37^0C and in 2010 it was 40.6^0C in Jessore. Boro cultivation area in 1985 was 3, 23,886.64 ha and in 2010, it has reached 22, 87,449.39 ha in Jessore. The ground water level has fallen drastically and the adjacent areas in Jessore. The ground water level was 26 feet from the surface in 1988 and it has fallen down by 32 feet (7.95 meter) in 2008. As a result, pulling of water has become extremely difficult.

The ecological and geological situation of Jessore is unique in many ways. This district is under brackish water ecosystem. It is the part of moribund delta. The district possesses a sturdy ecosystem and is a low level and vast plenty area. Its Physiographic feature is much diversified. It is mentionable here that the physiographic feature of an area may change in pace of time due to natural and artificial causes (Brammer, H. 2002). The soil of this region contains dark grey clay mixed with peat, calcareous dark clay loam and the salty clay loam of the Ganges meander flood plain. There are numerous small depressions (beels/baors) have small rivers criss-crossed the area. The elevation of the central part of the depression is about 8 meter above the sea level. The elevation of the flood plain ranges from 8 to 15 meters above the sea level. The flood plain covers the southeastern part of the district (Agricultural Census in 1996 and 2008).

Land use patterns as well as cropping patterns are changing in Bangladesh as like as Jessore due to a range of factors. According to the agriculture census in Jessore operated area is about 21, 49,798 ha in 1984, the trend is declining and in 1996, it is 19, 02,834 ha and in 2008, it has reached to about 20, 32,389 ha. The percentage of agriculture labor household in Jessore is 64.43 and 67.55 in 1986 and 2008 respectively (BBS, 2008).

This study aims to analyze the agriculture pattern changes in Jessore during the period 1981-2010 in respect of environment and social aspects.

1.2 Problem Statement

Agriculture is an important sector of the economy of Bangladesh. Since provision of food security, improvement of the living standard and generation of employment opportunities of the large population of the country are directly linked to the development of agriculture, all the people in Bangladesh are trying their best for proper utilization of land and have better production and subsequently improve their socio-economic condition.

Ensuring food security for all is one of the major challenges and the production of necessary food crops by changing land use patterns is a great challenge for the farm household in Bangladesh. Aiming to food security cropping pattern as well as farming system has been changed over period by the farmers with the introduction of new technologies and better management. Cropping intensity in Jessore increased from 169% to 182% in 1984 to 2008. Under this farming situation, farmers also changed their land use patterns and introduced new enterprises combination along with rice or without rice production in different areas. In this study area a few study has been conducted but land use patterns as well as change of cropping pattern yet not researched. So it is very much needed to study change of cropping pattern in Jessore.

Climate change is no longer hype, it is a reality and it is announcing its presence through increasingly erratic behavior. Agriculture is one of the most vulnerable systems to be affected by climate change in Bangladesh. Agricultural productivity in this region is likely to suffer severe losses because of high temperature, severe drought, flood conditions, and soil degradation. The ground water level has fallen drastically in Jessore district and the adjacent areas. The over use of land, chemical fertilizer, groundwater and pesticides has increased water and soil contamination which affected the biodiversity of the study area.

As a whole, the problems of current agriculture are climate change, land and soil problem, irrigation problem, soil fertility change, salinity intrusion, accessibility to inputs and marketing opportunities. So, the present study has undertaken to know the environmental aspects such as soil nutrients, rainfall, temperature, relative humidity, groundwater; and social aspects such as use of chemical fertilizer,

pesticides, transport and marketing system, communication, credit facilities, receive of training on agriculture technology by the farmers which have great influence in changing the agricultural pattern in Jessore District.

1.3 Literature Review

Literature review is very important for any kind of research. The purpose of this research is to review of literature having relevance of this study. The researcher extensively reviewed the available literature to search out related works in Jessore and Bangladesh as well as in other countries. No studies have found which deal with the problems confrontation in relation to the agricultural pattern changes. The collected information through review of literature may not be identical but similar to the present study: Unfortunately, no study has found which deals with the analysis of changing agricultural pattern in Jessore: Environmental and Social aspects. For the better understanding literature review has discussed as follows.

Numerous evaluations of recent trend in agriculture in Bangladesh and agro-environment toward sustainability have been conducted over the years, and the system has been modified following a number of studies (Robbani et al., 2007). Agriculture production has increased tremendously in many parts of the world as like as Bangladesh in the last few decades through the increased use of high-yielding varieties of seeds, inorganic fertilizers, pesticide and irrigation. Asian Institute of Technology, Pathumthani, Thailand has conducted Sustainability analysis of ecological and conventional agricultural system in Bangladesh (Rasul et al., 2003). In R Faruquee (ed.), Bangladesh agriculture in the 21st century, (Ahmed and Hasanuzzaman, 1998).

Robbani, M. et, al, (2007) has conducted a study on Agriculture in Bangladesh, Recent Trend and Agroenvironment Toward Sustainability. Bangladesh agriculture is now in the process of transforming from subsistence farming into commercial farming. An investigation by Food and Agriculture Organization (FAO) of the United Nations on the current status of land productivity in Bangladesh revealed that there is a general trend towards declining and stagnating crop yield. These adverse trends are considered to be due to intensive cropping through

indiscriminate use of fertilizers, pesticides, use of water irrigation and total removal of biomass from the agricultural fields.

CEGIS has conducted a study on the "Adaptive Crop Agriculture Including Innovative Farming Practices in the Coastal Zone of Bangladesh, 2008" in Satkhira District. The objective of the study was to find out suitable adaptation measures that have the potential to help farmers to adapt to climate changes and to identify suitable varieties of crops that would be able to adapt in order to cope with the climate change. In order to assess and analyze the problems, the study team members appraised the existing findings from literature review and community consultation. Physical suitability change under climate change scenarios is analyzed to assess potential threats to current land use practices.

Mondal and Hossain, 2009 has conducted Characterizing Long-term Changes of Bangladesh Climate in Context of Agriculture and Irrigation. The overall objective of this study was to characterize the spatial and temporal changes in long-term climate of Bangladesh using the measured data available with Bangladesh Meteorological Department (BMD) at different locations of Bangladesh. The results of rainfall, temperature, sunshine duration and evaporation analyses are reported, and following that, the possible impacts of the changes in these variables on irrigation water demand and crop production are discussed.

Hossain, M. A. (2004) has conducted country case study on environmental requirements, market access/entry and export competitiveness for horticultural products from Bangladesh. The researcher projected on building capacity for improved policy making and negotiation on key trade and environment issues.

Islam, M. S. et. al. (2010) has conducted study named "Changing Land Use Patterns and Their Impact on Food Security for Farm Households in Bangladesh". This study was carried out with the support of the National Food Policy Capacity Strengthening Program and financed under the Research Grants Scheme (RGS) of the National Food Policy Capacity Strengthening Program (NFPCSP). The purpose of the study is to assist in improving research and dialogue within civil society so as to inform and enrich the implementation of the National Food Policy.

Martinez, J. A. (2000) has conducted a research on application of landsat TM images to map the long term cropping patterns. These maps allow implicit spatial and temporal relationships among the crops growth in an agricultural area. Cropping pattern is understood as the spatial distribution of associations between crops or cropped and uncultivated land in the same fields along the years by the analyses time-series.

Bouis, H. E. (2000) has conducted a study on "Commercial vegetable and polyculture fish production in Bangladesh: Their impacts on household income and dietary quality". Numerous non-governmental organizations (NGOs) in Bangladesh are promoting adoption of vegetable and fish pond activities through credit and training programs targeted at women. The present study examined three such programs: like commercial vegetable production; polyculture fish production in household-owned ponds; polyculture fish production in group-managed ponds. Three such programs are examined, which promote adoption of polyculture fish production (two sites) and commercial vegetable production (one site). The programs evaluated income generation and not better nutrition as their primary objective. The fish and vegetable technologies are found to be more profitable than rice production, although rice production provided a higher share of total income. On the basis of the evidence collected, there is little reason to believe that adoption of the two technologies has improved the micronutrient status of members of adopting households through better dietary quality. There is no finding of disproportionately high own-consumption of fish and vegetables by adopting households. The impacts on overall household income, although positive, are not strong. The effects of adoption on women's status and time allocation do not change this position in the family or community.

Ali, M. A. et. al. (2010) conducted an investigation carried out based on the survey of the problems and prospects of fish fry trade in Jessore district in Bangladesh. Bangladesh is blessed with vast inland waters and it is covering an area of 5.31 million ha in which Pond and Ditches covering an area of 2.42 lac ha. Fish production from this water body during the year 2000- 2001 is 615,825 MT. Where as the total country fish production in the country in the year 2000-2001 is 17.81 lac MT. This is 34.5% of the total fish production (DoF, 2002). Fisheries sector provides

employment to over1.4 million full time fishermen, in addition to 11 million part time fishermen. It also contributes 9.12% of national income in 1995- 96 (BBS, 1996).

Karim, Z. (2011) made a study on Assessment of investment and financial flows to adapt to the climate change effects in the agriculture sector under UNDP global project capacity development for policy makers to address climate change. According to the Bangladesh Bureau of Statistics (BBS, 2007) about one-fifth of populations are hard core poor who consume less than 1805 kcal per capita per day (BBS, 2007). Results from crop simulation studies examining climate change impacts on agriculture showed a negative impact on crop productivity in Bangladesh. Fisheries, livestock and forestry sectors are also largely affected by climate change variability. The climate change induced devastating events will worsen livelihood of people with increased poverty.

Quddus, M. A. (2009) has conducted a research on crop production growth in different agro-ecological zones of Bangladesh. The purpose of this study was to evaluate the progress and regional variations of crop production in Bangladesh. The remarkable progress of rural literacy rate, ratio of agricultural workers to population, number of farmer's co-operative societies and per capita regional domestic agricultural products in two decades is observed in different regions. Wide disparities in the level of crop sector development have been observed across the regions. The overall results reveal that some of the regions are in better positions in respect of socioeconomic progress, land use pattern, input use, growth performance of HYV rice and food-grains production.

Haque et. al. (2010) has conducted Print Media and Climate Change in Bangladesh: The Missing Health Issue in an International Conference on Environmental Aspects of Bangladesh (ICEAB10), Japan, Sept. 2010. Coverage of reports on climate change is deficient. None of the daily newspapers has done any independent research on climate change and its impact on health in Bangladesh. Special issues on climate change, editorials and round table discussions with experts are insufficient within the context of the problem. As a result, there are no strategic plans regarding the management of or adaptation to climate change issues in Bangladesh. Print media has the potential to influence climate change policies through

independent research, roundtable meeting with development partners, UN bodies, and can highlight the damages up to the need.

Islam, A. K.M. S.(2008) conducted the study on "Analyzing Changes of Temperature over Bangladesh due to Global Warming Using Historic Data". It has been clearly found that temperature of winter season (December to February) has been raised much higher rate than that of summer season (June to August). This study also reveals that temperature has been increasing predominantly over the last 30 years (1978-2007) than last 60 years (1948-2007). In winter season (November-February), the main crops of Bangladesh are Boro (rice), wheat, potato, vegetables. Increase of winter temperature can reduce the environmental suitability for wheat, potato and other temperate crops grown in Rabi season. During the winter and pre-monsoon season (March-May) wheat and Boro mainly grow in the country. The trend of daily minimum temperature is higher in the country. Therefore, changes of climate will severely effect in decline grown of various winter crops of the country.

Nyanga, P. H. et.al. (2011) has carried out smallholder farmers' perceptions of climate change and conservation agriculture: evidence from Zambia. He found his research that most farmers attributed climate change to supernatural forces. Smallholder farmers' perceptions related to floods and droughts are significantly associated with adoption of conservation in agriculture. The extent to which smallholder farmers perceived conservation of agriculture as a climate change adaptation strategy is very low. Policy implications of the study area conservation of agriculture projects should not only focus on technical approaches to increase adoption rates but also consider social aspects such as perceptions that are equally important in conservation of agriculture. Inclusion of climate change communication to facilitate exchange of climatic information that could enable smallholder farmers relate to conservation agriculture as an adaptation strategy is essential.

Rashid, M. A. et. al. (2003) did a research on Socio-economic Parameters of Eggplant Pest Control in Jessore District of Bangladesh. Eggplant is cultivated all over the country; the greater Jessore region in the southwest is the major production area and is traditionally considered as the "vegetable basket" of the country. Intensive cultivation of eggplant in this area provides 30.2% of the summer and 21.5% of the

winter supply of this vegetable for the country (BBS, 1998). Nationwide, production area for eggplant has increased from 29,132 ha in 1994– 95 to 66,789 ha in 1998–99 and the production has gone up from 187,705 tons to 403,730 tons during this period (BBS, 1999). Although this represents an increase of 2.29 times in area under cultivation and 2.15 times increase in production volume nationwide, the production area and volume in the Jessore region increased by only 1.17 and 1.15 times, respectively (BBS, 1996; 1999). Several factors may have contributed to slower growth of eggplant production in Jessore. One of the most visible is the increasing damage by pest insects and farmers' increased reliance on the use of toxic chemical pesticides to combat them.

Weinberger, K. et. al. (2001) AVRDC-The World Vegetable Center has done study on Vegetable Production in Bangladesh: Commercialization and Rural Livelihoods. The researchers also carried out a project with the aim of overcoming constraints in vegetable production. An impact assessment of the USAID project is conducted in 2001. Results revealed that adopting farmers from the four districts in Bangladesh (Jessore, Noakhali, Rangpur and Savar) achieved approximately 30% higher net revenues from vegetable production than their non-adopting peers, among other advantages (Ali and Ahmed 2001). This study aims to understand the effect of increased vegetable production on the rural population beyond the direct farm level.

Biswas (1992) in his study, identified farmers faced problems in cotton cultivation. Non-availability of quality seed in time, unfavorable and high cost of fertilizer and insecticides, lack of operating capital, not getting fair weight and reasonable price according to grade, affects of cattle in cotton field, lack of technical knowledge. Lack of storage facility, stealing from field at maturity stage and late buying of raw cotton by cotton Development Board are identified as major problems of cotton farmers in Jessore district.

Rahman (1995) in his study, identified constraints faced by the farmer's in cotton cultivation non-availability of quality seed in time, unfavorable and high cost of fertilizer and insecticides, lack of operating capital, not getting fair weight and reasonable price according to grade.

Islam, M. S. (2007) conducted a study on potato preservation in cold storage in Bangladesh including the marketing aspects. He found that price spread per metric ton of potatoes appropriated by traders is higher in case of cold stored potatoes than non-stored potatoes.

Akand M. A. I. (2005) has revealed process of agricultural development in Bangladesh and development of commercial vegetables farming and marketing. He found that to overcome the problem of agriculture development in Bangladesh and also to develop the vegetables farming and marketing system.

Aziz M. A. (2006) has undertaken constraints faced by the farmers in potato cultivation in Jhikargacha upazila under Jessore district. He has found that farmers has faced different problems to cultivate potato which has diverted another way their cultivation movement.

Anisurzzaman M. (2008) has conducted problem confrontation of the farmers in tuberose cultivation of Jhikargacha upazila under Jessore district. He found different problems to cultivate of tuberose and way to overcome different problem of the tuberose cultivation system.

Islam, M. R. (2009) has conducted preference of information sources by the farmers in adopting vegetable production technologies. He has also found that much information has got various sources which have influences to the farmers in adopting crops cultivation.

Islam, M. R. (2010) has conducted present status of vegetables cultivation and problems confronted by the vegetables growers at production technologies.

Dorosh, P. et. al. (2002) has conducted Rice Price Stabilization in Bangladesh: An Analysis of Policy Options.

Salam, S. et. al. (2012) has conducted Price Behavior of Major Cereal Crops in Bangladesh. The key concern of the study is to evaluate the extent of the seasonal price fluctuation and spatial price relationship of major cereal crops in different markets in Bangladesh. In estimating seasonal price fluctuation of selected crops, it was found that crops prices fluctuated in different months within the year.

Ahmed, (2010) has reviewed to describe the causes of major changes in land use pattern of the coastal zone of Bangladesh and identify the effects on the environmental degradation obviously considered as a man-made disaster in the area. The paper shows that the way of using the lands in the coastal areas are gradually changing, that is, diverse, competitive and alarming. The land of coastal areas is used for different purposes. This includes: Agriculture, shrimp farming, salt production, forestry, ship-breaking yards, ports, industry, settlements, wetlands etc. The study reveals that land use in this area in 1950 had been mainly used for paddy cultivation, but due to human interferences, the natural drainage systems are greatly hampered and gradually salinity intrusion polluted the water, soil etc in the area.

Barmon, et. al. (2011) has conducted the study to estimate the impacts of price and price variability on acreage allocation of rice and wheat production in Bangladesh. Time series data of price and acreage allocation of rice and wheat production during 1983-84 to 2007-08, collected from Bangladesh Bureau of Statistics (BBS) were used in this study. The study indicated that the wholesale price of rice and wheat had significant impact on the allocation of land for rice and wheat production. Significant price variability was found both in case of rice and wheat crop in short-run (SR) and long-run (LR). Therefore, it might conclude that the price of rice and wheat should be adjusted rapidly along with allocation of rice and wheat production in Bangladesh.

Mondal, M. H. (2010) has studied crop agriculture in Bangladesh: found that challenges and opportunities of agriculture is going to difficult every year by several changes, such as loss of arable land, population growth, climate changes, inadequate management practices, unfair price of produces, and insufficient investment in research. Main problem of agriculture are loss of arable land and increase in the growth of population. These two problems of arable land loss and population growth need to be addressed simultaneously to ensure sustainable crop production. Country's crop production is also affected frequently by flood, drought, and salinity. Varieties/technologies tolerant to these natural hazards need to be developed. Renewable energy, reduction in the use of fossil fuels, and afforestation are recommended to mitigate the adverse effects of climate change. To sustain crop production, chemical fertilizers must be integrated with organic manure and costly

non-urea fertilizers should continue to be subsidized. Incidence of pests and diseases has lately become severe due to climate change impacts. Therefore, more varieties resistant to the pests should be evolved. Small and marginal farmers of Bangladesh have limited access to institutional credit. These farmers do not have farmers' associations or cooperatives to bargain for fair price of their produces.

Shamim et. al. (2010) has conducted Change in Temperature over Bangladesh Associated with Degrees of Global Warming. The research work is to study the temperature trend in Bangladesh. Long term changes of surface air temperature over Bangladesh have been studied using the available historical data collected by the Bangladesh Meteorological Department (BMD). Maximum, minimum and mean monthly temperature data of last sixty-three years (1948-2010) collected from 35 stations of BMD located all over the Bangladesh have been used in this study. It has been found that monthly maximum temperature shows a positive trend of increase at a rate of 0.50^{0}C per 100 year. The maximum increase occurred during November at a rate of 2.05^{0}C per 100 year. However, monthly minimum temperature shows more statistically significant trend of increase at a rate of 1.40^{0}C per 100 year. The maximum increase occurred during February at a rate of 2.73^{0}C per 100 year. Monthly mean temperature shows a positive trend of increase at a rate of 0.80^{0}C per 100 year. It is clearly found that monthly minimum temperature has increased significantly during the winter season (October to February) over the last sixty-three years. This study also reveals that temperature has increased predominantly over the last 21 years (1990 - 2010) than last 63 years (1948 - 2010).

Basak, et. al.(2013) has conducted an assessment of climate change and variability based on analysis of historical data of temperature and rainfall recorded at 34 meteorological stations located at seven regions in Bangladesh for the period of 1976-2008. The trend of variation of average maximum temperature annually has been found to be rising at a rate of 0.0186^{0}C per year, while the rate was 0.0152^{0}C per year. Monthly average maximum temperature analysis also found increasing trend for every month except April and January. The increasing trend was mainly significant for February and May to September. Data of monthly average minimum temperature

also found increasing trends for every month except November and January. Rainfall data analysis showed that for most of the stations, the total rainfall observed increasing trend for post-monsoon and monsoon seasons, while decreasing trend was showed for the winter season; there is no significant change in pre-monsoon rainfall pattern (Basak et. al. 2013).

The study concluded that climate change have noticeable impacts on the rainfall and temperature pattern as well as the seasonal pattern of Bangladesh. These observations are predominantly important for Bangladesh where agriculture is greatly dependent on rainfall and temperature patterns. The yields from rain-fed agriculture of Bangladesh could be reduced to 50% by 2020. For a nation with growing population and hunger, it will have an extremely negative effect on food security. Even though climatic change effects are extremely variable, by 2030, South Asian region could lose 10% of maize and rice yields, while neighboring countries like Pakistan could experience a 50% reduction in crop yield. Since seasonal pattern plays an important role for the poor people livelihoods, such changes threaten their livelihood security and affect the seasonal production cycle. Poor and marginal farmers with small land holdings or no land (cultivating others land) find it hard to cope with the variations in seasonal patterns as their crop production is declining that increases their food insecurity. As a result, Bangladesh would need to get ready for long-term adaptation including introducing different species and varieties, changing sowing dates due to variations of seasonal pattern, to practicing novel irrigation systems and water supply. In essence, we need to identify all existing vulnerabilities and future prospects, adjusting priorities, at times even altering trade and commodity policies in the agricultural sector whereas promoting education and training throughout the masses in all potential spheres. These observations are particularly significant in the context of Bangladesh where agriculture is heavily dependent on temperature and rainfall patterns.

Rahman, M. (2011), has conducted Country report: Bangladesh for Workshop on Climate Change and its Impact on Agriculture. He showed his report that climate is an important factor in agriculture and climate change has greatly influenced agricultural production and agriculture pattern change.

The above review and discussion indicate that no detailed studies are conducted in Bangladesh which addressed the agriculture pattern change in Jessore as like as Bangladesh. Accordingly, the present study has planned to analyze the agricultural pattern change in Jessore as a case study of Bangladesh.

1.4 Aim and Objective of the Study

The aim of the present study is "to assess the changing agricultural pattern in Jessore with special emphasis on environmental and social aspects".

Objectives of the study:

(a) To identify the changing nature of crop production at decimal interval in last three decades in Jessore (1981-2010).
(b) To find out the physical parameters that influenced the changing pattern of crop production in the study area.
(c) To assess the role of input materials which enhanced the crop production in last three decades in Jessore (1981-2010).
(d) To find out how skill levels of farmers influenced the agricultural pattern change in the study area.
(e) To evaluate the change of transport, marketing and modern equipments that influenced the agriculture pattern.

Chapter 2

RESEARCH DESIGN AND METHODOLOGY

2. Introduction

Analysis of agricultural pattern change has been selected as research topic and study area has been selected as Jessore district which consists of eight upazilas. For the purpose of the research the whole rural population of study area is being considered as total study population. Sample size of the study population has been selected by using appropriate formula by keeping in mind the objectives of the study. For this purposes, a research design has been developed. The research design and methodology to be followed to conduct the study to fulfill the objectives is presented in this chapter.

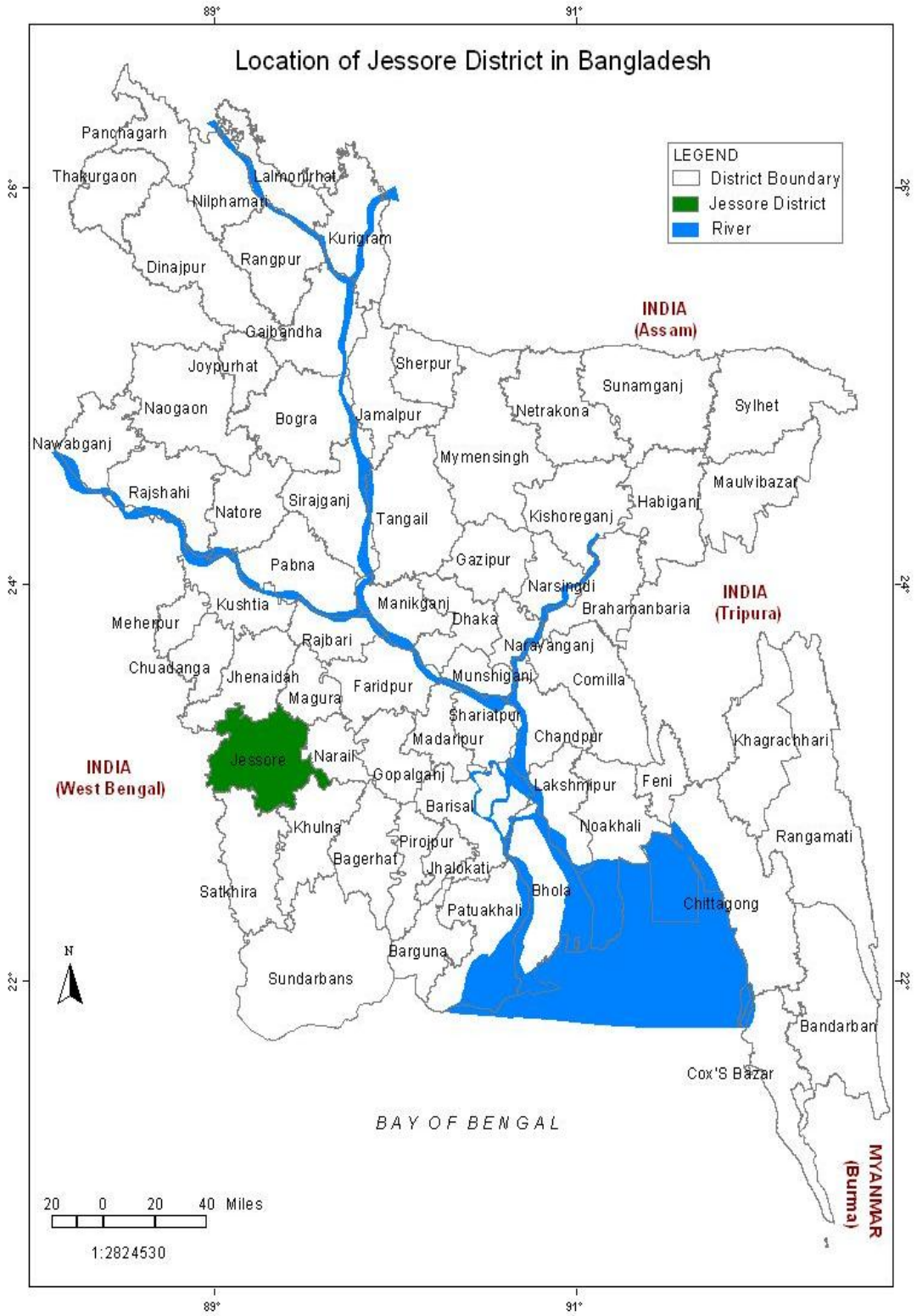
2.1 Study Area Selection

Jessore district stands on the south western part of Bangladesh (Figure 2.1). The weather, physiographic and soil characters of this district are suitable for agriculture. Remarkable change in agricultural pattern along with marketing and communication system and adaptation of modern agricultural machineries have been observed in Jessore district in last few decades. National and overseas demand of agricultural products has increased tremendously. In response to this demand pattern in agricultural practice has been going through a change. So, the area has been selected to evaluate the change of agricultural pattern in view of environment and social aspects.

2.2 Sampling Method

The samples have been selected through purposive random sampling method. The total sample size is 461 which have been selected through stratified random sampling method. The primary data have been collected by personal interview method with the help of well-designed and pre-tested questionnaire.

Figure 2.1 Location in Jessore District in Bangladesh



2.2.1 Process of Selecting a Sample Unit

Firstly, the whole rural populations (Household) in Jessore district, consisting of 8 upazilas have been considered as the study population (Figure 2.2). Then, total samples have been identified based on the required number of as per the calculation of sample size by following appropriate formula considering the total rural population of all the upazilas in Jessore. Primarily the sample size selection formula (William G. Cochran., 1967) stated below has been applied and then utilized the design effect to avert the sampling error. From calculation of the sampling size considering the design effect, total sample size has become 461. Then size of the sampling units are distributed at the union level as Primary Sampling Units (PSU), and ultimately samples have been selected at village level based on the population proportion.

In sampling unit selection process, all unions from the upazilas are listed in the sampling frame and specified number of unions has been selected randomly by keeping in mind the spatial distribution of the unions as shown in the Table 2.1. From each of the selected union, villages have been selected randomly by giving emphasis on the areal distribution of the villages and from the mouza/villages farmers have been selected randomly.

2.2.2 Sample Size

For Simple Random sampling the formula narrated by William G. Cochran., 1967, has been adopted for this research.

The size of the sample in a simple random sampling is estimated as per the following formula:

$$n = [(z^2 * p * q) + ME^2] / [ME^2 + z^2 * p * q / N]*D$$

Here z = 1.96, N = 296400, ME = 5 considering the 95% confidence level (i.e. confidence interval is 5),

Figure 2.2 Location of Survey Place in Jessore District

D = 1, for simple random sample

ME = +/- 5, i.e. at 95% Confidence level
p = .5, q = .5 (i.e. in percent it would be 50%)

Hence, as per above calculation following simple random sampling, the sample size becomes, n = 384

As in this research study, two stages sampling method have been applied, there are certainly design effects. This is to mention that, design effect is basically the ratio of the actual variance, under the sampling method actually used, to the variance computed under the assumption of simple random sampling. Calculations are performed as the formula below:

$D = 1 + \delta\ (n - 1)$, where

D is the design effect,

δ is the intra class correlation for the statistic, and,

n is the average size of the cluster

For this sampling, the value of design effect has been considered as 1.2.

Hence the total sample size would be as n = 384*1.2 = 461

Table 2.1 Details of the Sample Selection of the Study Area

Upazila	2001 Household (Rural)	Proportion of the Household Strata)	No of Households per Upazila	Actual Sample
Avoynagar	27840	9	43	44
Bagherpara	23400	8	36	36
Choughasa	25320	9	39	40
Jhikorgacga	33240	11	52	52
Keshobpur	27120	9	42	42
Sadar	76440	26	119	120
Monirampur	45840	15	72	72
Sharsa	37080	13	58	60
Jessore Zila	296400	100	461	465

While we have determined the sample size of the study area, then we distributed the samples among the upazila following the Probability Proportionate to Size (PPS) method. We identified the total number of households for each upazila and estimated the proportion of each upazila against total household. Then based on the proportions the total sample size has been allocated for each upazila.

Then, for selecting the samples from each upazila, we have chosen the union as another layer. On an average, we selected 20 respondents from each union. However some additional sample were chosen from selective unions for rounding factor and thus total sample were increased to 465. Thus total no. of unions become 25 for selecting the 461 respondents

2.3 Data Collection

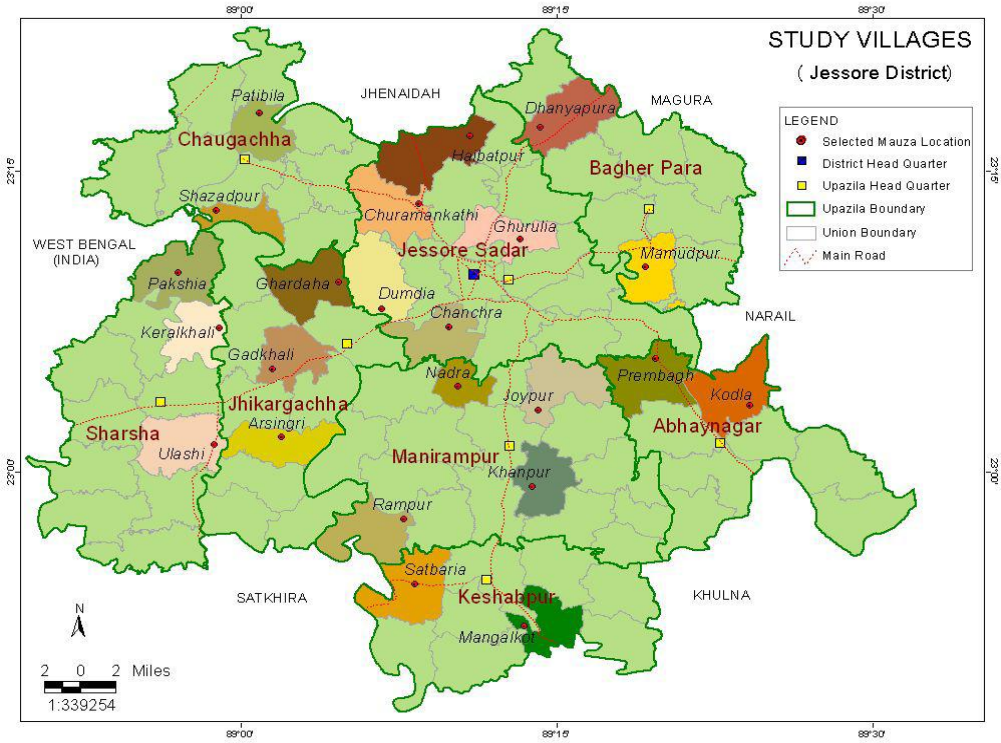
For this research work, the related data and information have been collected both from primary and secondary sources.

2.3.1 Sources of Primary Data

Primary data for this study have been generated mainly through questionnaire survey. The selected mouzas/villages are more or less evenly distributed in Jessore district for the selection of sample farmers for the questionnaire survey (Figure 2.3). Different sets of structured and non-structured questionnaires (appendix-I) have been

developed by keeping in mind the objectives of the study. In addition to that number of focus group discussions (FGDs) and numbers of key informant interview have been conducted in selected areas in Jessore district and also it has covered different types of observation and discussions with progressive farmers, farmers group, extension officials, women's groups, businessmen and NGO workers.

Figure 2.3 Location of Study Mouza/Villages in Jessore



In some cases telephonic discussions have been held with the stakeholders at various levels. Data which have been collected for study like personal information of the respondent specially age, education, occupation, yearly income, living period in this area, influential parameters like soil characteristics, rainfall, temperature, relative humidity, ground water condition, water bodies condition, flora condition, fauna condition, mechanization in agriculture, communication and transpiration have been collected. Information related to land and total duration of land use in a year has also been collected. Input like seed, fertilizer, pesticide, cultivation method, irrigation method, labor intensity, wages of labor, expenditure of cultivation/ha, return of product/ha, marketing system, place of marketing, mode of transport, chain of marketing have also been collected. Further women involvement in agriculture cultivation and marketing are the key part of questionnaire. Information of training and credit has received from government and private organizations.

2.3.2 Sources of Secondary Data

The secondary data and information have been collected from various sources including different year's Statistical Year Book of Bangladesh, Census of Population, different year's Statistical Year Book of Agriculture, books, journals, seminar/conference proceedings, maps, newspapers etc. Project Reports and Records/Documents of different Agencies (BBS, BARI, BARC, BRRI, DoE, BADC, BWDB, WARPO, BMD, LGED, RHD, DPHE and soil research institute) have been conducted. Review also conducted on international NGO (IUCN-Bangladesh), National NGOs (BCAS), CEGIS and others and Websites. Some of these are published documents and some of them are unpublished documents.

2.3.3 Review of Research Related Documents

Most of the available documents, reports of involved agencies and different studies conducted so far are collected and reviewed. The necessary information from the above documents is compiled accordingly. A list of published reports reviewed is presented in references chapter.

2.3.4 Office Visit

Office visits have been made to collect the required secondary information using different formats. Discussions have held with the personnel involved with research like DAE, DPHE, BADC, SRDI and BWDB to exchange views regarding various issues of different components of the research.

2.3.5 Field Level Data Collection

For collection of field level data a well-designed questionnaire has been used. The primary data have been collected by personal interview of farmers, businessmen, government officials and others.

2.4 Data Processing and Analysis

The study is based on qualitative and quantitative data. All the collected information have been processed and analyzed in the light of the scope of the study. Data processing includes coding, editing, data entry, validation, and storage and output generation. Both types of data have been processed by different techniques

with the help of a few software of computer like Excel, Access and SPSS. Excel has been used for analyzing secondary data and Microsoft Access has been used for primary data entry, validation, and tabular analysis. SPSS has been used for statistical analysis of data. Data interpretations have been made keeping in mind the objectives of the study. The data have been tabulated systematically and presented in appropriate manner.

2.5 Map Preparation Procedure (by using GIS)

GIS software is used for preparing map. Maps of the study area showing different locations like study Mouzas/Villagess, Unions, District, Rivers, Roads and Highways, Hats/Bazars, Agro-ecological Zones have been collected. Firstly all the collected maps are scanned to produce digital copy. Then it is being Geo corrected by GIS (Geographic Information System) and are digitized by using ARC/INFO software. Further, this digitized coverage is edited by using arc view software.

2.6 Research Time Line

For this research purpose the data have been collected during the time period of two year that is from January 2010 to December 2011.

2.7 Limitation of Research

The study provides some useful information of farmers and decision makers regarding agriculture patterns change of Bangladesh. However, there are some limitations of the study. In rural Bangladesh, many farmers are still illiterate and do not keep any written records of their farm business transactions and/or household consumption. As a result, they could not provide accurate information on previous land use patterns. Under the circumstances, the accuracy of data for the present study fully relied upon their memories and sincerity of the farmer.

2.8 Plan of Investigation

The thesis is organized in the following way. The subject of the present study is to “assess the changing agricultural pattern in Jessore with special emphasis on environment and social aspects”. Relevant information regarding the subject matter is necessary in order to develop the background for the investigation. Chapter one has introduced the research problem, literature review and objectives of this research work.

Chapter two narrates the research design and methodology including the sources of primary and secondary data. Limitation of research has also been discussed in this chapter. Changing agricultural pattern in Jessore has been discussed in chapter three. Agriculture sector encompasses crops including cereal crops, cash crops like jute, sugarcane, flower, vegetables etc., fisheries, livestock and forestry sub-sector and all of them has discussed in this chapter. Chapter four has described the influential parameters including soil, rainfall, temperature, groundwater level and relative humidity which have greatly influenced the agricultural pattern change. Input materials have been discussed in chapter five. Availability and use of input materials have enhanced the change in agricultural pattern in last three decades. Analysis of the skill levels of the farmers in relation to agricultural practices has been described the chapter six. Impact of marketing and transport management system on agricultural pattern has been discussed in chapter seven. The concluding chapter of this study is chapter eight. This chapter summarized the study and synthesized the study's findings and draws several recommendations for future research.. Although before and after comparison of the land use patterns has made but to get previous data is very difficult. The task of obtaining data proved to be very challenging and the possibility of data errors, therefore, cannot be fully ruled out.

Chapter 3

CHANGING AGRICULTURAL PATTERN

3. Introduction

Agriculture production has increased tremendously in many parts of the world as like as Bangladesh in the last few decades through the increased use of high-yielding varieties of seeds, inorganic fertilizers, pesticide, irrigation and modern equipment etc. Land use patterns as well as cropping patterns are changing in Bangladesh as like as Jessore due to a range of factors: in response to changing technology; increase of storage facilities, improved communication, marketing and networking system, new and high yielding varieties seed. In order to meet the demand of large population; as a way to increase the economic returns of farm enterprises and farmers try their best to maximize their land use pattern and cropping pattern. Country's crop production is also affected frequently by flood, drought, and salinity. As part of developments in the agriculture sector, most of the farmers in Bangladesh have introduced modern equipments, changing their cultivation methods, combination and crop rotation in last 2-3 decades (Barmon, et.al. 2007). As the same periods, the agricultural lands have been decreasing gradually from 1984 to 2008 (Agriculture Census, 1986, 1996, 2008). On the other hand production rate per unit area has increased over time. However, their incremental rate varies with varieties of crops including the cereal crops and other crops. This incremental rate seems to be positively related to the adaptation of improved inputs by the farmers. The inputs are use of high yielding varieties of seed, fertilizer, pesticide, irrigation, cultivation method, etc.

3.1 Rice

Rice is the staple food of about 142 million people of Bangladesh. Rice production provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country (BER-2010). Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm

families of the country grow rice. Rice is grown on about 10.5 million hectares of land which has remained almost stable over the past three decades. About 75% of the total cropped area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh (Agriculture Census 2008).

Total rice production in Bangladesh was about 10.59 million tons in the year 1971 when the country's population was only about 70.88 millions. However, the country is now producing about 25.0 million tons to feed her 142 million people. This indicates that the growth of rice production was much faster than the growth of population. This increased rice production has been possible largely due to the adoption of modern rice varieties on around 66% of the rice land which contributes to about 73% of the country's total rice production (Agriculture Census 2008). So the present research was carried out to know along with other crop how the rice production and its cropping pattern have been changed in Jessore during 1981-2010.

3.1.1 Broadcast Aus Rice

It is observed from the field survey that on average 80% respondents have cultivated broadcast Aus rice in the period of 1981-90 (Table 3.1.1). In 1991-2000 and in 2001-10, this cultivation trend has declined which is 18% and 15% respectively. In early 1981, the study area has cultivated three crops in high land and medium high land like broadcast Aus, transplant Aman and Rabi crops. After 1985, cropping pattern has changed dramatically. Broadcast Aus cultivation area has fallen to 18% in 1991-2000 to 15% in 2001-10. In 1981-90, average broadcast Aus rice yield is 1.78 metric ton (mton) per ha. This average production trend has gone up continuously. In 1991-2000 and 2001-10, it is 2.07 mton and 2.37 mton per ha respectively (Table 3.1.1). In 1981-2010, local seed use trend is decreasing continuously for having improved HYV seed. In 1981-90, it is 95% and 2001-10, it has gone down to 65 %(Table 3.1.1).

Table 3.1.1 Percentage of Farmers Produced Broadcast Aus of Different Periods in Jessore

Period	Rice Produced by Percentage of Farmer	Yield Ton/ha
1981-90	80%	1.78
1991-00	18%	2.07
2001-10	15%	2.37

Source: Field Survey from July 2010 to December 2011

3.1.2 Transplanted Aus Rice

After harvesting Boro rice cultivated land is used for Transplanted Aus rice which is locally called second block. Table 3.1.2 reveals that in 1981-90, 12% respondents have cultivated Transplanted Aus, in 1991-2000 and 2001-10 it has gone up to 37% and 51% respectively. In 1981-2010, the trend of Transplanted Aus cultivated area and also yield rate has increased. Transplanted Aus cultivation is profitable because it is an extra session of rice cultivation and most of the cases farmers do not use irrigation. In 1981-90, average yield is 2.37-3.26, 3.27-3.85 and 3.85 mton and above per ha when 32%, 53% and 15% respondents cultivated their land respectively. In the decade of 1991-2000, average production are 2.37-3.26, 3.27-3.85 and 3.85 mton and above per ha and respondents are 21%, 67% and 12% respectively. The production range of 3.27-3.85 rapidly increased which has been cultivated by 67% of the respondents and the production range of 2.37-3.26 and 3.85 mton and above have decreased swiftly. In the last decade of 2001-10, average production are 2.37-3.26, 3.27-3.85 and 3.85 mton and above per ha and respondents are 39%, 52% and 9% respectively (Table 3.1.2).

Table 3.1.2 Percentage of Farmers Produced Transplanted Aus Rice (*Second Block)* of Different Periods in Jessore

Period	Rice Produced by Percentage of Farmer	Average Yield/ ha(M.to n)	Period	Rice Produced by Percentage of Farmer	Period	Rice Produced by Percentage of Farmer	Period	Rice Produced by Percentage of Farmer
1981-90	12%	2.37-3.26	1981-1990	32%	1991-2000	21%	2001-10	39%
1991-2000	37%	3.27-3.85		53%		67%		52%
2001-10	51%	3.85+		15%		12%		9%

Source: Field Survey from July 2010 to December 2011

3.1.3 Broadcast Aman Rice

It is found from the field survey that in the period of 1981-90, average 65% respondents have cultivated Broadcast Aman rice (Table 3.1.3). In 1991-2000 and 2001-10, this trend has fallen to 32% and 3% respectively. Broadcast Aman usually cultivated in low land which remains under water for 6-7 months in a year. This rice has cultivated after harvesting Boro rice and some cases this land is kept as fallow land, this land has only been cultivated for Broadcast Aman. In 1981-2010, the trend of Broadcast Aman cultivation has decreased continuously and yield has increased

slightly. In 1981-90, average yield are 1.78-2.07, 2.08-2.67 and 2.67 mton and above per ha and 30%, 45% and 25% respondents cultivated their land respectively. In 1991-2000, average yield are 1.78-2.07, 2.08-2.67 and 2.67 mton and above per ha and respondents are 21%, 75% and 4% respectively. In the decade of 2001-10, average yield is 2.08-2.67 mton and above per ha which has been cultivated by 5% of the respondents (Table 3.1.3). Broadcast Aman has washed away from the study area because of adverse weather like less rainfall and cultivation of Boro rice and fish cultivation is more profitable than that of Aman cultivation.

Table 3.1.3 Percentage of Farmers Produced Broadcast Aman Rice of Different Periods in Jessore

Period	Rice Produced by Percentage of Farmer	Average Yield/ ha (M.ton)	Period	Rice Produced by Percentage of Farmer	Period	Rice Produced by Percentage of Farmer	Period	Rice Produced by Percentage of Farmer
1981-90	65%	1.78-2.07	1981-90	30%	1991-2000	21%	2001-10	0
1991-2000	32%	2.08-2.67		45%		75%		5%
2001-10	3%	2.67+		25%		4%		0

Source: Field Survey from July 2010 to December 2011

3.1.4 Transplanted Aman Rice

It is found from the field survey that average 69% respondents have cultivated Transplanted Aman rice in the period of 1981-90. This cultivation trend has gradually changed by the respondents and reached from 73% to 92% in the period of 1991-2000 and 2001-10 respectively (Table 3.1.4). From Table 3.1.4 it is found that in 1981-90, average yield of Transplanted Aman rice are 2.07-2.37, 2.38-2.96 and 2.96 mton and above per ha and respondents are 73%, 24% and 3% respectively. The trend of yield has increased rapidly. In 1991-2000, average yield of Transplanted Aman rice are 2.07-2.37, 2.38-2.96 and 2.96 mton and above per ha with 21%, 34% and 45% respondents respectively. Further in 2001-10, yields are 2.07-2.37, 2.38-2.96 and 2.96 mton and above per ha when respondents are 9%, 12% and 79% respectively. In early 1981-90, the farmer has started using HYV seed and HYV seed use has gone up sweetly. Respondents are 38% in 1981-90 increased to 76% and 95% in 1991-2000 and 2001-10 respectively.

Table 3.1.4 Percentage of Farmers Produced Transplanted Aman Rice of Different Periods in Jessore

Period	Rice Produced by Percentage of Farmer	Average Yield/ ha (M.ton)	Period	Rice Produced by Percentage of Farmer	Period	Rice Produced by Percentage of Farmer	Period	Rice Produced by Percentage of Farmer
1981-90	69%	2.07-2.37	1981-90	73	1991-2000	21	2001-10	9
1991-2000	73%	2.38-2.96		24		34		12
2001-10	92%	2.96+		3		45		79

Source: Field Survey from July 2010 to December 2011

3.1.5 Transplant Aman Local Rice

Transplant Aman local rice has been cultivated in the medium low land where the land does not remain under the rain water. In the period of 1985-86, Transplant Aman local rice cultivated area is 74,493.93 ha and yield is 3, 17,000 mton (Table 3.1.5). The trend of Transplant Aman local rice area has declined in different years from 1981-2010. In 1993-94, 2003-04 and 2009-10 Transplant Aman local rice cultivated area are 9,311.74, 7,287.45 and 1,619.43 ha and yield are 47,000, 27,000 and 6,000 mton respectively. Transplanted Aman local yield and its using area are decreasing gradually because it yield is very little than other types of rice.

Table 3.1.5 Transplanted Aman Rice Producing Area in Hectare and Yield in Mton of Different Periods in Jessore

Period	Area (ha)	Yield (Mton)
1985-86	74493.93	317000
1993-94	9311.74	47000
2003-04	7287.45	27000
2009-10	1619.43	6000

Sources: Different Year Agriculture Yearbook (1986, 1994, 2004 & 2010)

3.1.6 Transplant Aman HYV Rice

Transplant Aman HYV is cultivated in the low land where water remains for about 4-5 months in a year. It is observed from the survey that in the period of 1985-86, Transplant Aman HYV rice area is 43,319.84 ha and yield is 1,12,000 mton (Table 3.1.6). The trend of Transplant Aman HYV rice area has increased in different years from 1981-2010. In 1993-94, 2003-04 and 2009-10 Transplant Aman HYV rice area are 1,96,761.13, 2,88,663.97 and 1,23,481.78 ha and yield are 5,54,000, 5,79,000 and 3,27,000 mton respectively. Transplant Aman HYV rice area is increasing gradually from 1985 to 2004 but after 2004 this trend is declined.

Table 3.1.6 Transplanted Aman HYV Rice Producing Area in Hectare and Production in Mton of Different Periods in Jessore

Period	Area (ha)	Production(Mton)
1985-86	43319.84	112000
1993-94	196761.13	554000
2003-04	288663.97	579000
2009-10	123481.78	327000

Sources: Different Year Agriculture Yearbook (1986, 1994, 2004 & 2010)

3.1.7 Transplant Aman Pajam Rice

It is observed from the survey that in the period of 1985-86, Transplant Aman Pajam rice cultivated area is 2,336.03 ha and yield is 7.19 mton (Table 3.1.7). The trend of Transplant Aman Pajam rice area has decreased of different years in 1981-2010. In 1993-94, 2003-04 and 2009-10 transplant Aman Pajam rice cultivate area are 97.17, 319.84 and 291.50 ha and yield are 0.32, 0.92 and 0.84 mton respectively. Market price of Transplant Aman Pajam rice is high so its cultivation trend is gradually increasing.

Table 3.1.7 Transplanted Aman Pajam Rice Producing Area in Hectare and Production per Hectare in Mton of Different Periods in Jessore

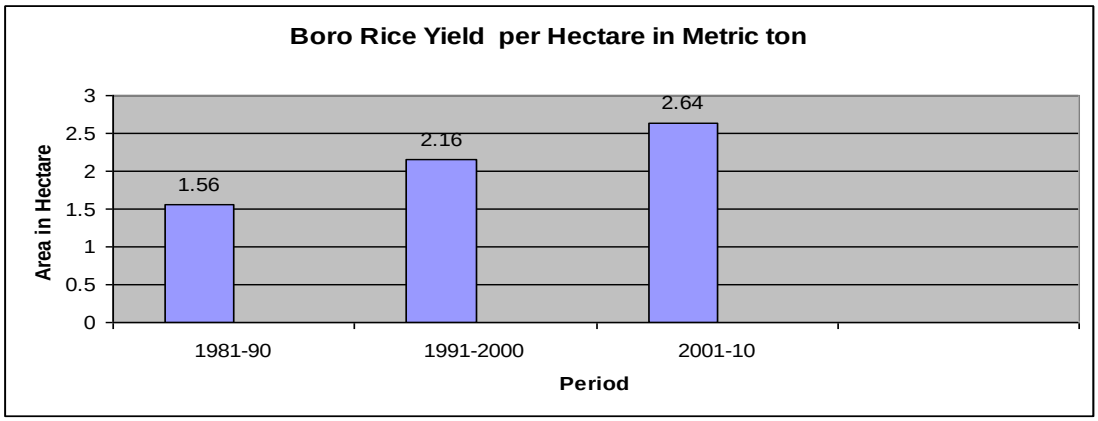
Period	Area (ha)	Production(Mton)/ha
1985-86	2336.03	7.19
1993-94	97.17	0.32
2003-04	319.84	0.92
2009-10	291.50	0.84

Sources: Different Year Agriculture Yearbook (1986, 1994, 2004 & 2010)

3.1.8 Boro Rice

In the period of 1981-90, Boro rice cultivation is in 25% of the cultivated area (Figure 3.1). In 1991-2000 and in 2001-10, the Boro rice cultivation trend has increased sharply which covers 85% and 98% area respectively. In early 1981, the study area has cultivated three crops in high land and medium high land like Broadcast Aus, Transplant Aman and Rabi Crops. After 1985, cropping pattern has changed drastically. Boro cultivation area has risen up and yield has increased rapidly (Figure 3.1).

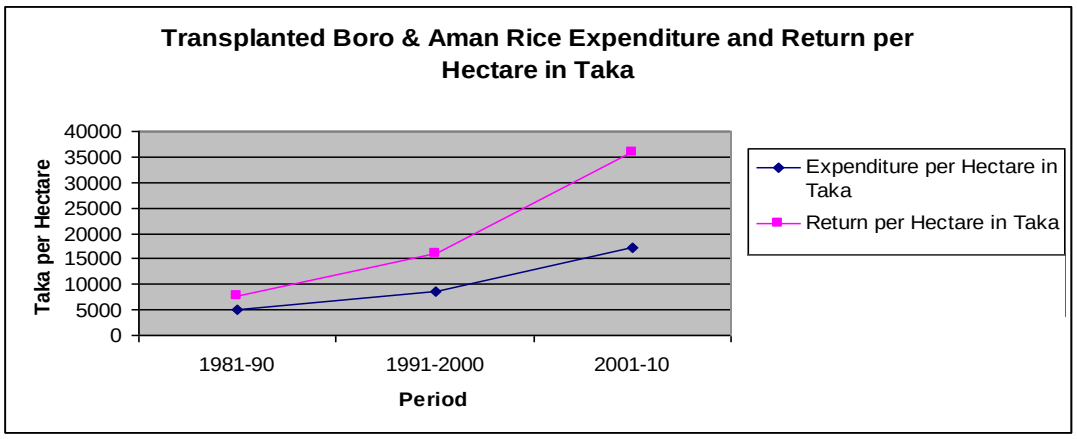
Figure 3.1 Boro Rice Yield Metricton per Hectare of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

In 1981-90, Boro Rice yield is 1.56 mton per ha. This yield trend has gone up continuously. In 1991-2000 and 2001-10, it is 2.16 mton and 2.64 mton per ha respectively. In 1981-2010, local seed use trend is decreasing gradually for improving HYV seed use. In 1981-90, it is 65% and in 2001-10, it has reached 88% of the production area.

Figure 3.1.1 Transplanted Boro & Aman Rice Expenditure and Return per Hectare in Taka



Source: Field Survey from July 2010 to December 2011

According to field survey, the expenditure of rice cultivation rose every year from 1981 to 2010. From the figure 3.2 it is observed that in 1981-1990, the average expenditure of rice cultivation is Tk. 5,044 per ha. The average expenditure of rice cultivation has gone up sharply to increase the production and meet to large population demand. In 1991-2000, the average expenditure of rice cultivation is Tk. 8,494 per ha. Gradually the average expenditure of rice cultivation has increased

rapidly and in 2001-10, it has gone up Tk. 17,221 per ha. It was noted that the average expenditure of rice cultivation has increased dramatically three times (Tk. 5,044 to Tk. 17,221) during three decades from 1981-2010 (Figure 3.1.1).

According to field survey, the real value of all crops and expenditure of agricultural yield has risen every year from 1981-2010. It is observed from the field survey that in the period of 1981-1990, average yield of rice in terms of taka is 7,625 per ha. The average rice yield has grown up sharply to meet the large population demand. In the period of 1991-2000, the average rice yield is Tk. 15,951 per ha. Day by day the average rice yield has increased rapidly and in 2001-10, it has gone up Tk. 35,731 per ha. Therefore, the result showed that average earning of rice per ha has risen almost five times (Tk. 7,625 to) during three decades from 1981-2010 (Figure 3.1.1).

3.2 Wheat

The wheat is a major food item and an important commodity on the world grain market. Wheat is grown under a wide range of climatic and soil conditions. However, it grows well in clay loam soils. In Bangladesh, it is a crop of Rabi season, requires dry weather and bright sunlight. Well distributed rainfall between 40 and 110 cm is congenial for its growth. Depending on variety and weather conditions, 100-120 days are required from sowing to harvest (Haque et al. 2012).

After independence, in 1971, Bangladesh faced an acute food shortage. Production of rice, the main crop declined because of the disruption of virtually all agricultural activities during the War of Liberation, and also due to various natural calamities and rapid population growth. It is realized that though about 80 percent of the total cropped area of Bangladesh is devoted to rice cultivation, rice alone could not meet the food requirement of the country. Wheat is therefore chosen as an alternate food crop in the winter season, which remains mostly free from natural calamities. Today, among the cereal crops, it is next to rice in importance (Haque et al. 2012).

Wheat is the second cereal crops in our country. For improving HYV seed, modern technology and climate change the cultivation of Wheat has changed gradually in Jessore. It is shown in the Table 3.2 that in 1981-90, average land area is 0.20 ha and average yield is 0.54 mton per ha. And average local seed use is 1.0%.

Whereas yield of Wheat have been decreasing day by day. So, in 1991-2000, average land area is 0.13 ha and average yield is 0.55 mton per ha. The Wheat cultivation trend is going on down and yield is decreasing.

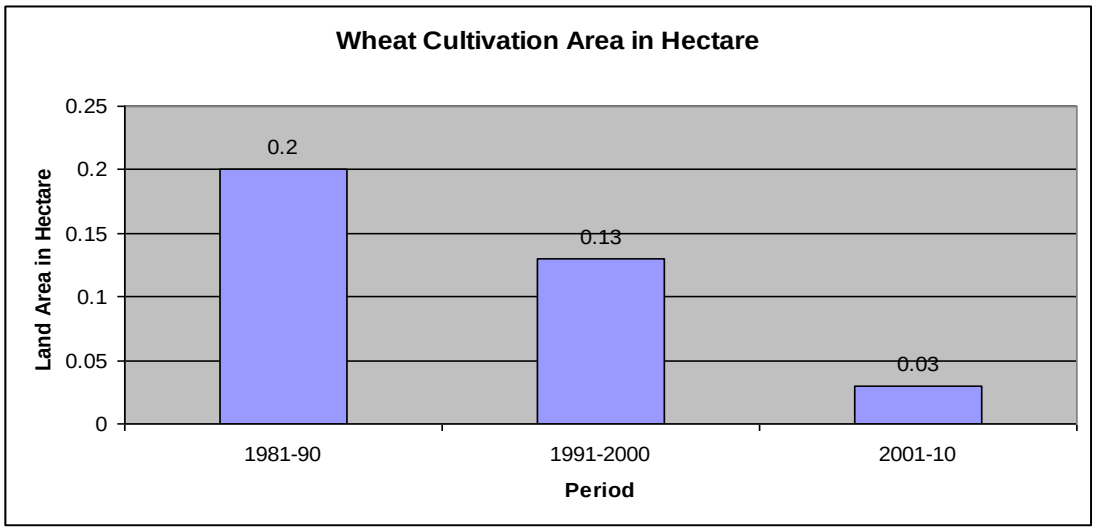
Table 3.2 Wheat Cultivation Area in Hectare, Yield in Mton and Percentage Local Seed Use of Different Periods in Jessore

Crop Name	Period 1981-1990			Period 1991-2000			Period 2001-2010		
	Average Land ha	Average Yield Mton	Local Seed Used %	Average Land ha	Average Yield Mton	Local Seed Used %	Average Land ha	Average Yield Mton	Local Seed Used %
Wheat	0.20	0.54	1.0	0.13	0.55	0.0	0.03	0.56	0.0

Source: Field Survey from July 2010 to December 2011

In 2001-10, average area is 0.03 ha and average yield is 0.56 mton per ha. From last two decades local seed has not been used, in other words HYV seed use is 100%. In last two decades total crop area has decreased but total yield of Wheat has little increase for good seed quality, irrigation, cultivation method and proper management (Figure3.2).

Figure 3.2 Wheat Cultivation Area in Hectare of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

From 1981-2010, in three decades the trend of local seed used has gone down. The respondents expressed that the trend of Wheat area is going down because of large population and high food demand; huge amount of Boro rice production with irrigation has increased. The Boro cultivation and irrigation in the area had hampered the Wheat cultivation to a great extent.

3.3 Vegetables

Vegetables are any herbaceous plant whose fruit, seeds, roots, tubers, bulbs, leaves etc are used as food. Nearly 100 different types of vegetable comprising both local and exotic type are grown in Bangladesh. Vegetable is important for nutritional, financial, and food security in Bangladesh. Vegetable farming in Bangladesh can be grouped into 3 categories based on scale of production and objectives of farming: vegetable production in homestead, for commercial market and farming for seed production (Rashid 2003).

Jessore is one of the largest vegetable growing areas covering 14% of the country's arable land (Weinberger, K. and Genova, C. A. (II). 2001). It is home of 150,000 farmers and 14,000 input sellers, traders and middlemen. The availability of abundant high and medium-high land, excellent soil and climatic conditions and early and late seasonal harvests give Jessore a headstart in the cultivation of vegetables. Farmers in Jessore have strong traditional skills. They are innovative and receptive to new ideas, which mean that modern technologies are being adopted to meet local needs (Bayes, 2012). The major constraints appear on a quality level and availability of inputs (seeds, fertilizers, pesticides) and specific services (information about the use of inputs).

In Jessore, the area under vegetable farming increased from 68,826 ha to 1, 44,939 ha during 1986-2004. Likewise, the yield of vegetable also increased from 28,000 mton to 51,000 mton during that period. Further it has increased area of 2, 80,972 ha and yield is 71,000 mton in 2010 (Different Agriculture Yearbook of 1986, 2004 and 2010).

Table 3.3 Vegetable Cultivation Area in Hectare, Yield in Taka and Percentage Local Seed Use in Different Periods in Jessore

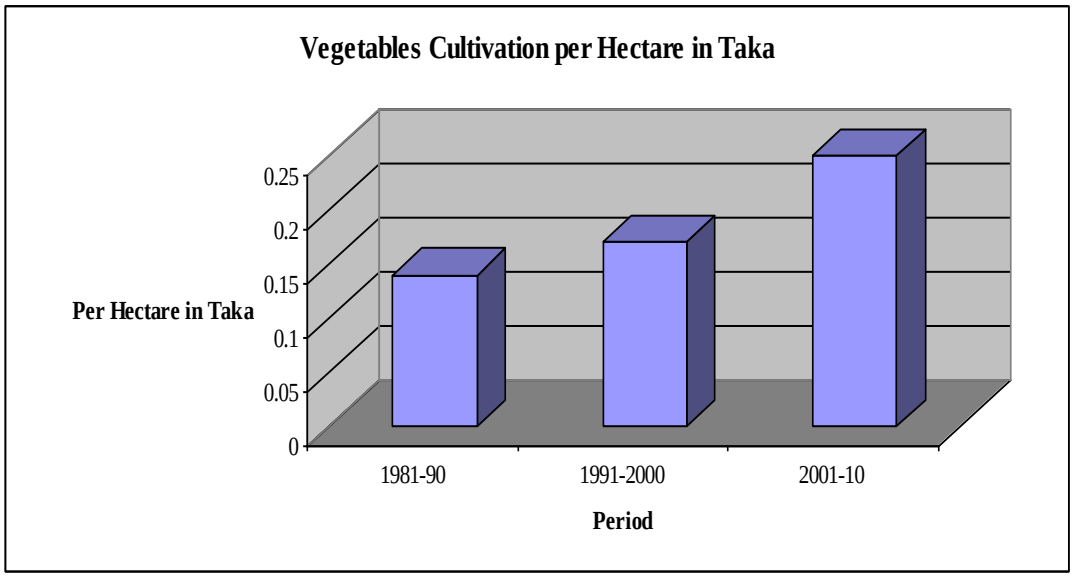
Crop Name	Period 1981-90			Period 1991-2000			Period 2001-10		
	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %
Vegetable	0.14	8,028	97.7	0.17	18,846	75.5	0.25	47,851	44.4

Source: Field Survey from July 2010 to December 2011

It is found from the field survey that in the period of 1981-90, average Vegetables area is 0.14 ha and average yield value of Vegetables is Tk. 8,028 (Table 3.3). The respondent of the study area prefer to deliver average yield value in taka,

otherwise they provide real weight of their products. It is easy to calculate total taka in a season of their products. Similarly average local seed use is 97.7%. The respondents of the study area have used more local seed because they have collected from own land or locally arrange. Vegetables cultivation has increased continuously because of suitable climate, marketing system and domestic and abroad demand. In 1991-2000, average vegetables cultivate land is 0.17 ha and average yield value is Tk. 18,846. Similarly average local seed use is 75.5%. On the other hand, in 2001-10, average Vegetables cultivate area is 0.25 ha (Figure 3.3) and yield value is Tk. 47,851. That time local seed was used by 44.4% of the respondents. It indicates that the farmers are using non local seed and buying the high yielding variety of seed from the market.

Figure 3.3 Vegetables Cultivation Area in Hectare of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

3.4 Banana

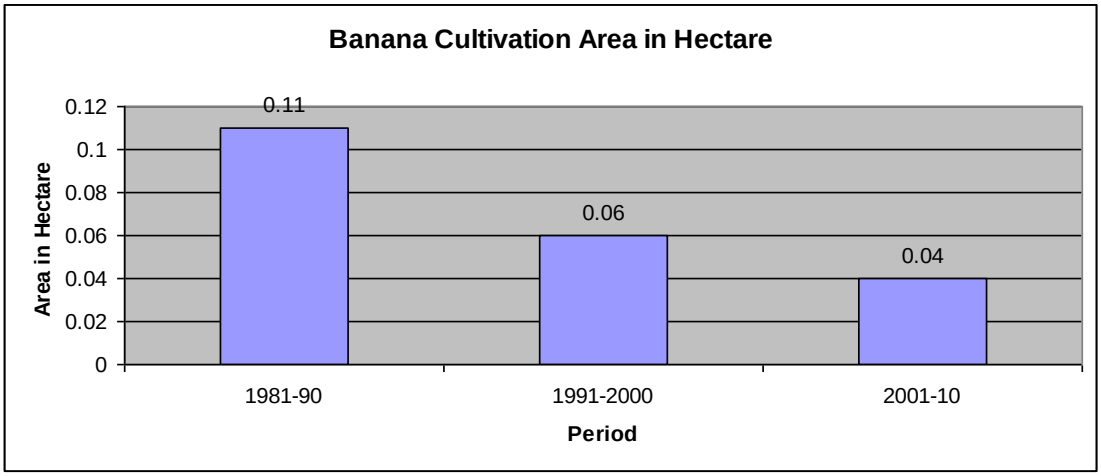
In the period of 1981-90, respondents have used their land with an average size of 0.11 ha for Banana cultivation and they sell their cultivated product in average Tk. 12,017 (Table 3.4). That time they have used local seed 53.8%. Whereas in 1991-2000 and 2001-10 respondents have used average land of 0.06 ha and 0.04 ha for Banana cultivation respectively (Figure 3.4) and yield value in average are Tk. 21,684 and Tk 34,343 respectively (Table 3.4). Earlier time they have used local seed by 30.2% and 16.3% respondents respectively. From 1981-2010, in three decades Banana cultivation and local seed use have decreased rapidly.

Table 3.4 Banana Cultivation Area in Hectare, Yield value in Taka and Percentage of Farmers Local Seed Used of Different Period in Jessore

Crop Name	Period 1981-90			Period 1991-2000			Period 2001-10		
	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %
Banana	0.11	12,017	53.8	0.06	21,684	30.2	0.04	34,343	16.3

Source: Field Survey from July 2010 to December 2011

Figure 3.4 Banana Cultivation Area in Hectare of Different Period in Jessore



Source: Field Survey from July 2010 to December 2011

3.5 Jute

Jute was once known as the golden fiber of Bangladesh, since it was the most important cash crop for the country. Bangladesh remains the world's second-largest producer of jute (after India) and the world's largest exporter of fiber. Jute fiber is produced mainly from two commercially important species, namely White Jute and Tossa Jute. Jute grows under wide variation of climatic conditions and stress of tropic and subtropics.

Jute grows well where the annual rainfall is 1500 mm or more, with at least 250 mm during each of the months of March, April and May. The optimum range of temperature required is 18°-33°C. Jute can be grown in a number of soil types, ranging from clay to sandy loam with optimum fertility, and soil pH ranging from 5.0-8.6. Jute is cultivated in the rainy season. Cultivation largely depends upon pre-monsoon showers and moisture conditions. Jute needs long day light for growth. Cow dung is generally used, along with NPK (N- nitrogen P- phosphorus, K-potassium) in appropriate proportion, according to the soil type. In Bangladesh, farmers generally

do not use any fertilizer in jute cultivation. Generally, 10-12 kg/ha seed is sown by the broadcasting method.

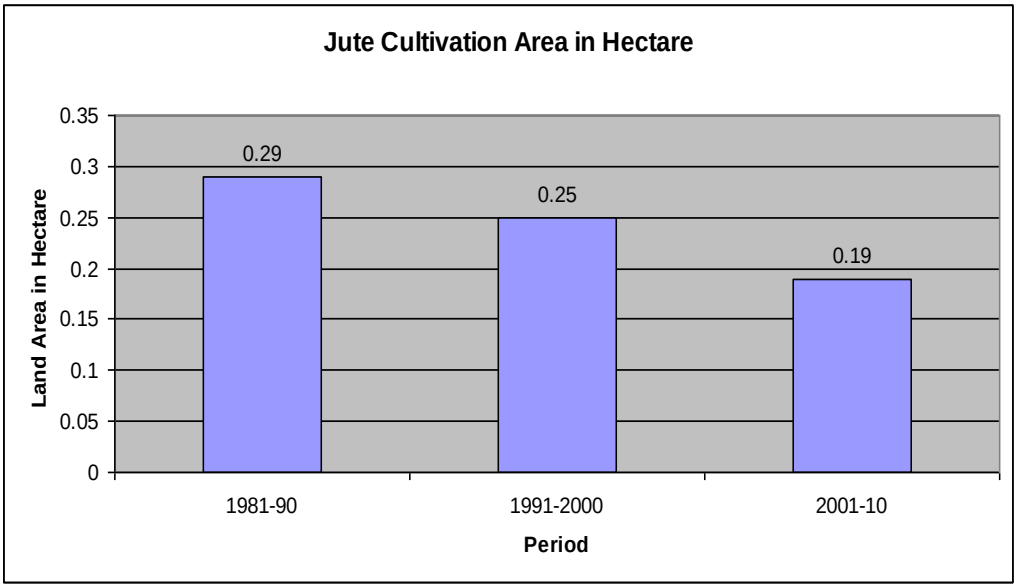
Table 3.5 Jute Cultivation Area in Hectare, Yield in Mton and Percentage of Farmers Used Local Seed of Different Periods in Jessore

Crop Name	Period 1981-90			Period 1991-2000			Period 2001-10		
	Average Land ha.	Average Yield Mton	Local Seed Used %	Average Land ha.	Average Yield Mton	Local Seed Used %	Average Land ha.	Average Yield Mton	Local Seed Used %
Jute	0.29	0.79	0.6	0.25	0.76	0.3	0.19	0.77	0.1

Source: Field Survey from July 2010 to December 2011

Seed is an important input for Jute cultivation. For modern technology and climate change the pattern of Jute seed use and cultivation area has been changing. In the period of 1981-90, average Jute cultivated area is 0.29 ha and average yield is 0.79 mton in a ha (Table 3.5). That time local seed was used by 0.6% of farmers. In 1991-2000 and 2001-10, average Jute cultivated area are 0.62 ha and 0.48 ha respectively (Figure 3.5) and average yield are 0.76 mton and 0.77 mton in a ha respectively (Figure 3.5). In these two decades in 1991-2010, local seed was used by 0.3% and 0.1% of respondents respectively. Almost all the farmers used non local high yielding variety of seed and bought from the market. In three decades, Jute cultivation area is going down due to climate change and respondents' situation demand. Jute production and processing expenditure is high on the other hand Boro rice cultivation is more profitable at that time of the year. In last two decades Jute yield has increased for good seed quality, irrigation, cultivation method and proper management.

Figure 3.5 Jute Cultivation Area of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

It is observes that in 1985-86, Jute area is 3, 59,514 ha and yield is 2, 36,000 mton (BBS 1986). The trend of Jute area has gone down in early 1981 and decreased it and it is still continuing in 2009-10. In 1993-94 and 2003-04 Jute area are 2, 41,296 and 1, 65,182 ha and yield are 1, 26,000 mton and 82,000 mton respectively (BBS 2004). Further in 2009-10 Jute is cultivated in 78,542 ha and yield is 33,000 mton (BBS 2010). In three decades Jute area has gone down but Jute yield has gone on high level.

3.6 Cotton

Cotton plants require about six months maturing. Harvesting is usually done three times at maturity. Cultivation of cotton requires water during the period of active plant growth, while dry weather conditions are necessary at maturity when the cotton boll opens. Cotton is planted in mid-July and harvesting is completed in mid-January, after which the land can be used for growing winter vegetables. Annual yield of cotton is approximately 35,000 metric ton. Locally produced cotton meets approximately only about 16% of the country's cotton need (Rahman, 1995). The cotton development board of the Ministry of Agriculture is in charge of taking care of cotton cultivation in the country. It operates three seed multiplication centers to provide farmers with good quality seeds and technical advice, but many farmers prefer to acquire seeds from their own cotton fields.

Jessore is the basket of cotton cultivation in Bangladesh. Once upon a time the lion share of cotton has produced in the study area but for more irrigation and Boro cultivation this pattern has been changing gradually. In the period of 1981-90, average Cotton crop land is 0.21 ha and average yield value of Cotton is Tk. 5,114 (Table 3.6). In the same time average local seed use is by 0.9% of farmers. Cotton area has declined continuously because of adverse climate and more input irrigation for Boro rice cultivation. In 1991-2000, average Cotton area is 0.09 ha and average yield value of Cotton is Tk. 8,102. That time local seed used by 0.6% of the respondents.

Table 3.6 Cotton Cultivation Area in Hectare, Yield Value in Taka and Percentage Farmers Used Local Seed of Different Periods in Jessore

Crop Name	Period 1981-90			Period 1991-2000			Period 2001-10		
	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %
Cotton	0.21	5,114	0.9	0.09	8,102	0.6	0.03	15,465	0.2

Source: Field Survey from July 2010 to December 2011

In 2001-10, average Cotton cultivation land is 0.03 ha and average Cotton yield value is Tk. 15,465. In the same time local seed has been used by 0.2% of farmers (Table 3.6). Cotton cultivation was introduced in this district in early 1980 and lion share of the country's demand has been supplied from this district.

In early 1981-90, most of the farmers of the study area have cultivated cotton. In 1986, Cotton Development Board of Bangladesh has established cotton research farm in Chowgacha Upazila under Jessore district. But after 1995, cotton cultivation has decreased in the study area for climate change, Boro rice cultivation and huge irrigation.

3.7 Flowers

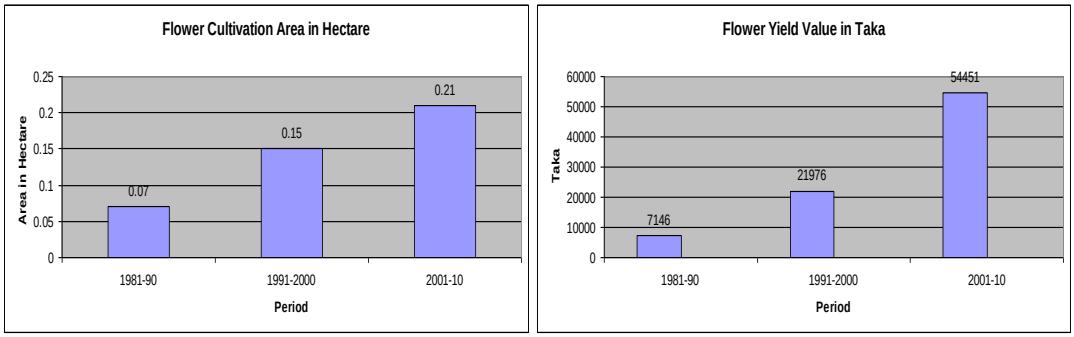
People all over the world realize that flowers enhance the quality of life and influence human feelings more than words or other gifts. This leads to increased use of flowers and ornamental plants. Flower is important for human civilization. Flowers are also largely grown for cut flowers, making essentials oils, water, perfume and medicines, etc. Today, floriculture as a farm enterprise has emerged as one of the most lucrative business profession in many countries having much higher potentials return in comparison to most of the field plantation and horticultural crops. Commercial production of flower in Bangladesh started from mid 1980s at Jessore district.

Jessore's flower cultivation is an emerging sector. This fast-growing flower market competes with flowers from India in Dhaka's markets. The ideal climatic and soil conditions combined with strong traditional and innovative skills enable the sector to make good inroads into the market. The flower producers in Jessore are very motivated as flowers generate higher returns than other crops (Bagchi, 2009). The sector has a tremendous growth potential if it is able to tap the flourishing domestic and exports markets. Now, around 10,000 hectares of land is under flower cultivation (Siddika, 2004). The major production is concentrated at Godkhali in Jessore which covers about 60% of total flower production. At present approximately 8,000 farmers are engaged in floriculture (Mou, 2006). Farmers involve highly in flower cultivation practice as it is more profitable than other crop and the demand for flower has been

increasing day by day. As a result, there exists a competition of high quality flower production. Production areas are concentrated in the rural environments, but the consumption is concentrated in the cities. There is no organization or association for marketing and distribution of flowers. The flowers, being highly perishable, require special post harvest management. But improved post harvest handling has not yet been initiated in Bangladesh. Inefficient post harvest management deteriorates the quality of flower and as a result farmers are deprived of getting expected price of flower (Bagchi and Raha 2011). So the quality management of flower is of utmost important of getting higher returns. Lack of modern harvesting technology, improper storage, transportation, handling and packing causes both qualitative and quantitative loss of flower. The labor-intensive flower sub-sector will contribute to poverty alleviation by creating more jobs and income.

Flower cultivation has introduced after 1984 in Kadkhali village at Jhikargacha upazila under Jessore district. At initial stage flower cultivation took place in small areas as a hobby not for commercial purpose. After three years it has inclined in and outside of the upazila for commercial purpose. In 1981-90, approximately Flower cultivation area is 0.07 ha (Figure 3.7) and average yield value is Tk. 7,146 (Figure 3.7.1). That time local seed being used by only 5% of the farmers.

Figure 3.7 & 3.7.1 Flower Cultivation Area in Hectare & Yield Value in Taka of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

After 1991, Flower Cultivation has risen rapidly. Farmers left the traditional crops like rice, jute and rabi crops, started to cultivate Flower cultivation instead of traditional crops. Flower cultivation area has enhanced average in 0.15 ha in 1991-

2000 to approximately in 0.21 ha in 2001-10(Figure 3.7). That time yield value has increased approximately Tk. 21,976 and in 1991-2000 to approximately Tk. 54,451(Figure 3.7.1). After in 1991, local seed use has washed away of the study area and all have used HYV seed.

Case Study of

Sher Ali Shardar

Sher Ali Shardar is the Flower-growing farmer in the district in Jessore. He is growing Flower for longest time. He started growing Flowers in 1983. He started cultivating tube rose as a hobby in his nursery by getting seeds from neighboring India. He decided to move into large-scale cultivation after he observed the tube rose flowers growing well and that the market is good. He realized that the weather in Jessore and Calcutta, India is the same where farmers are cultivating it successfully and decided to invest in the growing market. Upon the advice of his friend Nazrul Islam, who provided him information on the flower market and prices, he started cultivating different kinds of flowers. Later he encouraged other farmers to cultivate flowers and gave them seeds for free. The farmers of the study area has cultivated more amount of land and this trend is not limited in this district which has covered others districts largely.

3.8 Sugarcane

Sugarcane is a tall tropical perennial plant of the genus *Saccharum*, a member of the grass family Gramineae. The area under sugarcane farming increased from 4, 72,064.78 ha to 4, 91,093.12 ha in 1986 to 2004. Yield of sugarcane has decreased from 30,000 mton to 29,000 mton during that period. Further area has increased to 3,40,080.97 ha and yield is 47,000 mton during 2010 (Different Year Agriculture Yearbook of 1984, 2004 and 2010). A sugarcane plant has prominently jointed stalks, each bearing two ranks of sword-shaped but gracefully arching leaves. Some varieties may have stalks that are 5-7 meter long. The diameter is very variable in different varieties.

Sugarcane grows to the best advantage on a rich, moist soil under sunny skies in a tropical climate. Clay-loam soil with some proportion of sand and silt, mixed with humus is among the best soils for sugarcane cultivation. Uniform high temperatures, strong sunlight, and frequent showers during the growing season are desirable. Irrigation is not necessary if the annual rainfall is 1,250-1,500 mm. A soil pH between 6 and 7.5 has been found suitable for plant growth. High humidity during the growing period and dry weather at maturation leads to satisfactory production.

It is found from the field survey that in 1981-90, average Sugarcane cultivate area was 0.16 ha and that time average Sugarcane yield value was Tk. 3,520 (Table 3.8). Whereas in 1991-2000, for the climate having changed, the farmers have changed their cultivation pattern for more profit. They have used their land of 0.07 ha for Sugarcane cultivation. That time average yield value is Tk. 5,096 because the value of goods has rapidly increased. Yield and commodity value have far difference between two decades from 1981-2000.

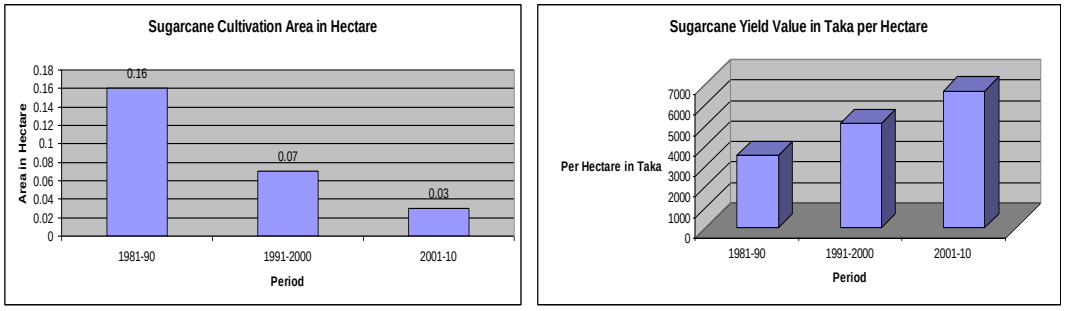
Table 3.8 Sugarcane Cultivation Area in Hectare, Yield in Taka and Percentage of Farmers Used Local Seed of Different Periods in Jessore

Crop Name	Period 1981-90			Period 1991-2000			Period 2001-10		
	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %
Sugarcane	0.16	3,520	100%	0.07	5,096	100%	0.03	6,662	100%

Source: Field Survey from July 2010 to December 2011

The Sugarcane yield is decreasing tremendously day by day. In the period of 2001-10, average cultivate area is very little which is 0.03 ha (Figure 3.8) and in the same time average yield value is Tk. 6,662 (Figure 3.8.1). In the whole period 100% farmers used local seed.

Figure 3.8 & 3.8.1 Sugarcane Cultivation Area in Hectare & Yield Value in Taka per Hectare of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

It is an annual crop; sugarcane keeps the land occupied throughout the year. Consequently, some farmers are inclined to cultivate other profitable crop rather than sugarcane. This has resulted in a decline in crop acreage as well as the yield of the commodity in whole study period.

3.9 Fruit Gardening

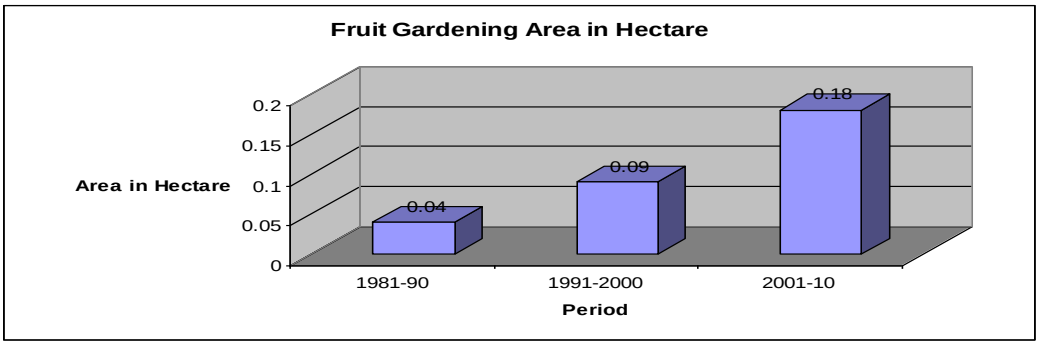
For local demand Fruit Gardening pattern has been changing day by day in the study area. It reveals from the Table 3.9 that in 1981-90, average Fruit Gardening area is 0.04 ha and yield value of Fruit Gardening is Tk. 3,774. That time local seed (i.e. cultivated and stored by farmers himself) use is 79.3%. In 1981-90, all lands are not used for commercial purpose. After 1990, farmers started Fruit Gardening on commercial basis and have Mango and Lichi gardening and after 2000 huge amount of land have been used for *Bau kool* gardening. This time population growth is very high and with more food demand farmers made maximum used of their land and they do not keep any fallow land. Whereas in 1991-2000, average Fruit Gardening area is 0.09 ha and yield value of Fruit Gardening is Tk. 6,795(Table 3.9). That time local seed use is 17.4%. Fruit gardening has increased as farmers started to use more HYV rather than local seed during 1991-2010. In 2001-10, average Fruit Gardening land is 0.18 ha (Figure 3.9) and production value of Fruit Gardening is Tk. 12,893. That time used of local seed by 9.1% of the farmers

Table 3.9 Fruit Gardening Cultivation Area in Hectare, Yield in Taka and Percentage of Farmers Used Local Seed of Different Periods in Jessore

Crop Name	Period 1981-90			Period 1991-2000			Period 2001-10		
	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %
Fruit Gardening	0.04	3,774	79.3	0.09	6,795	17.4	0.18	12,893	9.1

Source: Field Survey from July 2010 to December 2011

Figure 3.9 Fruit Gardening Cultivation Area in Hectare of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

3.10 Timber Tree

Bangladesh is a highly populated country. Because of high population density and shrinking natural resource base there is enormous pressure on the natural resources of the country. As obvious, there is a crying demand for wood for the swelling population. As a consequence of rapid economic growth through industrialization and agriculture, forests are continuously decreasing.

After 1995, the people of the study area are found very aware of environment. The environment of the study area is very bad because most of the rivers are dead. During the rainy season water remains there for six months but rests of the months of a year remain dry (Mitra, 2001). About 90% water bodies of the study area are dead and do not keep water more than six months in a year. For this reason local people care for forests and biodiversity conservation, livelihood improvement, non-timber forest products including medicinal plants, post harvest technology and technology transfer (DoF. 2002 & 2008). The people of the study area have changed their land use pattern in few decades. They have made fish gher or fish cultivated in low land and high land used for plantation.

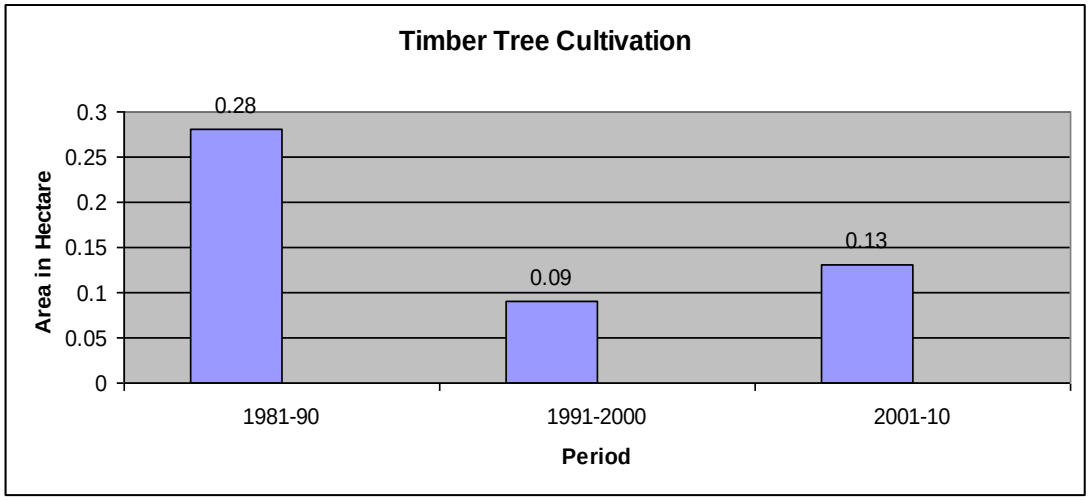
For more profitable Production and climate change the Timber Tree cultivation has been changing. Table 3.10 presents that average Timber Tree cultivation area is 0.28 ha and average yield value is Tk. 21,366 in 1981-90. That time local seed use was 32.4%. After 1991-2000, with change and improve technology, increase local, national and abroad demand Timber Tree cultivation improves rapidly. Average Timber Tree cultivation area is 0.09 ha (Figure 3.10) and average yield value is Tk. 34,622. That time local seed use is 2.7%. Because of rapid climate change, Timber Tree cultivation has changed gradually in 2001-10, average land area is 0.13 ha and average yield value is Tk. 83,693 and that local seed use is 2.6% (Table 3.10).

Table 3.10 Timber Tree Cultivation Area in Hectare, Yield in Taka and Percentage of Farmers Used Local Seed of Different Periods in Jessore

Crop Name	Period 1981-90			Period 1991-2000			Period 2001-10		
	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %
Timber Tree	0.28	21,366	32.4	0.09	34,622	2.7	0.13	83,693	2.6

Source: Field Survey from July 2010 to December 2011

Figure 3.10 Timber Tree Cultivation Area in Hectare of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

3.11 Date Tree

One of the most important industries in the district is the cultivation and manufacture of Date-sugar or *Khajur-gur*. Indeed, the people in the north and west of the district, and to some extent also in other parts of it, may almost be said to depend as much upon the cultivation of Date–palms, as upon any other branch of agriculture. Jessore district ranks first in yield of Khajur-gur in Bangladesh. In 1970-71, there are 4,516 ha under Date-Tree of which 3,585 ha are under Juice-giving trees (Bari and Latiful, 1979). The annual yield of juice during the year has estimated at 2, 50, 00,000 tons, and production per ha has arrived at 55.58 tons (Bari and Latiful, 1979).

In 1981, Date tree plantation was very profitable in this district. At that time majority percent of the households cultivated the date tree because it is a tradition of all family to take Date tree juice and rice with Date tree gur in every morning. Date trees contribute many ways to a family like it is a main source of fuel and earning source of income. And some cases it is used for house making materials. In 1981-90, Date tree plantation was going on smoothly but in some cases a few household leave this cultivation for commercial purpose and those house hold cultivate other crops to meet their own family demand. In 1981-90, average number of Date tree plantation for each family is 26 (Table 3.11). Day by day the number of cultivation of Date tree is decreasing tremendously. In 1991-2000, average number of Date tree plantation for each family is 15 and in 2001-10, it has gone down 4 (Table 3.11).

Table 3.11 Date Tree Plantation of Number of Different Periods in Jessore

Crop Name	Period 1981-90	Period 1991-2000	Period 2001-10
Date Tree Number Per Family	26	15	4

Source: Field Survey from July 2010 to December 2011

Date tree cultivation has been decreasing rapidly. For decreasing the Date tree plantation there are some basic reasons which have been functioning behind this. It has found from the field survey that 24% respondent have left Date tree cultivation because it is not profitable. Sixty two percent respondents expresses that they have not cultivated Date tree because of lack of fuel to make sugar from the juice (Table 3.11.1).

Table 3.11.1 Reason for Less Date Tree Cultivation

Item Name	Respondent	Percentage
Nonprofit	112	24
Lack of Fuel	289	62
Lack of Manpower	35	8
Irrigation	29	6
Total	**465**	**100.0**

Source: Field Survey from July 2010 to December 2011

Eight percent respondents replied that they have left Date tree cultivation because of lack of manpower to manage the process. And further six percent respondents answered that they have not cultivated Date tree because of irrigation for Boro rice cultivation. But a few farmers are still cultivating Date tree because they have available manpower and can manage fuel themselves. Once upon a time the lion share of Date sugar has been produced in Jessore and still this district meets the national demand.

3.12 Rabi Crops

The Rabi season starts at the end of the humid period and last to the pre-kharif season. Rabi crops are Pulses-Gram including Arhar, Masur, Motor, Mung, Mashkalai, Kheshari, Garikalai, other pulses. Oil Seed-Til, Rape & Mastard, Groundnut, Linseeds, Castor, Other oilseed, Spices and Condiments-Chillies, Onion, Garlic, Turmeric, Ginger, Coriander and other Spices and Condiments are also known as Rabi crop.

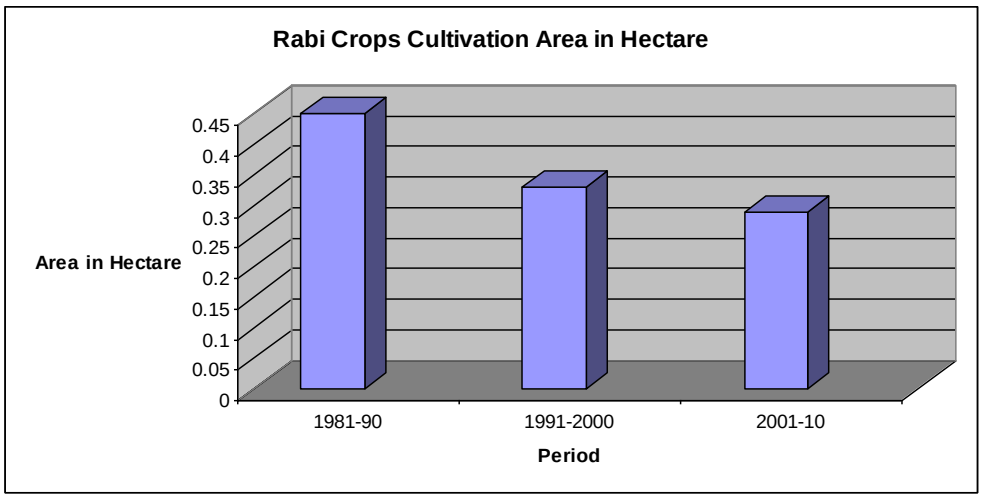
Table 3.12 Rabi Crops Cultivation Area in Hectare, Yield in Taka and Percentage of Farmers Used Local Seed of Different Periods in Jessore

Crop Name	Period 1981-90			Period 1991-2000			Period 2001-10		
	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %	Average Land ha.	Average Yield Tk.	Local Seed Used %
Rabi	0.45	2,902	99.2	0.33	4,710	40.8	0.29	9,875	25.9

Source: Field Survey from July 2010 to December 2011

It is found from the field survey that in the period of 1981-90, average Rabi crops cultivated area is 0.45 ha and average yield value is Tk. 2,902 per farmer (Table 3.12). In 1981-90 local seed was used by 99.2% of the farmers. The respondents of the study area have used more local seed because they have collected seed from own cultivation by their traditional knowledge and therefore they want to use local seed than HYV seed. Rabi crops cultivation as well as use of local seed have fallen continuously because of adverse weather, non profitable and more irrigation for Boro cultivation.

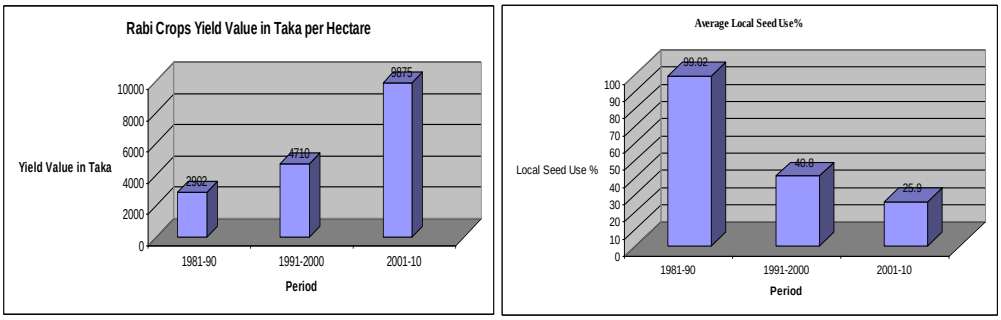
Figure 3.12 Yield of Rabi Crops Area in Hectare of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

In 1991-2000, average Rabi crops area is 0.33 ha (Figure 3.12) and average yield value is Tk. 4,710 (Figure 3.12.1). That time it has average used local seed 40.8 % (Figure 3.12.2). In 2001-10, average Rabi crops cultivable land, yield value and local seed use are 0.29 ha, Tk. 9,875 and 25.9% respectively. Rabi crops cultivation has washed away from the study area because it is non profit crops. More profit crops are HYV rice and vegetables cultivation. Huge amount of irrigation is needed for Boro rice cultivation and also needed for crops yield for adverse weather which greatly hampers Rabi crop cultivation.

Figure 3.12.1 & 3.12.2 Rabi Crops Yield Value in Taka per ha & Rabi Crops Local Seed Use %



Source: Field Survey from July 2010 to December 2011

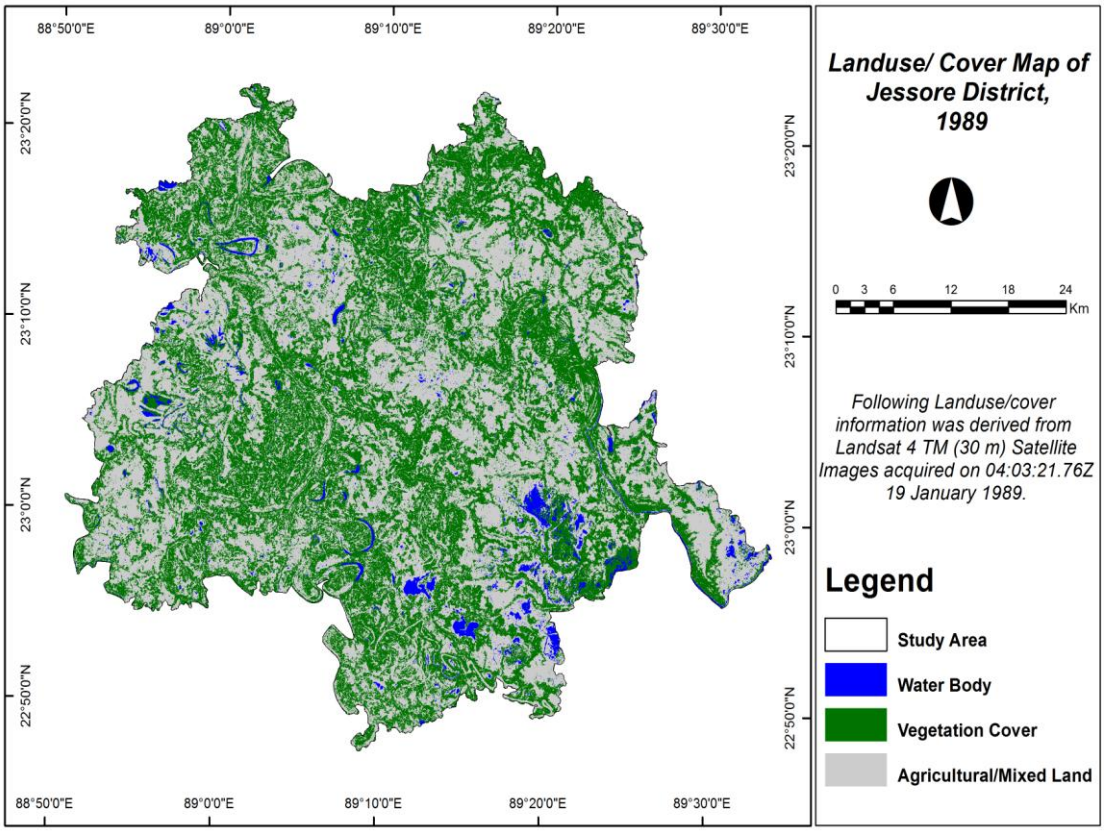
3.13 Land Use Variation

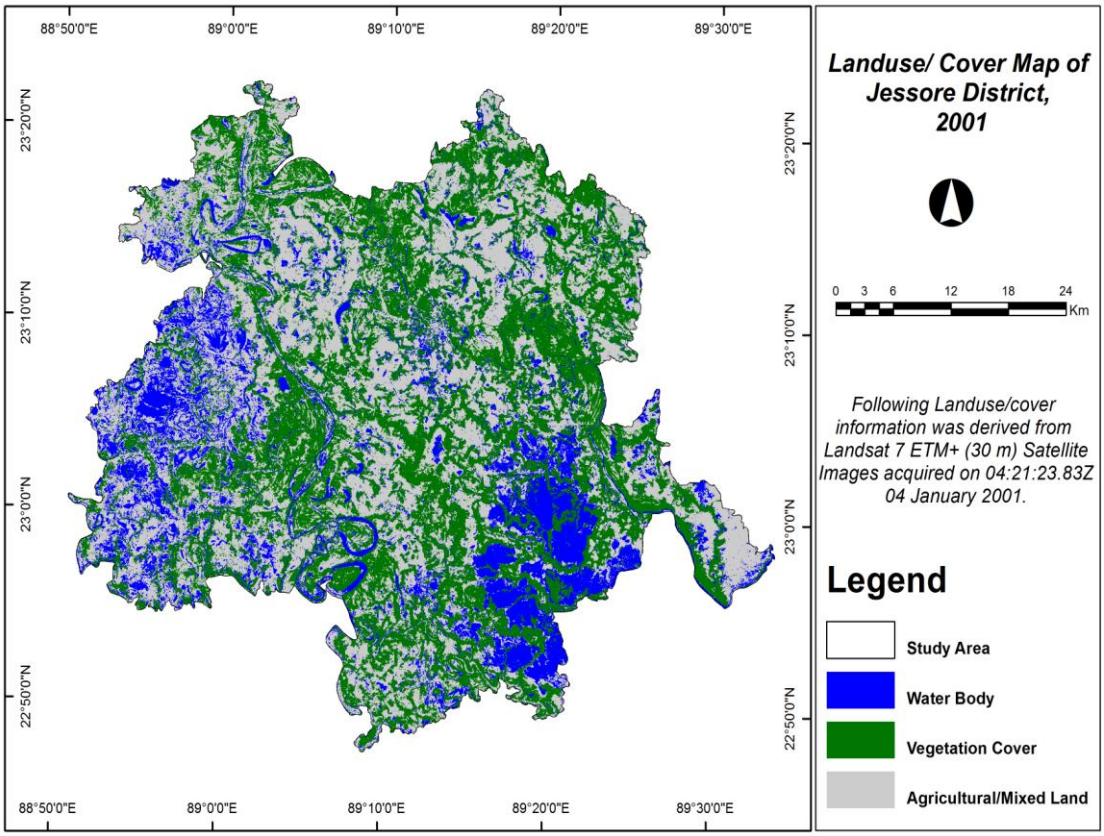
The Remote Sensing (RS) and Geographic Information System (GIS) methods and other statistical data summarization techniques have been used for finding information about the LULC (Land use and land cover) change in the Jessore District. The function of remotely sensed data in this study is to identify the LULC coverage of different study years and generate statistics. The GIS functions are used for combining vector layers into raster layer to overlay the maps for identifying the LULC cover area. To conduct the study, a great deal of mechanism and information was needed which was fulfilled this research. Landsat satellite images were obtained from USGS in January 1989, 2001 and 2010. Data were processing in ArcGIS 10.1, ENVI 5.1 using (FLAASH) and ERDAS Imagine 2010 (ATCOR) and find out statistics and output maps.

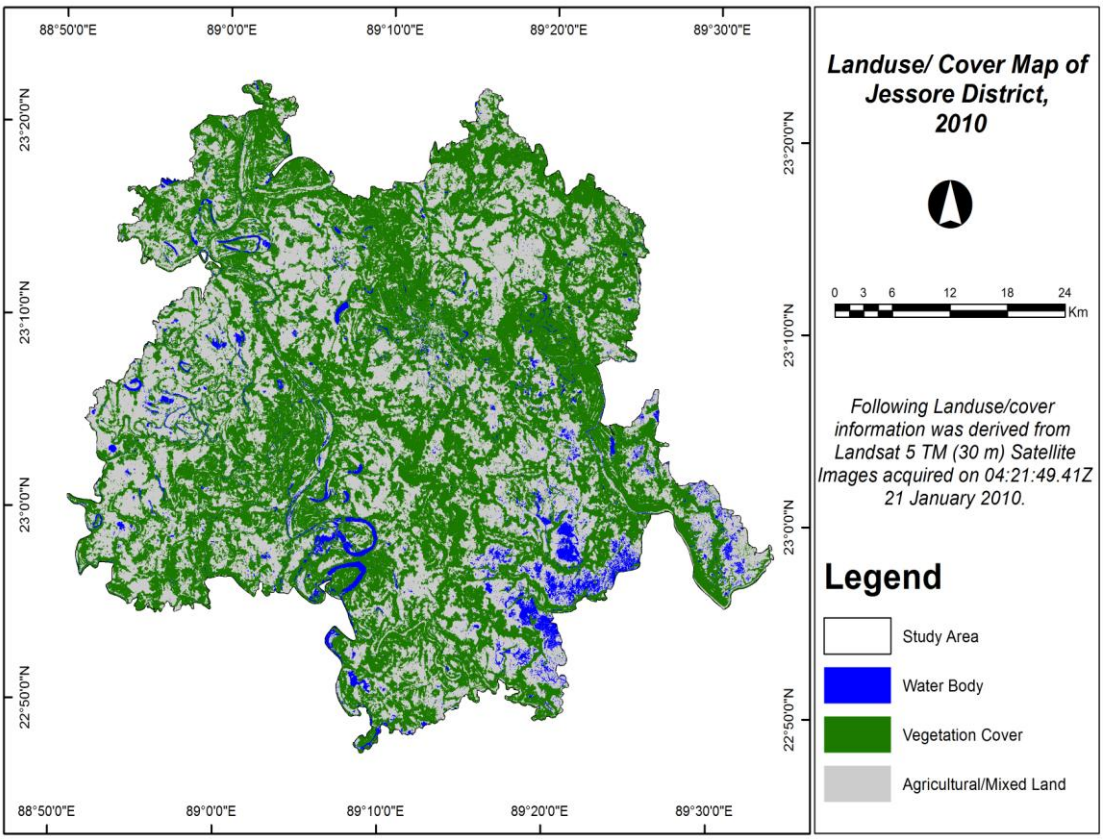
These maps illustrate satellite-detected areas of land use/variation/ Land cover map of Jessore districts, extracted from Landsat data was analyzed to allow comparison with land use variation among 1989, 2001 and 2010. The data showed that standing water body was 67.64 sq. km. in 1989 that increased to 480.64 sq. km, in 2001, which again declined to 113.11 sq. km. it in 2010 (Table 3.13). The opposite trend has been found for the vegetation and the agriculture coverage area.

Vegetation covered 1215.25 sq. km. in 1989 which has decreased to1038.94 sq. km. in 2001. Further it has again increased to 1393.85 sq. km in 2010. The decrease of vegetation in 2001 might be due to sudden flooding in 2001(Figure 3.13).

Figure 3.13 Satellite Image Land Use Variations in Jessore in 1989, 2001 and 2010







Source: Satellite Image, 2014

Agriculture has covered 1303.31 sq. km. in 1989, which has gone down to 1066.61 sq. km. in 2001. Further it has again increased little 1079.27 sq. km. in 2010(Table 3.13). The agricultural land decreased in 2001 for flooding and later stages for use of land for housing and commercial purposes.

Table 3.13 Land Use Variation sq. Km of Different Periods in Jessore Analysis by Satellite Image

Type	**1989**	**2001**	**2010**
Water	67.635	480.638	113.105
Vegetation	1215.25	1038.94	1393.85
Agriculture	1303.31	1066.61	1079.27
Total	**2586.195**	**2586.188**	**2586.225**

Source: Satellite Image, 2014

The reason of high water and low vegetation and agriculture content in 2001 is due to flood and water logging during this time. The water-logging problem at the area of Jhikargacha, Manirampur, Keshabpur upazila of Jessore district has been created since 2001 is another reason for more coverage of water area of the district. Reason is flash flood occurred in 2000. Water has run 5.45 cm and 4.57 cm up from

danger point (WDB 2004, Jessore) in 2000 and 2001 respectively. That is why the water area is more in 2001. In 2001, water area expands over vast space due to Bhabodoho tragedy ((Ali and Ahmed, 2001, Tidal River Management (TRM) Kibria, Z. and Mahmud, I., 2010). However, these data show overall water, vegetation and agricultural conditions in these decades.

3.14 Cropping Time

Agricultural cropping time is mainly dominated by the input materials and influential parameters. For improving modern technology the agricultural cropping time has been changing. Climate has changed gradually which has greatly influenced in cropping times. It has been found that cropping time varied from one to three times in a year. In the period of 1981-90, out of 465 respondents, 214 and 251farmers have cultivated their land in one time and two times which are 46% and 54% respectively. There is no respondent three times in this period. The cropping time has been changing gradually in the period of 1991-2010. In 1991-2000, out of 465 respondents, 46, 51 and 368 farmers have cultivated their land in one time, two times and three times which are 10%, 11% and 79% respectively. Three times has rapidly increased and one time and two times have swiftly decreased from 1991-2000. In the period of 2001-10, the frequency of cropping time has increased than previous decades for modern technology and population pressure.

Table 3. 14 Cropping Times of Different Periods in Jessore

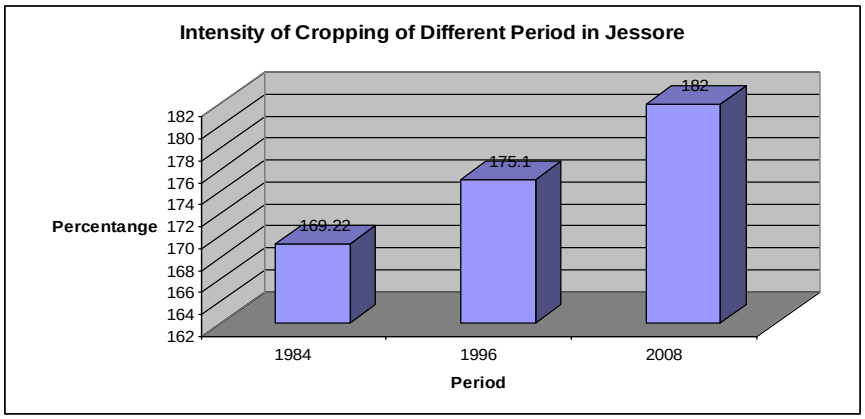
Cropping Time	1981-90		1991-2000		2001-10	
	Respondent	%	Respondent	%	Respondent	%
One Time	214	46	46	10	-	-
Two Time	251	54	51	11	116	25
Three Time	-	-	368	79	349	75
Total	465	100	465	100	465	100

Source: Field Survey from July 2010 to December 2011

3.15 Intensity of Cropping

Cropping intensity is measured as the ratio of gross cropped area to the net sown area. Table 3.15 illustrates that it was demonstrated the cropping intensity 169.22%, 1755 and 182% in 1984, 1996 and 2008 respectively. i.e. it was increased 13% in twenty four years (Figure 3.15).

Figure 3.15 Cropping Times of Different Periods in Jessore



Source: Agricultural Census1984, 1996 and 2008

The highest cropping intensity was observed in the 'Bagharpara upazila', the second highest in 'Ghikargacha Upazila', in 2008. The lowest cropping intensity was observed in 'Abhaynagar and Keshabpur Upazila' during same period for water logging. The highest cropping intensity was observed in Bagharpara and Ghikargacha upazila for good soil quality and plain land. Ghikargacha area is cultivate flower whole year and bagherpara cultivate vegetables and rice year the round.

Table 3.15 Intensity of Cropping of different periods in Jessore

Year	Abhaynagar	Bagharpara	Chaugacha	Ghikargach	Keshabpur	Sadar	Manirampur	Sharsha	Jessore
1884	161.6	189.9	150.9	168.8	182.5	165.3	181.5	152.6	169.22
1996	150.7	175.0	183.0	185.3	163.4	174.1	175.9	183.2	175.00
2008	153.0	205	184	195	160	185	175	190	182.00

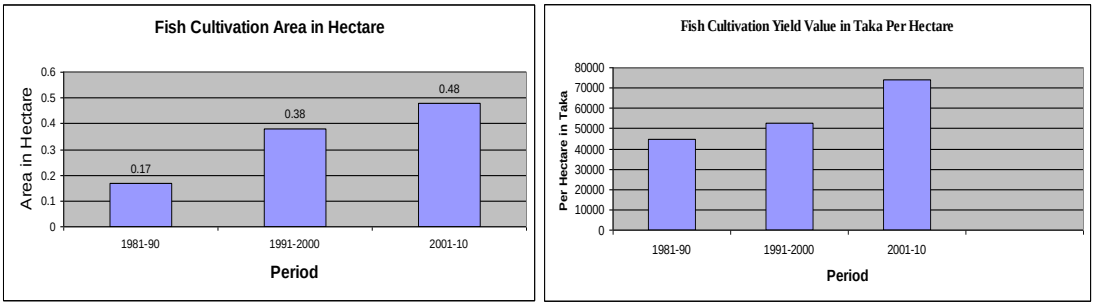
Source: Agricultural Census1983, 1996 and 2008

3.16 Fish Cultivation

Fisheries represent the second most productive and dynamic sub-sector of agriculture. Fish and fisheries are equally important for the livelihoods, food and income generation of the people of Bangladesh. The sector contributes about 4.65% to GDP, 20.60% of gross agricultural product, and 4.04% of export earnings (Year Book of Agricultural Statistics 2010). It is estimated that about 1.25 million people are directly employed in this sub sector. Over 12 million additional rural people indirectly earn their livelihoods from fisheries related activities. Bangladesh's fisheries resources are generally classified into inland and marine fisheries. Inland fisheries comprise of capture or open water fishery and culture or closed water fisheries, Jessore district has covered inland fisheries (DoF. 2002 & 2008). According to the

2007-2008 catch statistics, fish production in Bangladesh is 2.57 million tones (BBS 2008). Fish yield in Bangladesh as like as Jessore has tremendously increased for well environment and other logistical supports.

Figure 3.16 & 3.16.1 Fish Cultivation Area in Hectare & Yield Value in Taka of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

Jessore is in the best position of Fish Cultivation in Bangladesh and this trend is going on about for last three decades. It reveals from the Table 3.16 that in 1981-90, average Fish Cultivated land is 0.17 ha and average yield value of Fish per hectare in Jessore is Tk.44, 482(Figure 3.16.1). At the same time they cultivate on an average 84.1% local Fish variety. The respondents of the study area have used more local fish because they have collected the fish fry through own management by their traditional knowledge. Fish cultivation has been increasing day by day because of more fallows and wet lands are being used for this purpose. The fish cultivation is increasing rapidly for suitable climate, marketing system and local and national demand.

Table 3.16 Fish Cultivation Area in Hectare, Yield in Taka and Percentage of Farmers Used Local Fish Fry of Different Periods in Jessore

Crop Name	Period 1981-90			Period 1991-2000			Period 2001-10		
	Average Land ha.	Average Yield Tk.	Local Fish Fry Used %	Average Land ha.	Average Yield Tk.	Local Fish Fry Used %	Average Land ha.	Average Yield Tk.	Local Fish Fry Used %
Fish	0.17	44,482	84.1	0.38	52,596	56.8	0.48	74,125	28.5

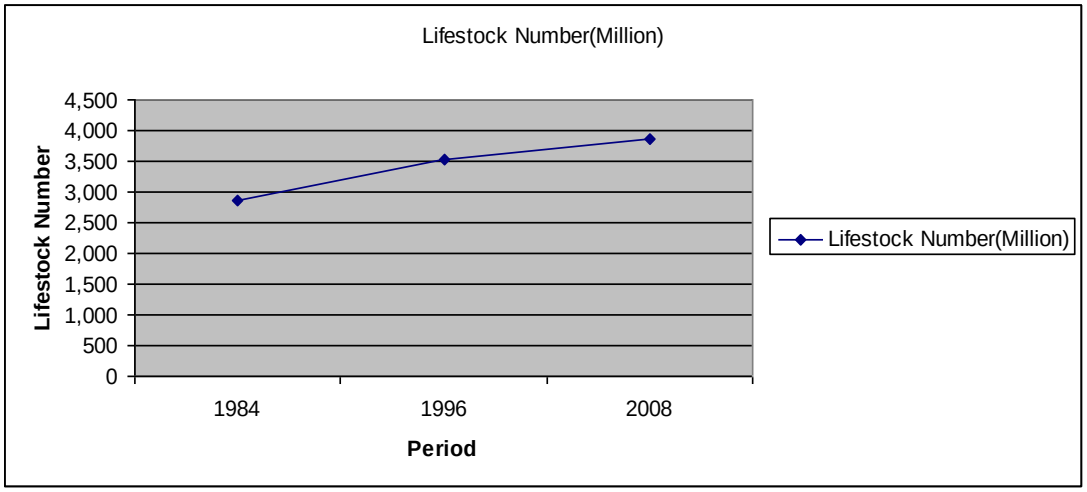
Source: Field Survey from July 2010 to December 2011

In 1991-2000, average Fish Cultivated land is 0.38 ha (Figure 3.16) and average yield value of Fish is Tk. 52,596 (Figure 3.16.1). At that time there is an average cultivated local Fish 75.5%. In 2001-10, average Fish Cultivated land is 0.48 ha (Figure 3.16.) and average yield value of Fish is Tk. 74,125. That time they have on an average cultivated local Fish 28.5 %(Table 3.16).

3.17 Livestock

Livestock is an integral component of agricultural economy of Bangladesh. This sub-sector of agriculture has multifarious functional aspects such as food, nutrition, income generation, savings, foreign currency earning, draft power, manure, fuel, transport, etc. About 36% of the total animal protein comes from the livestock. In FY 2008-09 the estimated share of the livestock sub-sector in GDP at constant prices is 2.73%. In the current fiscal year, the estimated growth rate in this sector is 3.46% which is 2.44% in FY 2007-08. The export earning from leather and leather goods is 4.31% of the total export, 20% of the population is directly and 50% is partly dependent on this sector (BBS-2009).

Figure 3.17 Livestock Number Different Periods in Jessore



Sources: Different Year Agriculture Yearbook (BBS)-1984, 1996 & 2008

Bangladesh has huge number of livestock and poultry, population with a very high density and low productivity. The country has about 23.0 million cattle, 1.3 million buffalo, 22.0 million goats, 3.0 million sheep, 221.30 million chicken and 41.23 million ducks (BBS- 2009). Productivity of all species of local livestock and poultry is far below the world average due to low genetic potentials and weak management practices. That is why; the farmers are diverted to move to another option to cultivate in the recent years. Jessore district has livestock and poultry of 2,873 million in 1984 (Figure 3.17). The amount has increased in 1996 and 2008 which reached 3,522 million and 3,853 million respectively (Agriculture Census in Jessore at 1984, 1996 and 2008).

Table 3.17 Livestock Number of Different Periods in Jessore

Period	Number(Million)
1984	2,873
1996	3,522
2008	3,853

Sources: Different Year Agriculture Yearbook (BBS)-1984, 1996 & 2008

For improved irrigation system, modern method and appliances, available modern input materials and modern technology agriculture pattern has changed rapidly in the study area. Climate change has influenced greatly to change agriculture pattern. Marketing system, transport management and well communication system has acted as a machine to change agriculture pattern. Local, national and abroad demand has influenced greatly to change agriculture pattern. As a result physical and social environment have made a vital role to change agriculture pattern in the study area. Global climate change and weather abnormality has changed agriculture pattern in the study area.

Chapter 4

INFLUENTIAL PARAMETERS IN CHANGING AGRICULTURAL PATTERN

4. Introduction

Due to variation in biophysical and socioeconomic conditions, indicators used in one country are not necessarily applicable to other countries. In view of biophysical and socioeconomic conditions in the study area, a few indicators have been selected for evaluation of the agricultural systems. Various types of indicators are representing ecological, economic and social dimensions of changing agriculture pattern. Bangladesh has got the natural advantage of favorable soil and climatic condition and abundant supply of inexpensive labor force. Various influential climatic parameters such as rainfall, temperature, relative humidity, sunshine hour, ground water level, agro ecological zones, physiography, soil etc have the consequent effects on changing agriculture pattern.

4.1 Soil Classification

Soil is the natural medium for growth of land plants. Alternatively, the accumulation of unconsolidated rocks and minerals fragments and organic matter formed in place at the earth's surface; capable of supporting life. Practically, soil is a three-phase system covering solid, liquid and gaseous phases. The solid phase comprises both organic and inorganic matter while the liquid and gaseous phases contain water and air respectively.

In southern part of the district, the soil contains dark grey clay mixed with peat and the northern part contains salty clay loam of the Ganges meander flood plain. In the central part, calcareous dark clay loam is formed for the impact of the old Ganges flood plain. The low land containing alluvium is suitable for high yield of Aman rice and vegetables in Jessore (Bari and Latiful, 1979).

The soil in different sub divisions does not show any marked difference in character or in composition. The real distinction between one kind of soil and another is agricultural and based on the proportion of sand and clay the soil contains and on its level and the consequent effect of rain water on it. The classifications of soil water in

vogue, among the cultivators, are (1) *balia* (sandy), (2) *matial* (clayey) and (3) *doash* (loam, a mixture of soil and clay), each of these three classes can be subdivided into two sub- classes (1) high and (2) low (Bari and Latiful, 1979).

There are, thus, six agricultural classifications of the soil, viz. (1) high sandy, (2) low sandy, (3) high matial, (4) low *matial*, (5) high *doash* and (6) low doash. There are many *beels* and *boar* in the south-west part of the district. The soil is extremely clayed and rich by decomposed vegetables. The yield of boro paddy is high in this part (Bari and Latiful, 1979).

4.2 Soil Chemical Characteristics

A total of Eight properties, viz. soil pH, nitrogen (N), phosphorus (P), potassium (K), sulphar (S), zinc (Zn), organic matter content (OM) and electro connectivity (EC) has been analyzed among the period from 1996 and 2010. It has been found that the data collected from different upazilas in Jessore district and compared the average chemical characteristics of soil of the above parameters. All land types have found medium high land (Saheed, et.al. 1970).

4.2.1 Methodology Followed for Soil Sample Collection

Thirty two soil samples, 8 from each Upazila, are collected from randomly selected farm plots of sampled households. Leaving 2.5 meter area along the four sides of the sample field, nine well-distributed sampling spots are selected for soil sample collection. Soil samples are collected from 0 to 20 cm deep plough layer from the designated spot by using an auger. These samples are air-dried and are mixed thoroughly to make a composite sample for each plot. Then, samples are collected from paddy fields about one month after harvesting of paddy. Each soil sample has divided into four equal parts from which two diagonal parts are retained and the remaining two parts are removed. This process has repeated until the successive quarter reduced to a weight of about 0.5 kg. The samples are then put into plastic bags and are properly labeled showing soil sample number, the farmers' name and address, and date of collection. Then, the soil samples are brought to the laboratory of the Soil Resource Development Institute, Rajshahi, for analysis (SRDI, 2012).

4.2.2 Organic Matter

Soil organic matter is the residue of living and non-living origins of plant, animal and microorganisms. Dead residues exist in various degrees of decomposition ranging from un decomposed to completely decomposed. The mineral matter mostly supplies the mineral elements derived from rocks. Particles of various sizes are also generated from rocks by weathering. Soil is not an inexhaustible store of plant nutrients; even though it is called the bank of nutrients. Improved soil fertility is a precondition for increased crop production. Organic matter content not only influences soil productivity but also improves its texture and structure. It helps to reduce leaching of nutrients, increases water holding capacity, supports the activities of microorganisms, improves drainage, reduces erosion and promotes plant hormones (BARC, 1997; Dahal, 1996). A good soil should have at least 2.5% organic matter but in Bangladesh most of the soil has less than 1.5%, and some soils even less than 1% organic matter (BARC, 2005). Many scientists expressed their concern over the depletion of organic matter content in the soils due to imbalance use of inorganic fertilizer, growing one type of crop in the same land continuously through traditional practices (Ahsan & Karim, 1988). In Jessore district the organic matter recorded 1.80% in 1996 and 1.35% in 2010(Table 4.1 & 4.2). In 2010, the contain of organic matter was lower due to excessive use of land, more use of chemical fertilizers, pesticides & herbicides as well as soil erosion. The lower trend of organic matter was observed in all Upazilas specially at Jhikargacha, Avaynagar and Bagharpara.

4.2.3 Electrical Conductivity

The electrical conductivity of collected soil sample from the study area has found to be decreased from 1996 to 2010. The electrical conductivity has decreased more in Chowgacha with a far difference of 0.79 to 0.70 in the year 1996 to 2010 respectively (Table 4.1 & 4.2). Sarsa and Jhikargacha Upazila have also experienced similar type of decrease from 1996 to 2010 and rest upazilas have similar trend of decrease from 1996 to 2010 which indicated that the soil of the study area is non saline, where as United States Salinity Laboratory Staff (1954) defined saline soil as those with EC, which is more than 4.

Table 4.2.1 Average Chemical Characteristics of Soil in Jessore District -1996

Upazila Name	Land Type	PH	EC Meter	OM %	N %	Phosphorus Microgram	K(Potasium) Microgram	Sulphar Microgram	Zn Micr
Bagharpara	Medium High Land	7.1-8.4	0.70	2.15	0.11	11.78	0.39	15.66	1.62
Sarsa	Do	6.0-7.6	0.92	2.43	0.93	17.71	0.24	14.02	0.24
Keshabpur	Do	6.6-8.4	1.62	2.19	0.28	14	0.26	13.10	1.60
Jhikorgacha	Do	7.0-8.4	0.76	1.80	0.26	17	0.18	16.40	0.27
Chowgacha	Do	6.7-8.6	0.79	2.33	0.16	8.1	0.16	14.04	2.5
Avaynagor	Do	6.2-8.2	4.21	1.94	0.20	12	0.13	12.07	2.7
Sadar	Do	7.0-8.4	1.8	2.15	0.12	12.89	0.23	15.03	0.80
Manirampur	Do	6.4-8.3	1.96	2.07	0.24	13.2	0.19	15.57	1.76

Source: Soil Resource Development Institute, 1996, Agriculture Ministry, Bangladesh

Table 4.2.2 Average Chemical Characteristics of Soil in Jessore District -2010

Upazila Name	Land Type	PH	EC Meter	OM %	N %	Phosporas Microgram	K(Potasium) Microgram	Salpar Micr	Zn Micro
Bagharpara	Medium High Land	8.1	0.7	1.45	0.06	16.70	0.10	25.06	1.06
Sarsa	Do	8.2	0.75	1.32	0.07	15.71	0.14	35.14	0.94
Keshabpur	Do	8.3	0.80	1.28	0.06	10.1	0.09	54.1	1.05
Jhikorgacha	Do	8.2	0.76	1.35	0.05	17.10	0.11	21.3	1.02
Chowgacha	Do	8.3	0.70	1.38	0.07	21.5	0.10	30.4	1.03
Avaynagor	Do	8.1	0.73	1.41	0.6	10.23	0.13	9.4	1.17
Sadar	Do	8.2	0.55	1.38	0.07	11.80	0.12	8.1	1.18
Manirampur	Do	8.0	0.50	1.09	0.05	9.6	0.13	9.5	1.20

Source: Soil Resource Development Institute, Rajshahi, , Agriculture Ministry Bangladesh, 01/08/2012

4.2.4 Soil pH

Soil pH is the most important factor of nutrient availability in soils. The effect of soil pH on nutrient availability is clearly illustrated (Table 4.1 & 4.2). In most cases, pH 6-7 is optimum for adequate availability of nutrients in soils. At Bagharpara, the soil pH has found 8.4 in 1996 and 8.1 in 2010 which is similar to all other Upazilas. This decreasing trend is due to excessive use of ground water & land, chemical fertilizers, pesticides and salty water enter in the land, water logging etc.

4.2.5 Nitrogen

Nitrogen (N) is an indicator of soil fertility as its requirements for most of the crops are high and considered as a major determinant of growth and yield of crops (Hossain & Kashem, 1997). N is the most limiting nutrient in crop production all over the world as like as Bangladesh. Understanding the behavior of N in soil is essential for maximizing crop productivity and profitability and on the other hand for reducing

the possible negative impact of N fertilization on the environment. As N fertilizer is the main promoter of crop growth and yield, it is important to improve management practices that minimize N losses and increase the recovery of applied N by the crop. These help in increased productive efficiency and reducing negative impact of N use on the environment. The N (%) is found 8.1 in 1996 and 0.07 in 2010 at Chowgacha Upazila and trend is similar in all other Upazilas (Table 4.1 & 4.2). The N is being lowest due to excessive use of land; no remain fellow land and not for using organic fertilizer, more use chemical fertilizer etc.

4.2.6 Phosphorus

In 1996, Soil of Sarsa Upazila in Jessore district contained 17.71 Phosphorous Microgram and in 2010 has contained 15.71 Phosphorus Microgram(Table 4.1 & 4.2). The trend of decreasing is going on rapidly and different causes are working behind the decreasing volume of phosphorous, like excessive use of land, not maintaining crop diversification and cropping pattern, adulteration and more use of land, low use of TSP, DAP and SSP.

4.2.7 Potassium

K (Potassium) content in the soil is higher in 1996 than in 2010. The volume of potassium is decreasing day by day and this trend is going on rapidly till date. Potassium of soil has contained 0.23 Microgram (um) and 0.12 Microgram in 1996 and 2010 respectively of Sadar Upazila in Jessore (Table 4.1 & 4.2). Different causes are working behind of decreasing the volume of potassium, like as excessive use of land; no remain fallow land, improper utilization of pesticide, farmers do not maintain appropriate cropping pattern, adulteration and excessive use of Murate of Potash (MOP) fertilizer regarding this issue in the study area and not use of MOP.

4.2.8 Sulphur

The Sulphur content has recorded higher 25.06 M in 2010 at Bagharpara Upazila whereas in 1996 it was 15.66 M (Table 4.1 & 4.2). Noted that other upazila's in Jessore has the same trend considering at Bagharpara Upazila. Increasing the volume of Sulphur is observed for various reasons like as excessive use of land, improper use of pesticides, not maintaining of appropriate cropping pattern, adulteration and more use of chemical fertilizer like Zn Sulphur, H- Sulphur, NH4- Sulphur.

4.2.9 Zinc

It has shown Table 4.1 & 4.2 that Zn has recorded 2.7 Microgram and 1.17 Microgram in 1996 and 2010 respectively at Avaynagar Upazila. This decreasing trend is same in the all other upazilas. The trend is decreasing due to loss of Zn, not proper use of Zn related fertilizers. The lower proportioned Zn has recorded due to excessive use of land, less use of fertilizer, adulteration and more use of chemical fertilizer but not properly.

Due to over use of land, growing the same crop in the same land continuously, lack of organic fertilizers and chemical fertilizers causes decrease of soil nutrients during last three decades.

4.3 Atmosphere and Climate

4.3.1 Temperature

The country has an almost uniformly humid, warm, tropical climate. On the basis of temperature and rainfall, there are three main recognizable cropping seasons as follows:

1) The hot summer season from March to June is characterized by high temperatures and called as Kharif-I . The maximum temperatures in the year are reaching between the last week of March and the end of April, when average maximum annual temperatures range from 24^0C to 34.8^0C in different parts of the country (Basak et. al.2013).

2) From June to October is the hot and humid monsoon season with temperature ranging from 20^0C to 36^0C, and heavy rainfall about two-thirds of the mean annual rainfall. During this period agricultural season Kharif-II prevails. In June there is a marked fall in temperature, because of the monsoon rains (Basak et. al.2013).

3) The relatively cooler and drier winter extends from November to February when temperature range from 8^0C to 15^0C and minimum temperature can fall below 5^0C in the north of Bangladesh though frost is extremely rare. During this period agricultural season Rabi prevails. The temperature fall gradually throughout November and December and in the last week of December, northern areas of the

Northern region record a maximum of 9^0C, and in the Sylhet Hills the mean minimum temperature is 8^0C (Basak et. al. 2013).

Table 4.3.1 illustrates the daily maximum and minimum temperature in Jessore district recorded in 1981-2010. In 1989 the daily temperature has recorded with 41.50^{0}C as maximum and 5.9^0 C as minimum temperature. This decade an average temperature is 31.18^{0}C. The trend of daily maximum temperature has shown positive increase, and minimum temperature has shown negative increase. In 1995 the daily temperature has recorded with 42.70^{0}C as maximum and 6.0^{0}C as minimum temperature. This decade an average temperature is 34.540C (Table 4.3.1).

In 2001-10, the daily temperature has recorded in 2009 with 43.20^{0}C as maximum and 5.0^0 C in 2003 as minimum temperature. The average temperature of this decade is 38.71^{0}C.

Table 4.3.1 Maximum, Minimum and Average Temperature-^{0}C in Jessore (1981-2010)

Year	Maxi Tem	Mini Tem	Average
1981-90	41.5 (1989)	5.9 (1989)	31.18
1991-2000	42.7 (1995)	6.0 (1995)	34.54
2001-10	43.2 (2009)	5.0 (2003)	38.71

Source: BMD

There is a slight difference in temperature in three decades from 1981-2010 in thirty years, and each decade maximum temperature increases slightly and minimum temperature also increased little slightly (Table 4.3.1 and Annexure 01) which indicate increase of temperature in last decades (2001-2010). The temperature has greatly influenced the agriculture pattern change in the study area.

As the temperature has been increasing in last three decades, so the cropping pattern has changed and a few crops have vanished and a few crops production has become less or more of the study area. So that new variety of crops which could sustain in high temperature will be planted in the future as adaptation to climate change.

4.3.2 Rainfall

As mentioned briefly above, there are three main periods of rainfall corresponding to the seasons described, each with its distinct source of precipitation. These are:

1) The pre-monsoon thunderstorms known as the Nor'westers (North-westerlies) begin in March. The Nor'westers arise due to a variety of reasons, the main ones being the steady flow of cool dry air above 1800 meters altitude from the northwest (Anti-Trades), a warm, moist current below 1800 meters from the south, intense evapo-transpiration in the Bengal basin and Assam, and katabatic winds from the surrounding mountains(Rashid, 1991).

2) The heavy summer rain known as the Monsoons starts from the end of May and continue till mid-October. The main rainy period begins with the coming of the moisture-laden Southwest Trades, popularly known as the Monsoons, which are drawn to the Indian sub-continent by the intense heat and consequent low pressure over Punjab (in Pakistan and India) and the Upper Ganges Valley(Rashid, 1991).

3) The western depression of winter rains occurs mainly from 20th January to 25th February, when it rains from 1 cm to 4 cm. In recent years the weather pattern has been erratic, with a reduction of the cool, dry season (Rashid, 1991). This could be a temporary phenomenon, or it may be the beginning of long term changes due to global warming caused by greenhouse gases. Possible connections with *El Nino* have only now begun to attract attention as a major possible influence on climatic patterns in the Subcontinent (Rashid, 1991).

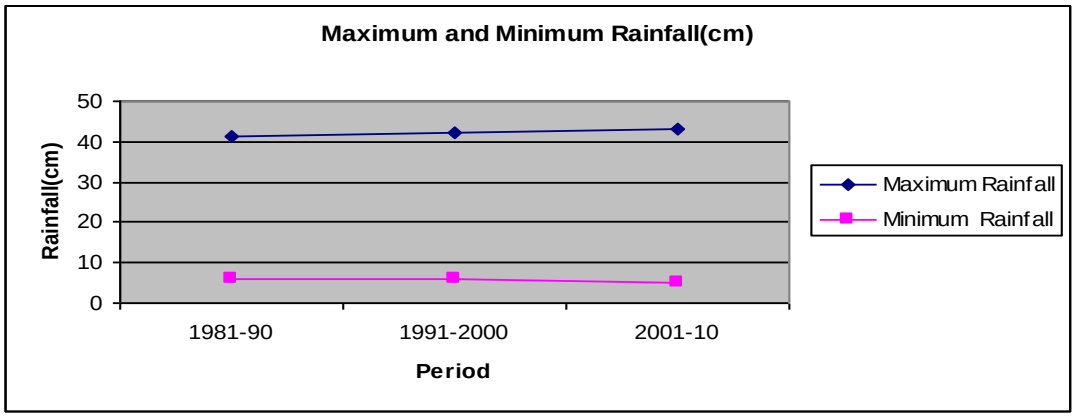
Figure 4.3.2 describes that the daily maximum, minimum and average rainfall in Jessore district has recorded in 1981-90. In 1986 and 1982, the daily rainfall has recorded with 2073 cm as maximum and 1265 cm as minimum rainfall. This decades average rainfall is 1436 cm. December and January is recorded less rainfall and most of the cases from November to February is rainless and July and August is recorded more rainfall (Figure 4.3.2 and Annexure 02).

The daily maximum, minimum and average rainfall in Jessore district has recorded in 1991-2000. In 2000 and 1994, the daily rainfall has recorded with 1888

cm as maximum and 1269 as minimum. In this decade average rainfall is 1299 cm. December and January has recorded less rainfall and most of the cases these two months are rainless, and July to August has recorded more rainfall.

The daily maximum, minimum and average rainfall in Jessore district has recorded in 2001-10. In 2004 and 2010, the daily rainfall has recorded with 2477 cm as maximum and 1371 cm as minimum(Figure 4.3.2 and Annexure 02). Whereas last decade 2001-10 average rain fall is 1546 cm. There is a yearly slight difference in rainfall in thirty years from 1981-2010 and in last decades November, December and January have recorded less rainfall and June, July and August have recorded more rainfall. Variation of rainfall in last three decades modulates to change the agriculture pattern.

Figure 4.3.2 Maximum and Minimum Rainfall in Jessore (1981-2010)



Source: BMD

As the rainfall has decreased but crop production has increased dramatically because people use ground water for irrigation which is expensive and not friendly to environment. So, more surface water reservoir e.g. rivers, canals, ponds could minimize the environmental hazard.

4.3.3 Relative Humidity

Table 4.3.3 reveals that for the period 1981-1990, the yearly maximum and minimum relative humidity in Jessore district is recorded as 74.95% in 1982 and 57.76% in 1987 respectively. July and August record more relative humidity and February records less relative humidity. For the period 1991-2000, the yearly maximum and minimum relative humidity has recorded as 73.91% in 1998 and

69.15% in 1992 respectively (Table 4.3.3). September records more relative humidity and February records less relative humidity.

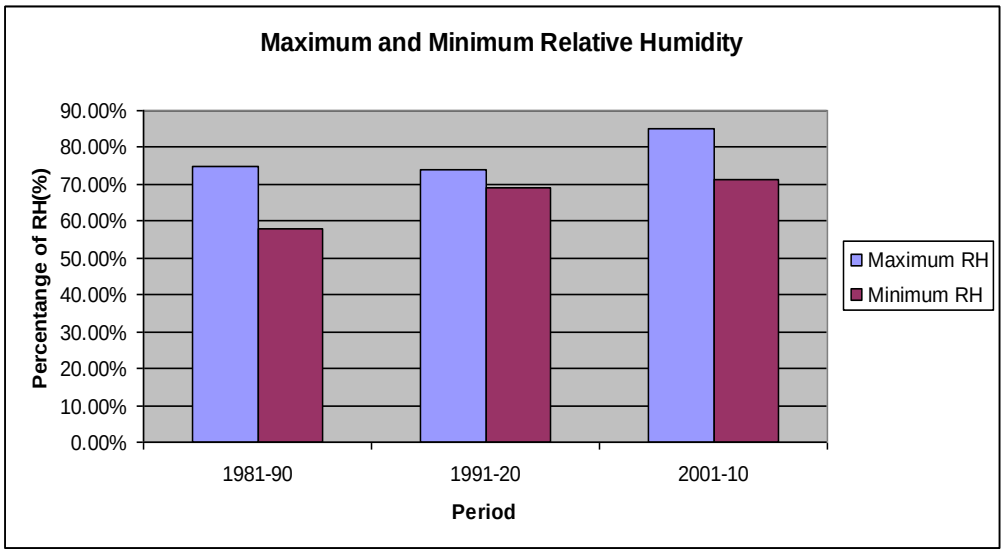
Table 4.3.3 Maximum and Minimum Relative Humidity in Jessore (1981-2010)

Year	Maximum RH	Minimum RH
1981-90	74.95% (1982)	57.7% (1987)
1991-20	73.91% (1998)	69.15% (1992)
2001-10	85.06% (2008)	71.13% (2005)

Source: BMD

For the period 2001-2010, the yearly maximum and minimum relative humidity has recorded 85.06% in 2008 and 71.13% in 2005 respectively. There is a slight difference in relative humidity in three decades from 1981-2010 and last decade has higher relative humidity than the others. September has recorded more relative humidity and February has recorded less relative humidity (Figure 4.3.3 and Annexure 03). Relative humidity keeps great influence on the change of agricultural pattern.

Figure 4.3.3 Maximum and Minimum Relative Humidity in Jessore (1981-2010)



Source: BMD

Plant growth is influenced by the level of relative humidity like as maximum cereal crops & cash crops. Different insects and diseases have favorable condition to attack different crops like rice, jute, sugarcane etc. in high Relative Humidity condition. Crop yield has hampered due to high Relative Humidity. On the other hand plant growth has negative influence for low relative humidity like as pulses, oil and vegetables.

4.3.4 Ground Water Level Condition

Groundwater is one of the components of the hydrological cycle, stored underground in rock layers called aquifers - it is a result of infiltration of rainfall and surface water with which it maintains a close relationship. Groundwater represents around 30% of freshwater resources of the earth, while lakes and rivers correspond to less than 1%. The largest volume of freshwater is stored in glaciers (69%). When this water reaches the ground water table (i.e. the groundwater's upper level), it begins a long, slow journey underground, moving at rates ranging from a few millimeters to a few meters per day(BWDB-2004).

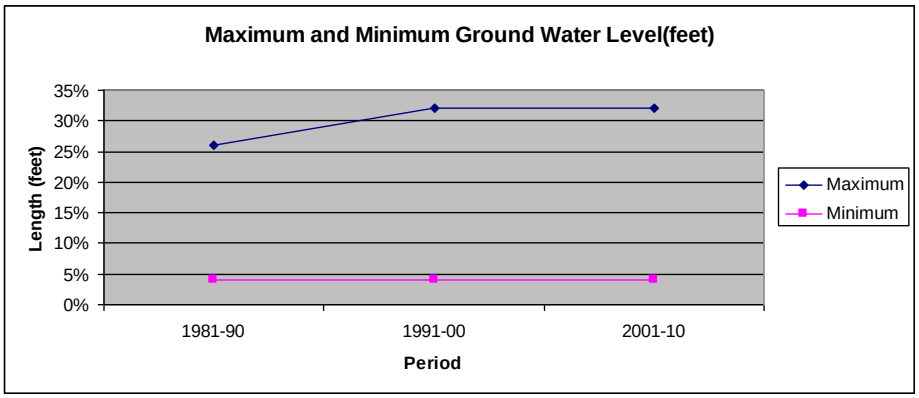
The groundwater table over most of Bangladesh lies very close to the surface and fluctuates with the annual recharge discharge conditions. Recharge to aquifers in Bangladesh is mainly from vertical percolation of rainwater and floodwater. Average rainfall in Jessore is 1648 CM in 1990 and in 2010 it has fall down 1371 CM (MDB 2012). Rivers and other standing water bodies provide local recharge to the nearby aquifers. But in Jessore district except little part of Bhairab, all rivers keep water for 6-7 months in a year. 12 Baor in Jessore keeps water the year round (WDB, 2010). The main component of discharge is the withdrawal of groundwater by different types of tube wells.

At present groundwater contributes to 77% of total irrigated area in Bangladesh (BBS, 2008). The groundwater irrigation increased with the expansion of High Yielding Variety (HYV) rice cultivation. About 80% of groundwater is used for crop production of which Boro paddy alone consumes 73% of total irrigation. Hence, Boro rice production is increasing at about one percent annually and contributes to 55% of the total rice production (BBS, 2007). Boro production in Jessore district in 1985 is 3, 27, 91,498 ha and in 2010, it has reached 22, 90, 61,538 ha.

The level of ground water has fallen drastically in Jessore district and the adjacent areas in the month of April-May. It is gathered (DPHE, Jessore 2012) that the ground water level has fallen by 32 feet (7.95 meter) from the surface. As a result, pulling of tube-well water has become extremely difficult. The irrigation machine can hardly pump out water in Jessore district. According to sources in the Department of Public Health Engineering in Jessore there are a total of 21,549 tube-wells in eight Upazila. The ground water level in Jessore has come down to the lowest level with

irrigation crisis turning for the worse. The officials of the department concerned apprehend that if there has been no rain within February, 50% of tube-wells would face difficulties in pumping out waters with adverse impact on environment as well as on irrigation to boro fields in the peak hour (Hossain-1997).

Figure 4.3.4 Maximum and Minimum Ground Water Level Jessore 1981-2010



Source: DPHE in Jessore in different year.

Table 4.3.4 reveals that the groundwater level is at or very close to the surface during the monsoon. Four feet in Dalgram at Bagharpara Upazila in 1988 whereas it is at maximum depth during the months of April-May. It is 26 feet in Putkhali at Sarsa Upazila, Mohakal at Bagharpara Upazila and Kashimnagar at Manirampur Upazila in 1989. The groundwater level at the monsoon is eight feet in Panisara at Jhikorgacha Upazila in 2004 whereas groundwater level at maximum depth during the months of April-May is 32 feet (9.75 Meter) at Deara, Fatepur, Haybotpur, Ichali, Kachua, Kashimpur at sadar Upazila in 2009 (Figure 4.3.4 and Annexure 04)). After (DPHE, Jessore 2012) measuring the ground water level on April-May it is found that it is coming down dramatically because water discharge opportunity is increasing day by day. Thus it is seen that the ground water level has been falling to the lowest an alarming proportion which greatly influences our agriculture pattern change.

Table 4.3.4 Maximum and Minimum Ground Water Level in Jessore 1981-2010

	Year	**Depth**	**Union & Upazila**
1981-90	1986-1988	4 Feet	Dalgram
	1989	26 Feet	Putkhali(Sarsa), Mahakal, (Bagharpara), Kashimnagar (Manirampur)
1991-2000	1991	10 Feet	Manirampur (Manirampur)
	1996	32 Feet	Sukpukuria, Pasapol (Chawgacha), Noranropur(Sadar), Navaron(Jhikorgacha)
2001-10	2004	8 Feet	Panisara (Jhikorgacha)
	2009	32 Feet	Deara, Fatepur, Haybotpur, Ichali, Kachua, Kashemour(Sadar)

Source: DPHE in Jessore in different year.

Excessive use of ground water for agriculture cultivation makes contamination of arsenic. In Jessore average 40% tubewell is affected by arsenic for more use of ground water (DPHE, Jessore-2012) which affected different area like Keshabpur, Jhikorgacha and Manirampur upazila.

As the rainfall has decreased, ground water use has increased dramatically to produce the crops. For using high ground water arsenic, salt and pH of the soil are changing and creating problems for human health. So, more surface water reservoir is desirable to solve the problem of over use of ground water.

The physical environment of Bangladesh is diverse, and there is a mixture of both traditional and modern methods of agriculture, all very closely adapted to the heterogeneous conditions. This complexity of environmental and utilization patterns has important implications for the vulnerability and depletion of the natural resource base. Moreover, rapid and frequent natural dynamic changes are taking place in the hydrological and river systems, soil fertility, ground water level condition and they are also subject to the influence of various human interventions. This situation has affected more in Jessore district. These factors in turn influence the land use patterns and eventually influence the cropping pattern in Jessore district and same situation in the whole Bangladesh.

Chapter 5

ROLE OF INPUT MATERIALS IN CHANGE OF AGRICULTURAL PATTERN

5. Introduction

The soils, rainfall, temperature and water availability of Bangladesh make it ideal for agricultural production which has been practised for thousand of years and it has supported our economy. Fertilizers, irrigation, land preparation, equipments, pesticides & herbicides, fuel, agricultural equipment and seeds are also the additional inputs in crop production. The main inputs used in crop production in Jessore district in Bangladesh are discussed in this chapter.

Farmers generally use various types of fertilizers (chemical and organic) to enhance the soil fertility for maximum yield. However, usually the farmers do not use that much chemical fertilizers except homestead manure and cow dung for crop production before 1990. Later stage, little amount of cowdung and compost are generally used as soil nutrient than chemical fertilizer. Chemical fertilizers such as urea, triple super phosphate (TSP), murate of potash (MP), gypsum and zinc sulfate are commonly used in paddy production in Bangladesh (BARC-2005). However, the farmers apply chemical fertilizers of various types for Multi Varieties (MV) production.

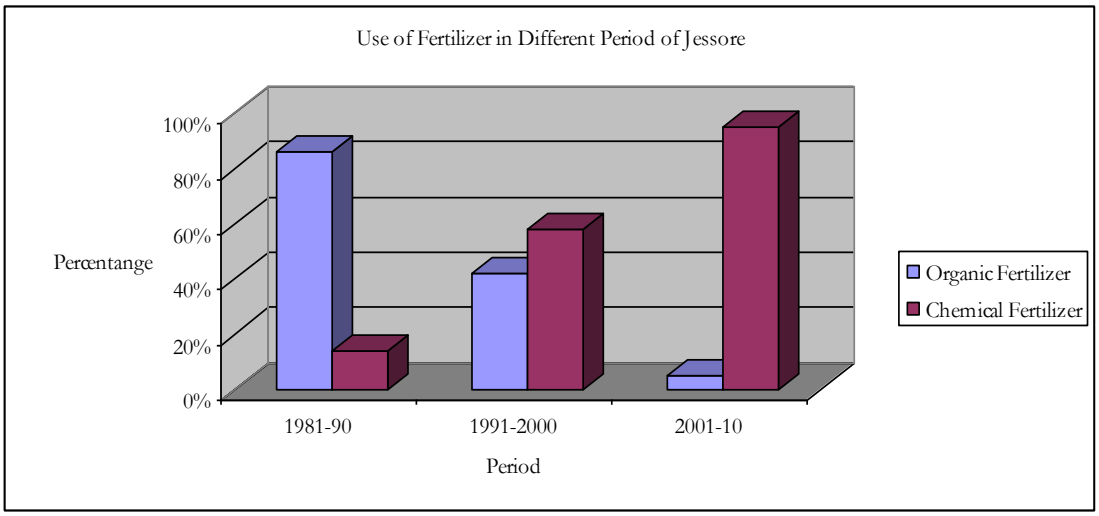
Farmers have used different types of seed to increase crop production such as HYV, local, homemade seed, from BADC etc. Farmers use different types of cultivation method and irrigation method for increase of soil fertility and crop production, and also they use a lot of pesticides to control pests of different types in order to have more production in agriculture.

5.1 Use of Fertilizer

Fertilizer is one of the main inputs required for increasing crop production. The expansion of modern agricultural practices together with intensified cultivation has led to an increasing demand for fertilizers. It is therefore, necessary to ensure timely supply of fertilizers to match the demand. In practice farmers usually do not receive appropriate supply of good quality of fertilizer in the market. Obviously they have to depend on the supply available in the market. Most of the time these fertilizers

are not supplied as good quality. As a result of overused of fertilizers as well as adulteration, the fertility of land is declining on the one hand and the potential yield is not achieved on the other. In this respect, it is extremely important to adopt and implement the policies to encourage the farmers using balanced fertilizers to protect the soil fertility (BARC-2005).

Figure 5.1 Use of Fertilizer of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

It is observed from the field survey that in 1981-90, use of organic fertilizers is 86% (Table 5.1). Use of organic fertilizer has fallen down dramatically over the periods. In 1991-2000, it has gone down to 42%. Whereas, this trend is going down very sharply and in 2001-10, it has gone down the lowest point in 5%. On the other hand, in 1981-90, use of chemical fertilizer is 14% and this trend has risen up gradually. In the period of 1991-2000, use of chemical fertilizers is 58%. Day by day this trend has gone up tremendously. From 2001-10, it has reached top point in 95% (Table 5.1 and Figure 5.1). Use of organic fertilizer has reduced from 1981 to 2010 due to improve technology, transport and communication and availability of chemical fertilizer. Cowdung has been used for fuel and the respondents are not interested to cattle rearing for not having profit.

Table 5.1 Use of Fertilizer of Different Periods in Jessore

	Period		
Fertilizer Name	1981-90	1991-2000	2001-10
Organic Fertilizer	86%	42%	5%
Chemical Fertilizer	14%	58%	95%

Source: Field Survey from July 2010 to December 2011

According to farmers, they had to use increasingly large amounts of inorganic fertilizers over the successive years to maintain the yield due to gradual deterioration of soil quality because of continuous cultivation of rice with irrigation and overuse of inorganic fertilizers. Farmers in other parts of Bangladesh have had similar experience (Hossain & Kashem, 1997; Rahman & Thapa, 1999).

Declining soil fertility has been the major concern for agricultural sustainability in Bangladesh. It is believed that declining land productivity to a considerable extent, be attributed to the lack of adequate amounts of organic matter in soil (BARC, 1997; Hossain & Kashem, 1997). Traditionally, farmers used to apply farmyard manure (FYM) and mulch crop residues to land to enhance soil fertility.

Figure 5.1.1 Photograph of fertilizers used in Different Period in Jessore

(a) Put Organic Fertilizer

(b) Put the Organic Fertilizer

(c) Put the Herbicides

(d) Put the Chemical Fertilizer

(e) Put the Guti Urea Fertilizer

(f) Put the Guti Urea Fertilizer

This tradition has been abandoned gradually due to reduced livestock herd size and increased use of dung and crop residues as fuel. As a result, most soils in Bangladesh have organic matter content of less than 2%, some soils have even less than 1% (BARC, 1997; Hossain & Kashem, 1997). Organic matter in the soil contributes to improve soil structure and productivity (Poincelot, 1986), as well as enhances the disease resistant capacity of crops (Kotschi, et. al. 1989).

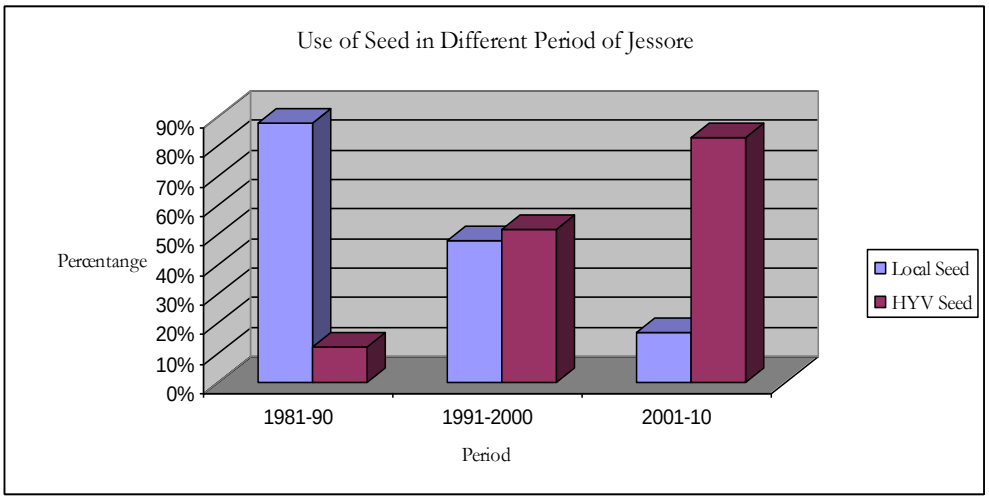
Table 5.1 shows that use of organic fertilizer has decreased rapidly whereas use of inorganic fertilizer has increased swiftly. Use of fertilizer trend has changed in order to increase production so that they have changed agriculture pattern.

5.2 Use of Seed

Seed is the basic and only live input in agricultural industry and plays a crucial role in boosting up the agricultural production as well as economy of the country. We remained mostly dependent on the imported seeds and quality is unknown, in spite of a favorable prevailing environment for seed production in our country (Biswas-2009). Since its inception the renowned plant breeders of Bangladesh Agriculture Development Corporation (BADC), Bangladesh Agriculture Research Council(BARC) and Bangladesh Agriculture Research Institute (BARI) independently and also with the collaboration of local, national and foreign agricultural scientists have developed a lot of high yielding and hybrid varieties according to the expectations of our farmers which is suitable for our soil and environment, diseases and insects resistant, more profitable and better quality. A few companies research department with its highly qualified scientists, support staff and skilled workers, dedicates itself to the demanding process of variety testing, selection, hybridization and production of foundation seeds. Nation wide networks of small farmers are engaged in contract in every village and ward with deputy sub agriculture officers.

In the period of 1981-90 use of local seed (home-collect) was 88% (Table 5.2) and on the other hand use of HYV seed is 12%. Use of HYV seed has risen up rapidly and otherwise use of local seed has gone down sharply. In the period of 1991-2000, use of HYV seed is 48% and on the other hand use of local seed is 52%. Day by day the use of HYV seed has gone up tremendously and side by side use of local seed is decreasing very rapidly.

Figure 5.2 Use of Seed of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

From 2001-10, use of HYV seed has gone up to top most point and local seed use has gone down to a very low point. In 2001-10, use of HYV seed is 83% and local seed use is 17% only (Figure 5.2).

Table 5.2 Use of Seed of Different Periods in Jessore

	Period		
Seed Use	1981-90	1991-2000	2001-10
Local Seed	88%	48%	17%
HYV Seed	12%	52%	83%

Source: Field Survey from July 2010 to December 2011

Public and private sector have improved significantly to provide new HYV seed. That new HYV seed has easily reached to the respondents, Yield from this seed is very high so the respondents have used more HYV seed. To adapt the HYV seed, farmer has changed agriculture pattern which lead to increase the overall yield.

5.3 Cultivation Method (Instrument)

Machinery appliance such as use of tractors instead of wooden ploughs pulled by cows is remarkable in the study area. The rural non-farm sector has covered the rural industries and services to provide different materials. Most rural industries are devoted to grain milling and food processing, with a tendency to acquire urban features as the mills tend to locate around road networks and commercial hubs. The most important difference from the past is the commercial orientation of this new

rural feature. A significant element of the rural non-farm sector is the technology-based services of agro-machinery and the rapid spread of electrical appliances with the progress of rural electrification. Various rural growth centers have emerged around commercial hubs (BADC-2009).

Figure 5.3 Photograph of Cultivation method (Instrument) in different period in Jessore

(a) Digging the dry land by plough

(b) Digging the mud land by plough

(c) Prepar the dry land by Ladder

(d) Digging the dry land by Powertiller

(e) Digging the muddy land by Powertiller

(f) Digging the dry land by Tractor

Source: Field Survey from July 2010 to December 2011

It has found from the field survey that in the period of 1981-90, use of traditional method (plough) is 97% and on the other hand use of modern method (tractor, power tiller) is 3% (Table 5.3). In 1981-90 tractor and power tiller was new comer appliances and its handle was not available to the rural people. Population pressure is increasing sharply and local food demand is increasing highly. So the cultivation method has changed rapidly. Use of modern method has risen up gradually and use of traditional method has gone down sharply. In the period of 1991-2000, use of modern method is 48% and on the other hand use of traditional method is 52%.

Table 5.3 Cultivation Method of Different Periods in Jessore

Cultivation Method	Period		
	1981-90	1991-2000	2001-10
Traditional Method	97%	48%	2%
Modern Method	3%	52%	98%

Source: Field Survey from July 2010 to December 2011

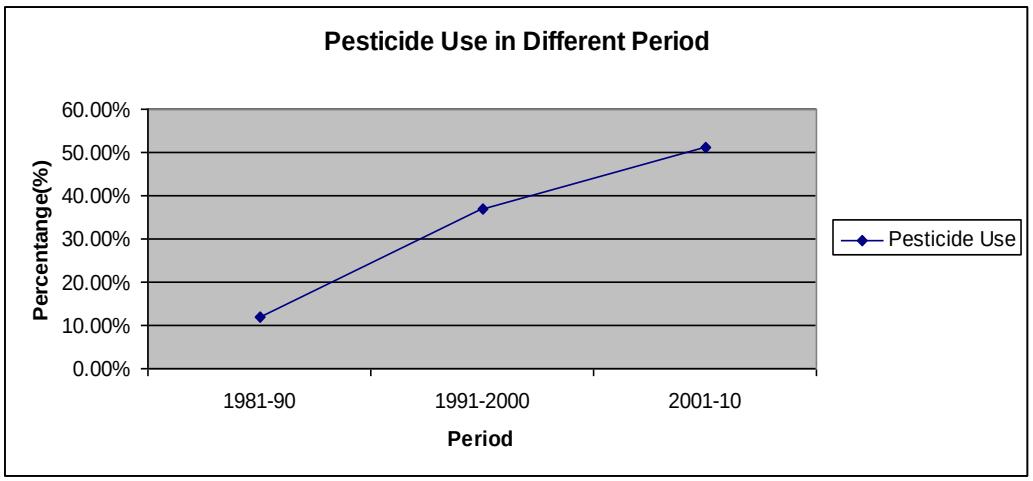
Day by day the use of modern method has gone up tremendously and traditional method has gone down very rapidly. In 2001-10, the use of modern method is 98% and use of traditional method is 2% (Table 5.3). It has been reported by other study that the numbers of tractor and power tiller were 556 and 1236 in 1996 which has changed to 207 and 3804 in 2008 respectively in Jessore (Agriculture Census 1996 & 2008). Tractor number has decreased gradually for high value and power tiller number has increased rapidly for reasonable price. For the changing of cultivation method, agriculture pattern has changed very swiftly.

5.4 Use of Pesticide

Agricultural production has increased tremendously in many parts of the world in last few decades through the increased use of high-yielding varieties of seeds, inorganic fertilizers, pesticides and water, resulting in very high costs of production (Biswas, 1992; Conway, 1990; Edwards & Wali, 1993; Paoletti, Stinner, & Lorenzoni, 1989; Pretty, 1995; Repetto, 1987). Overuse and inappropriate use of agro-chemicals have led to contamination of water, loss of genetic diversity and deterioration of soil quality (O'Connell, 1991; Pretty, 1995). Indiscriminate use of pesticides and insecticides causes many adverse effects, including soil and water pollution, and sickness among farmers (Sattar & Mian, 1999). As a consequence, they are facing problems that include earthworms, fish and frogs dying, diarrhoea, skin diseases, headaches and declining soil fertility (Rahman and Thapa, 1999, Brandon, 1998). It is estimated that 20–30 million ha of land have been severely affected, and another 60–80 million ha have been moderately affected largely by salinity and water-logging arising from overuse and imbalanced use of irrigation, inorganic fertilizers and pesticides (Biswas, 1992). Increasing evidence of human health problems associated with consumption of agrochemicals, including pesticides is also emerging (e.g., Pingali & Roger, 1995; Rola & Pingali, 1993), as toxic elements have entered into the food chain (Harwood, 1990; O'Connell, 1991). Increased vulnerability of

crops to insect and pest attacks, loss of fish and other aquatic resources, declining crop yields, and deterioration of animal and human health due to agro-chemicals have raised concerns about the long-term sustainability of such system by World Resources Institute (WRI-1993). Bangladesh is no an exception, as its agriculture is highly dependent upon such inputs. In Bangladesh, where agriculture is the main source of livelihood of two-thirds of the rural population, a serious concern has arisen about the sustainability of agriculture in the face of deterioration of land quality, declining yield, and increased population. Being a land-scarce country, emphasis has been given to increase food production by intensifying the use of land, inorganic fertilizers, pesticides and water. Subsidies are provided on inorganic fertilizers, pesticides, and irrigation equipment to enable farmers to adopt these technologies for increasing crop yields (Hossain, 1988). This has caused major changes in cropping patterns, use of agricultural inputs, and management of soil fertility. Likewise, cropping intensity and the area under irrigation and HYV paddy have all increased considerably. Use of inorganic fertilizers increased six times during 1970–90, and the use of pesticides increased about threefold in just one decade, during 1982–92 (Rahman & Thapa, 1999).

Figure 5.4 Use of Pesticide of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

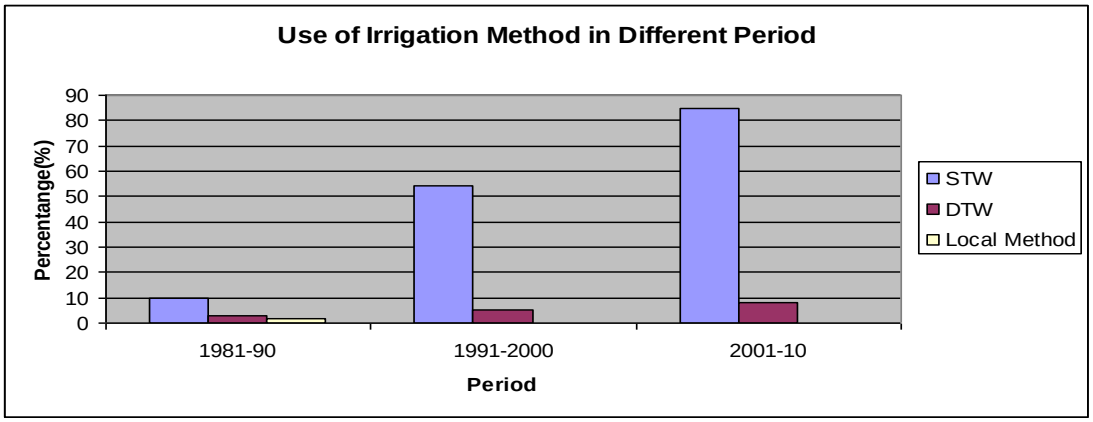
It is observed from the field survey that in the period of 1981-90, average 12% respondent have used pesticide to control insecticide in order to increase production (Figure 5.4). The volume use of pesticide has increased gradually. After ten years in 2000, the volume of pesticide use has rapidly increased which is 37% and this figure has gone up very swiftly which is 51% in the period of 2010.

The use of pesticide trend is increasing due to availability of products and easy to handle. Weedicide (herbicide) is very effective to kill weeds. Last decades, it is widely used to eliminate weeds as it can save time and money of the farmers.

5.5 Use of Irrigation Method

Land productivity mainly depends on irrigation facility, application of chemical fertilizers, varieties of seed and production environments. When crops are produced under different farming systems, then production environment plays a significant role on land productivity. It is in the entire country (Huda, 2000), ground water is the main source of irrigation in the study area, which is pumped out using diesel operated pumping sets due to lack of electricity. Diesel accounts are high for more than two-thirds of the cost of irrigation. Moreover, engines, their spare parts, and diesel fuel come from outside, which exposes farmers to the risk of rising production costs and dwindling profit margins arising from market distortions and changing national and international trade. Therefore, it is justified to consider irrigation water as external input in the context of our study area (BADC-2005).

Figure 5.5 Use of Irrigation Method of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

Irrigation makes an important role for cops yield. Average 10% respondent have used Shallow Tube Well (STW) for irrigation in order to increase yield (Figure 5.5) in the period of 1981-90. That time average 3% and 2% respondent have used Deep Tube Well (DTW) and local method respectively for irrigation to increase yield. The use of STW trend is positive. After ten years in 1991-2000, the use of STW is 54% and this figure has reached 85% in the period of 2001-10. Day by day the uses of STW have gone up tremendously (Figure 5.5).

Figure 5.5. 1 Photograph of Irrigation Methods in Agriculture in Different Period in Jessore

(a) Irrigation by the Copicol

(b) Irrigation by the Sauti

(c) Irrigation by the Copicol

(d) Irrigation by the Swallow Machine

(e) Irrigation by the Sauti

(f) Irrigation by the Copikal

Source: Field Survey from July 2010 to December 2011

The uses of DTW have increased very slowly. In 1991-2000, the use of DTW is 5% and this figure is 8% in the period of 2001-10 (Figure 5.5). The use of DTW trend has increased very slowly because to install it farmers need to make a cooperative society and it is very costly and time consuming mechanism. Otherwise use of STW trend has increased tremendously as its installation does not need any cooperative society and its prize is reasonable, easy and portable. By improving the machinery appliances local method has misplaced in our society in 1991 because local method is costly and very slow, skill labor is not available to handle local instrument. Whereas most of the water source of the study area is not capable to provide water. With more use of modern appliances the agriculture pattern has changed in the study area for more yields of crops.

5.6 Labor Intensity

Bangladesh has lost productive arable land because of population pressure and river erosion. In Bangladesh, only 4.14% of net cultivable land remains as current

fallow, which means that there is hardly any scope for increasing cultivable land. The percentage of agriculture house hold in Jessore district is 64.43, 60.95 and 67.55 in 1986, 1996 and 2008 respectively (Agriculture Census 1986, 1996 and 2008). The country also faces a difficult land distribution challenge to achieve food security for all groups in society. About 20% of the rural households have no cultivable land and another 38% have less than 0.20 ha (BBS, 2006). Currently, cropping intensity is 185% (BBS-2012). Thus, the only possible option for increasing agricultural production is to increase both the cropping intensity and yields simultaneously. In this respect, policies adopted by the government are to take supportive programs for inter-cropping in a field instead of single cropping; and take appropriate measures in reducing the gap between potential yield and farmers' realized yield of different crops to raise the present level of production significantly (Choudhury, 2008).

Figure 5.6 Photograph of Harvesting (Instrument) of Different Period in Jessore

(a) Harvesting the Crops by Head

(b) Harvesting the Crops by Trolley

(c) Harvesting Crops in Open Field

(d) Harvest Crops by Tractor

(e) Harvesting Crops in Polder Machine

(f) Harvest Crops by Powertiller

Source: Field Survey from July 2010 to December 2011

It is observed from the field survey that in the period of 1981-90, labor intensity is 63% in the study area (Table 5.6). Population pressure has gone up sharply and home and abroad food demand is increasing rapidly. Labor cost has increased with this change. Agricultural machineries and other inputs have reached to farmer over time. So the labor intensity has changed gradually. In the period of 1991-2000, labor intensity is 45% and this situation is changing rapidly. In the period of 2001-10, it has reached 32% (Table 5.6).

Table 5.6 Labor Intensity of Different Periods in Jessore

Item Name	Period		
	1981-90	1991-2000	2001-10
Labor Intensity (%)	63	45	32

Source: Field Survey from July 2010 to December 2011

5.7 Wages of Labor

Education acts as the engine of growth for economic and social development of a nation. Human resources development is at the core of Bangladesh's development efforts and access to quality education is critical to poverty reduction and economic development. Lower poverty line is 41% in 1991 and 34.3% in 2000 and further 17.6% in 2010. Higher poverty line is 56.6% in 1991 and 48.9% in 2000 and further 31.50% in 2010. Literacy rate in Jessore is 25.08% in 1995 and 46.09% in 2001 (Statistical Yearbook, 2008).

Figure 5.7 Photograph of Carrying of Various Modes in Different Periods in Jessore

(a) Carrying the Crops by Shoulder

(b) Carrying the Crops by Head

(c) Carrying the Crops by Shoulder

(d) Carrying the Crops by Shoulder

Source: Field Survey from July 2010 to December 2011

Table 5.7 Wages of Labor of Different Periods in Jessore

Item Name	1981-90		1991-2000		2001-10	
	Working Hour	Per Day Taka	Working Hour	Per Day Taka	Working Hour	Per Day Taka
Wages of Labor	10	20-25	8	70-80	6	200

Source: Field Survey from July 2010 to December 2011

5.8 Women Participation in Agriculture

In Bangladesh, being a traditional Muslim society, women in Bangladesh hardly participate in agricultural activities outside home (Hossain and Bayes, 2009; Abdullah and Zeidenstein, 1982). Women's agricultural activities are confined to homestead production as well as pre & post-harvest operations; however, in recent years they are mostly involved in livestock and poultry rearing activities, besides crop production activities. A number of studies have conducted on women's activities during 1980s (Abdullah and Zeidenstein, 1982; Ahsan, et.al, 1986; Chowdhury, 1986; Farouk, 1979 and 1983; Halim and McCarrthy, 1985; Westergaard, 1983, Jaim and Rahman, 1988). However, these studies found that women's contribution to socio-economic development are not visible, perhaps due to a set of social norms that enabled men to dominate women (Bose, et. al., 2009).

There has been scarcity of rural agricultural labor force in recent years and farm technologies have not yet sufficiently developed to cope with this scarcity. Therefore, women participation, particularly in agriculture as entrepreneurs is increasing in Bangladesh (Hossain and Jaim 2011; Birner, et. al. 2010). The progress is attributed to poverty, empowerment of women by NGOs, and migration of male members from agriculture to non-farm occupation. In the absence of male members, women's role is changing from unpaid family worker to farm managers, a phenomenon termed as "feminization of agriculture".

It has found from the field survey that in the period of 1981-90, women participation of agriculture of sowing is 7 which is 1.5% (Table 5.8.1). Whereas, this trend is rising very slowly. In the period of 1991-2000 & 2001-10, women participation is 12 & 61 which is 2.58% & 13% respectively.

Table 5. 8.1 Women Participation of Sowing of Different Periods in Jessore

Item Name	1981-90		1991-2000		2001-10	
Sowing	Respondent	%	Respondent	%	Respondent	%
Participation	7	1.5	12	2.58	61	13

Source: Field Survey from July 2010 to December 2011

Women participation in agriculture for pre harvesting is 9 which is 2% (Table 5.8.2) in the period of 1981-90. This increasing trend is rising slowly. Whereas in the period of 1991-2000 & 2001-10, women participation are 13 & 71 which are 2.79% & 15.26% respectively.

Table 5. 8.2 Women Participation of Pre Harvesting in Different Periods in Jessore

Item Name	1981-90		1991-2000		2001-10	
Pre Harvesting	Respondent	%	Respondent	%	Respondent	%
Participation	9	2	13	2.79	71	15.26

Source: Field Survey from July 2010 to December 2011

Figure 5.8 Photographs of Women Participation in Agriculture in Different Period in Jessore


a) Ripping the Rice Plant


(b) Harvesting Rice by Polder Machine


(c) Collecting the Maize


(d) Collecting the Potato


(e) Collecting the Tomato


(f) Collecting the Cotton


(g) Collecting the Rice


(h) Collecting the Nat


(i) Collecting the Rice

Source: Field Survey from July 2010 to December 2011

It is observed from the field survey that in the period of 1981-90, women participation in agriculture for post harvesting is 13 which is 3% (Table 5.8.3). This increasing trend is rising slowly. In the period of 1991-2000 & 2001-10, women participations are 56 & 134 which are 12% and 29% respectively.

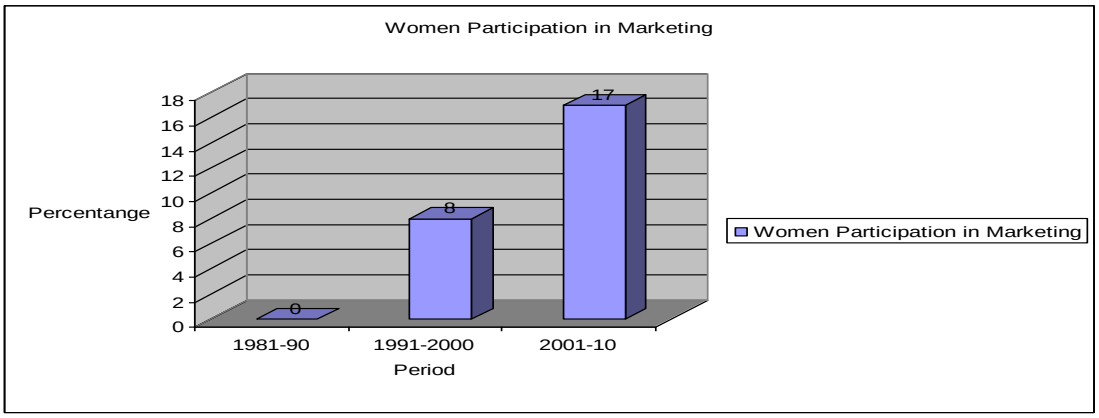
Table 5. 8.3 Women Participation of Post Harvesting of Different Periods in Jessore

Item Name	**1981-90**		**1991-2000**		**2001-10**	
Post Harvesting	Respondent	%	Respondent	%	Respondent	%
Participation	13	3	56	12	134	29

Source: Field Survey from July 2010 to December 2011

There is no women participation in agriculture marketing in the period of 1981-90 (Figure 5.8.1). This situation is changing in very little and this trend is growing on slowly. In the first decades women were not participate in the marketing system for religious bar and social thoroughness.

Figure 5.8.1 Women Participation in Marketing of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

Day by day for their own or family demand the women have gone out in the market and got participated in the marketing system. In the period of 1991-2000 and 2001-10, women participations in agriculture marketing are 8 & 17 which are 1.72% and 3.65% respectively (Figure 5.8.1). Women participation in agriculture marketing is growing very slowly.

Women participation in agriculture in different stage is increasing rapidly and this trend is going on continuously which has great influenced to change in agriculture pattern.

Chapter 6

AGRICULTURAL PATTERN CHANGE FOR SKILL LEVELS OF FARMERS

6. Introduction

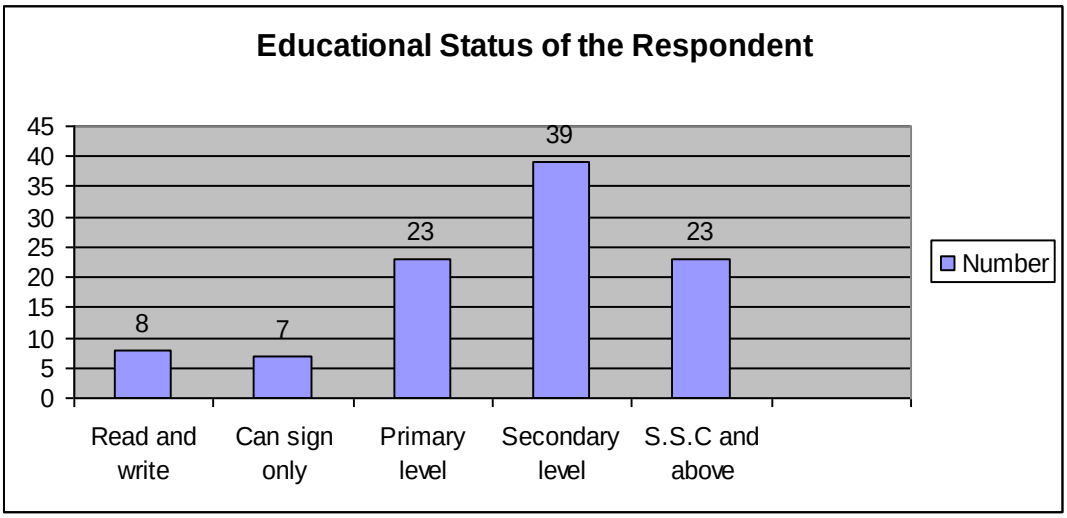
Bangladesh is the 7th largest country in population in the world and land size of 90th in the world. Major challenge to agriculture is increasing in the growth of population. Growth rates of population at present stands at 1.26% (Population Census 2011). Such a growth rate of a country of 1, 43,000 sq. km is viewed as a great challenge for not only different economic development activities but also as crisis for accommodation, environment and meeting other basic needs (food, education, and health). But the population growth demands more number of workers at field level, the number has considerably been reduced (Hossain and Bayes, 2009).

Bangladesh's economy draws its main strength from agriculture sector. The sector contributes to annual GDP of agriculture and crop subsector of fisheries, livestock, and forestry (BBS, 2008). The dominance of agriculture continues well into the 21st century as the nation fights against poverty and strives to raise standard of living of its people through sustained economic growth. The skill level of the farmer in the study area is discussed here keeping in mind to fulfill the research objectives.

6.1 Educational Status of Farmers

It is observed from the field survey that 39% of the farmers attended secondary schools (Table 6.1). The Secondary level of education is higher at Jhikargacha Upazila (47.2%) and little less at Bagharpara Upazila (46%). While the Secondary level of education among the farmer of Sarsa and Chowgacha Upazila are lower which are 27.6% and 30% respectively. About one quarter (23%) respondents have finished S.S.C and above level of education (Figure 6.1). Here it is mentioned that S.S.C and above level of education is high at Manirampur Upazila and the lowest at Bagharpara Upazila. Seven percent of the respondents have no formal schooling; they can not read and write, they can only sign in order to solve their problem.

Figure 6.1 Educational Status of the Respondent in Jessore in 2010-11



Source: Field Survey from July 2010 to December 2011

Here it is to be mentioned that they learn how to sign so that they take loan or resolve their purpose. Eight percent farmer has attended adult literacy programs and learned how to read and write. And another one-fourth of them (23%) attended primary schools only. In other words, as reflected in literacy rate is higher in Manirampur Upazila and the lowest at Bagharpara Upazila (Table 6.1). About two-fifth farmers have achieved secondary level of education. With their level of education and long experience people gathered vast knowledge about agriculture and they have no hesitancy to invest in agriculture and adopt modern facilities interms of machineries or other inputs which acts as a machine to change agriculture pattern in the study area.

Table 6.1 Educational Status of the Respondent in Jessore in 2010-11

	Keshabpur	Manirampur	Avaynagar	Sharsha	Sadar	Bagharpara	Jhakorgacha	Chowgacha	Total
Read and write	5.0	4.0	9.5	12.1	13.3	5.4	1.9	5.0	8.0
Can sign only	2.5	8.0	4.8	5.2	6.7	2.7	5.7	12.5	7.0
Primary level	25.0	16.0	19.0	34.5	14.2	32.4	26.4	37.5	23.0
Secondary level	42.5	38.7	42.9	27.6	40.0	45.9	47.2	30.0	39.0
SSC and above	25.0	33.3	23.8	20.7	25.8	13.5	18.9	15.0	23.0
Total (%)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Field Survey from July 2010 to December 2011

6.2 Secondary Occupation of the Farmers

A total of 68% respondents (farmers) reported not having any secondary occupation of their own. The major secondary occupations of the remaining respondents are business and service related activities. It is worth mentioning that business seems to be more popular secondary occupation among the farmers of Manirampur Upazila and Sadar Upazila covering 39% and 32% respondents respectively (Table 6.2).

Table 6.2 Secondary Occupation of the Respondent by Upazila (%) of Different Periods in Jessore

Profession	Keshabpur	Manirampur	Avaynagar	Sarsa	Sadar	Bagharpara	Jhikargacha	Chowgacha	Total
No Secondary Occupation	70.0	60.0	78.6	74.1	62.5	70.3	66.0	75.0	67.7
Business	25.0	38.7	19.0	19.0	31.7	21.6	26.4	22.5	28.2
Service	5.0	1.3	2.4	6.9	5.8	8.1	7.5	2.5	4.1
Total (%)	100	100	100	100	100	100	100	100	100

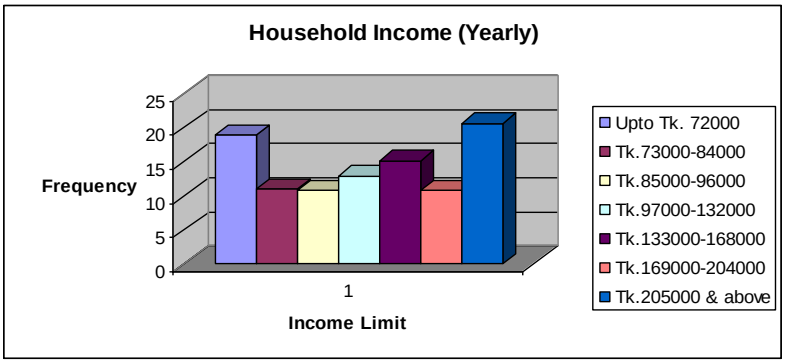
Source: Field Survey from July 2010 to December 2011

However, it is clear from the Table 6.2 that agriculture and business are common occupations of the people in the study area. More than two-third respondents have no secondary occupation and they are fully involved in agricultural an activity which has encouraged them in changing the agriculture pattern.

6.3 Yearly Household Income of the Farmers

It has observed from the Table 6.3 that the average yearly income of about 19% of the respondent is up to Tk. 72,000 only. Average 11% respondent's income is Tk. 73,000-84,000 per year. On the other hand, the amount of Tk. 85,000-96,000 and Tk. 1,69,000-2,04,000 earning are found for same percentage of respondent (10.8%). The average yearly income of the sample households is found at Tk.97,000-1,32,000. About 13% of the respondents have this amount of earning (Figure 6.3).

Figure 6.3 Yearly Household Income of the Farmers of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

The average yearly income of 15.1% of the respondents is Tk.1, 33,000-1, 68,000. Average 20.6% respondents said that their yearly income is Tk. 2, 05,000 & above. Average 15.1% respondent expressed that their average yearly income is Tk. 1, 33,000-1, 68,000 only (Table 6.3).

Table 6.3. Yearly Household Income of the Farmers of Different Periods in Jessore

Amount of Tk.	Keshabpur	Manirampur	Avaynagar	Sharsha	Sadar	Bagharpara	Jhakorgacha	Chowgacha	Total
Upto Tk. 72000	32.5	8.0	40.5	24.1	15.0	21.6	17.0	7.5	18.9
Tk.73000-84000	7.5	10.7	16.7	13.8	5.8	13.5	17.0	10.0	11.0
Tk.85000-96000	12.5	5.3	4.8	12.1	10.8	21.6	11.3	12.5	10.8
Tk.97000-132000	5.0	14.7	16.7	15.5	9.2	16.2	17.0	12.5	12.9
Tk.133000-168000	10.0	18.7	7.1	13.8	17.5	10.8	18.9	15.0	15.1
Tk.169000-204000	7.5	14.7	11.9	8.6	12.5	2.7	11.3	10.0	10.8
Tk.205000 & above	25.0	28.0	2.4	12.1	29.2	13.5	7.5	32.5	20.6
Total (%)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Field Survey from July 2010 to December 2011

Average yearly income of up to Tk. 72,000 is poor farmer and up to Tk. 2,05,000 & above is rich farmer. The poor farmers have tried hard and rich farmer have invested more amounts which influence to change agriculture pattern.

6.4 Age Distribution of the Farmers

Average age of the sample farmers is found 51.8 years. Of them, 22.2 percent respondent identified them as 45 years old or below (Table 6.4). Avaynagar and Bagharpara Upazila respondents are slightly higher percentage in this age group among the eight Upazila which is 33.3 percent and 32.4 percent respectively. About 29 percent

of the respondents belong to the aged group of 46-50 years. Chowgacha Upazila got the highest position which is 40 percent and Avaynagar and Manirampur Upazila are the lowest position which is 19 percent and 18.7 percent respectively. Twenty four percent respondent are from the age group 51-55 years and 27 percent respondent are 56 and above years old. Majority of the respondents has covered the aged group of 46-50 years and 56 years and above (Table 6.4).

Table 6.4 Age Distribution of the Farmers by Different Upazila of Different Periods in Jessore

Year of Age	Keshabpur	Manirampur	Avaynagar	Sarsa	Sadar	Bagharpara	Jhikorgacha	Chowgacha	Total
Age upto 45 years	25.0	17.3	33.3	24.1	15.0	32.4	28.3	17.5	22.2
46-50 years	25.0	18.7	19.0	31.0	30.0	27.0	37.7	40.0	28.4
51-55 years	17.5	28.0	14.3	8.6	30.8	24.3	18.9	20.0	22.2
56 and above years	32.5	36.0	33.3	36.2	24.2	16.2	15.1	22.5	27.3
Total (%)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

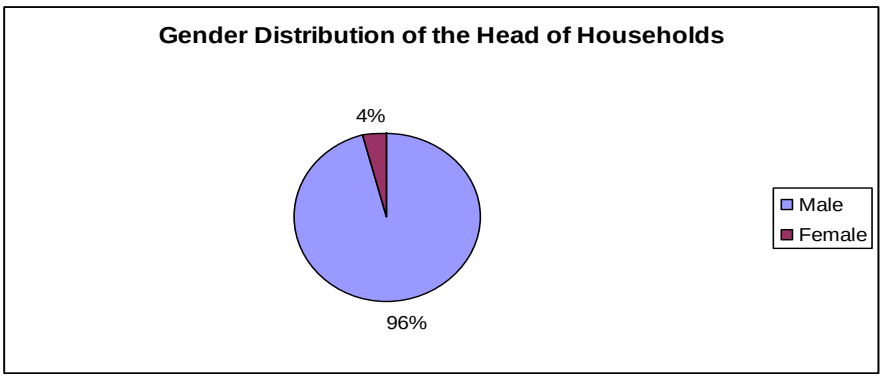
Source: Field Survey from July 2010 to December 2011

All of them are involve with Agriculture from their childhood. As a result they are long experienced in their field. At this stage of life people have matured level of understanding with long experience and they have taken bold and wise decision which act as a machine to change the agriculture pattern.

6.5 Gender Distribution of the Head of Households

Of the total respondents of 465 covered in eight upazilas in Jessore district, it has found that overall 96% households (HH) are male-headed while 4% is female-headed (Figure 6.5). Among the eight Upazilas, female-headed HHs has been found to be more at Keshabpur and Bagherpara Upazilas.

Figure 6.5 Gender Distributions of the Head of Households of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

6.6 Receive Training on Agriculture Technology

Agricultural related training is very needed to develop efficient manpower in agricultural disciplines and in order to increase the rate of yield on a sustained basis. To expand the scope of agricultural education GoB and NGOs have been established a numbers of institutions.

In 1981-90, 10 respondents have received training from GoB which constitutes 2.2% of the sample farmers (Table 6.6). Majority respondent have received technical training and majority trainee farmers are from Jhikargacha, Bagharpara, Sadar and Chowgacha Upazila. Jhikargacha is in the best position of receiving training. At that time no body has received training from NGO. In 1991-2000, 39 respondents have received training from GoB which constitutes 8.4

Table 6.6 Receiving Training on Agriculture Technology from GoB and NGO of Different Periods in Jessore

Upazila Name	1980-90			1991-00			2001-10		
	GoB	NGOs	**All**	GoB	NGOs	**All**	GoB	NGOs	**All**
Keshabpur	1.2	-	-	5.0	-	5.0	27.5	-	27.5
Monirampur	1.3	-	1.3	12.0	-	12.0	38.7	2.7	41.3
Avaynagar	1.1	-	-	2.4	-	2.4	23.8	-	23.8
Sharsha	2.1	-	-	5.2	-	6.9	31.0	-	31.0
Sadar	2.5	-	2.5	11.7	3.4	11.7	43.3	3.3	44.2
Bagharpara	5.4	-	5.4	5.4	-	5.4	16.2	-	16.2
Jhakorgacha	5.7	-	5.7	9.4	-	9.4	28.3	3.8	28.3
Chowgacha	2.5	-	2.5	7.5	-	7.5	27.5	5.0	32.5
Total (%)	2.2	-	2.2	8.4	0.4	8.6	32.7	2.2	33.8
Total (n)	10	-	10	39	2	40	152	10	157
Total (N)	465			465			465		

Source: Field Survey from July 2010 to December 2011

percent of the sample farmers and 2 respondents have received training from NGO. Majority respondents have received training are from Manirampur and Sadar Upazila which is 12.0 percent and 11.7 percent respectively. In 2001-2010, 152 respondents have received training on agriculture technology from GoB which is 32.7 percent and 10 respondents have received training from NGO which is 2.2 percent (Table 6.6). The respondents expressed their opinion that before receiving the training, they did

not know the proportion of fertilizer and pesticide to use; they did not know the right time to use fertilizer and pesticide. Before receiving training they used to use seed, fertilizer, plough and pesticide by using their traditional knowledge which created many problems that is why they did not get high yield. But now majority respondents have received the training and gathered vast knowledge and take a bold initiative to change the agriculture pattern. They are also the role model for the other farmers in the area. As a result through limited number of trained farmers almost all the farmer of the study area are now using modern knowledge of agriculture to get high yield and changed the agriculture pattern in the area.

6.7 Receive of Credit

Majority of the farmers of Bangladesh are small and marginal (below 1.01 ha) category which is about 90%. They are very often constrained by finance and thus cannot afford high cost for management. They have very limited access to institutional credit because of collateral requirement. By now, only 27% of farmers have received institutional credit (BBS, 2007). The credit amount again is quite inadequate and not advanced in time. They are also not eligible for micro credit of NGOs (Non Government Organization) that deal mainly with landless farmers.

The Agricultural Credit Foundation is a non-profit organization under the Company Act of 1994 with the primary objective of increasing investment in agricultural activities through meeting the demand for credit by the landless, marginal and small farmers; and at the same time to alleviate poverty and raise the overall living standard by creating new employment opportunities through intensification of crop cultivation and agricultural diversification.

It appears from the Table 6.7 that in the period of 1981-90, 93, 24 and 19 respondents express that they have received credit from GoB bank, NGO and private money lender which are 20% 5% and 4% respectively. In the period of 1991-2000, 159, 9, 93 and 37 respondents answered that they have taken loan from GoB bank, private bank, NGO and private money lender which are 34%, 2%, 20% and 8% respectively.

Table 6.7 Receive of Credit in Different Periods in Jessore

Institute Name	1981-90		1991-2000		2001-10	
	Respondent	**%**	**Respondent**	**%**	**Respondent**	**%**
GoB Bank	93	20	159	34	172	37
Private Bank	0	0	9	2	67	14
NGO	24	5	93	20	117	25
Private Money Lender	19	4	37	8	-	-

Source: Field Survey from July 2010 to December 2011

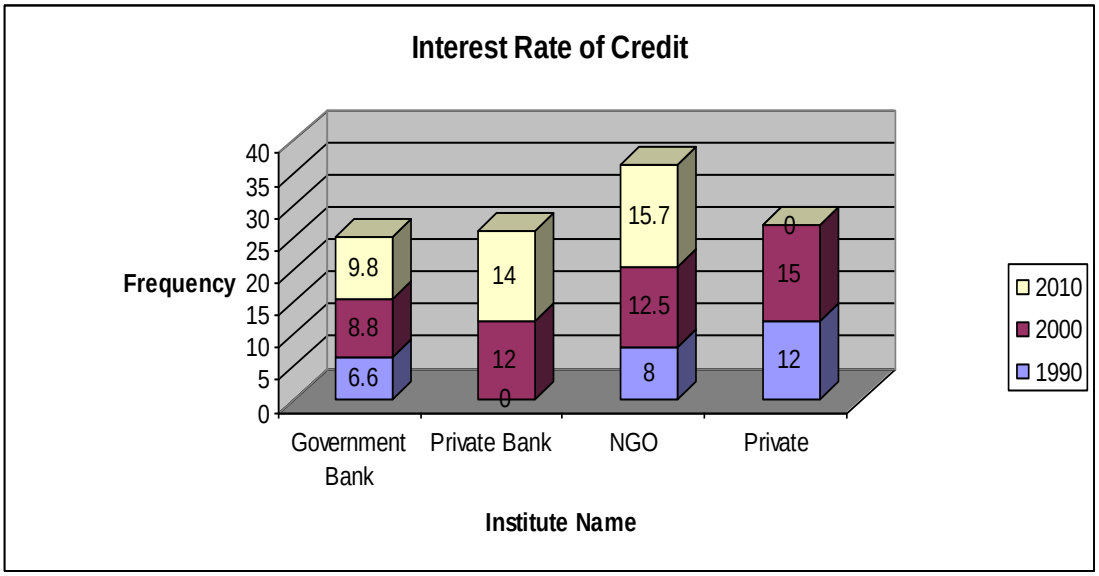
In the period of 2001-10, 172, 67 and 117 respondents replied that they have got credit from GoB bank, private bank and NGO which are 37%, 14% and 25% respectively (Table 6.7). The trends of receiving credit from GoB bank, private bank and NGO have been increasing gradually by the respondents but in 1981-90, except private bank. The respondents have received credit and they have provided all input in their field on right time, they have kept full concentration to agriculture cultivation which has influenced in changing the agricultural pattern.

6.8 Interest Rate of Credit of Different Institutions

It has shown in Table 6.8 that in the period of 1981-90, respondents expressed that they have received credit of Tk. 8080 from Government bank with average interest rate of 6.6%. The amount of Tk. 12,000 credit have received from NGO with average interest rate is 8.0%, on the other hand, Tk. 20,000 have received as credit from private money lender with average interest rate is 12.0%. Day by day the interest rate is increasing moderately. The respondents mentioned that in 1991-2000, they have received credit of Tk. 11,688 from the government bank with average interest rate is 8.8% (Table 6.8). Whereas some farmers received credit of Tk. 10,000 from private bank with average interest rate is 12.0%, received credit of Tk. 25,846 from NGO with average interest rate is 12.5%, and received credit of Tk. 12,000 from private money lender with average interest rate is 15.0% (Figure 6.8).

Day by day the interest rate is increasing rapidly. Respondents replied that in the period of 2001-10, they have received credit of Tk. 30,074 from Government bank with average interest rate is 9.8% whereas, they received credit of Tk. 2, 05,000 from private bank with average interest rate is 14% and taken credit of Tk. 23,423 from NGO with average interest rate is 15.7% (Figure 6.8).

Figure 6.8 Interest Rate of Credit of Different Institute of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

Comparatively in three decades from 1981-2010, interest rate of credit is high for NGO and Private Bank respectively and dramatically the rate has been increasing. Day by day the respondents have got more opportunity to get the credit facility which increases the potentially of agriculture pattern change.

Table 6.8 Interest Rate of Credit of Different Institute of Different Period in Jessore

Institute Name	1981-90		1991-00		2001-10	
	Average Amount	**Avg. Intr. Rate**	**Average Amount**	**Avg. Intr. Rate**	**Average Amount**	**Avg. Intr. Rate**
Government Bank	8,080	6.6	11,688	8.8	30,074	9.8
Private Bank	-	-	10,000	12.0	205,000	14.0
NGO	12,000	8.0	25,846	12.5	23,423	15.7
Private Money Lender	20,000	12.0	12,000	15.0	-	-

Source: Field Survey from July 2010 to December 2011

6.9 Problem Faces to Receive Credit

Respondents mentioned that they have faced different problem to receive credit from various organizations. 51 respondents expressed that they have faced different problem to receive loan from government or private organization which is 11 % (Table 6.9).

Table 6.9 Problem Faces to Receive Credit of Different Periods in Jessore

Item Name	Keshabpur	Manirampur	Avaynagar	Sarsa	Sadar	agharpara	Jhikargacha	Chowgacha	Total	Respondent No
Yes	10.0	26.7	2.4	5.2	12.5	2.7	12.5	10.0	11.0	51
No	90.0	73.3	97.6	94.8	87.5	97.3	87.5	90.0	89.0	414
Total (%)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**465**

Source: Field Survey from July 2010 to December 2011

On the other hand 414 respondents did not face any problem to receive credit from any government or private organization which is 89%. Manirampur Upazila is in the best position to overcome the problems in receiving credit which is 26.7%. Sadar and Jhikargacha Upazila are in middle and same position to overcome the problems to receive credit which is 12.5%.

The skill level of the farmer in the study area has discussed above which has great influenced to change agricultural pattern. Educational status of the farmer, yearly income and different training program are more effective to enhance the agriculture pattern change. Age of the farmers and receiving of credit are important factors, acted as machine which is to change the agriculture pattern.

Chapter 7

INFLUENCES OF MARKETING AND TRANSPORT SYSTEM ON CHANGING AGRICULTURAL PATTERN

7. Introduction

Jessore rose to prominence under Mughal rule in the 17th century, as a Fouzdar (Military Governor) was appointed with headquarters at Mirzapur on the bank of Kobadak River. During British rule while Kolkata was developed as the second capital of the British Empire, Jessore got prominence as the connecting town to Kolkata for the eastern part of Bengal through railway and also road (Mitra, 2001). After liberation of Bangladesh, the importance of Jessore further grew due to the main land border between Bangladesh and India at Benapole and also due to its good road network. It is seen that the growth of urbanization in Jessore is more compared to surrounding towns due to pressure from neighboring districts and also from India. Jessore city has passed its glorious era with urban growth and land use change and now development is taking place in a dynamic ways with numbers of positive parameters like land elevation, road accessibility, land price, location of important structures and other such important factors.

The road network in Jessore district consists of pucca 455.48 km, semi pucca 163.82 km and mud road 3628.69 km; waterways 70 nautical mile; railways 48 km; and one airport. Traditional transport includes Palanquin and bullock cart. These means of transport are either extinct or nearly extinct.

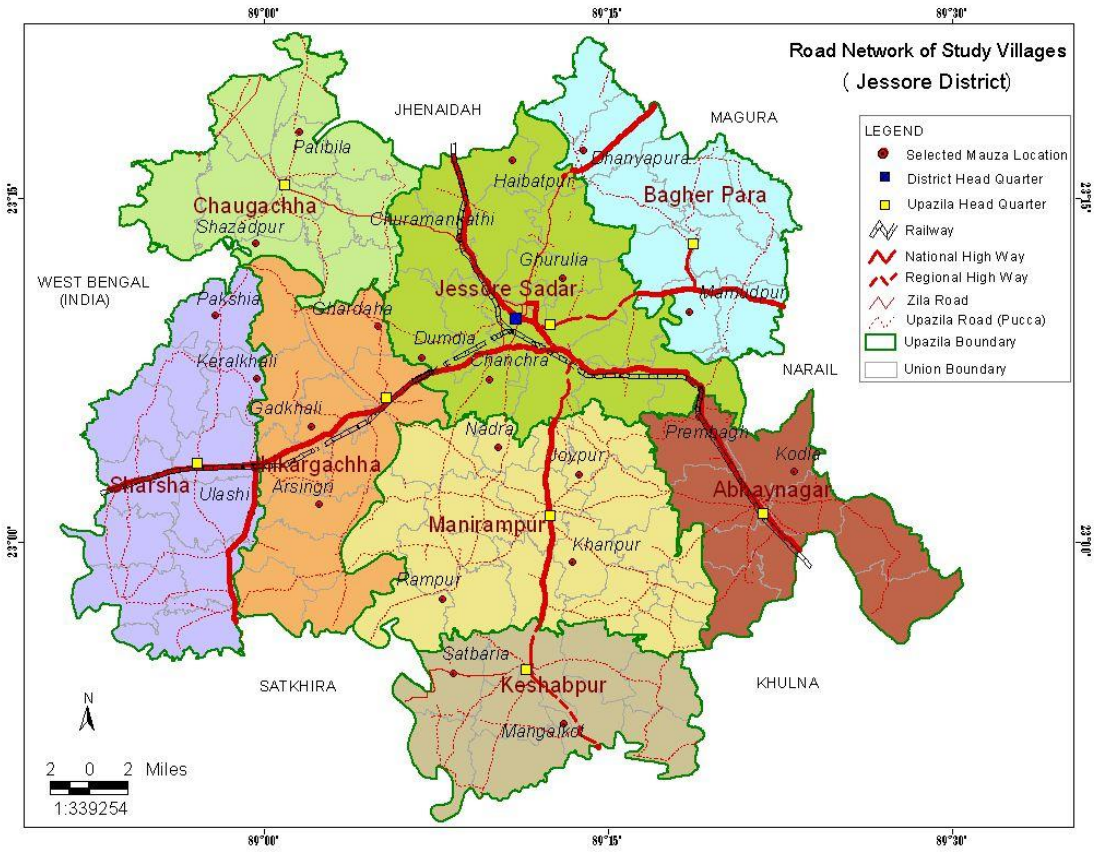
Jessore City is still growing as an economic hub in the south western part of Bangladesh. The largest land port 34 km from Jessore is attracting more business and investments in this area to tie a nod with India in terms of importing and exporting goods. Jessore is still depending more on motorized transportation modes for carrying goods and passengers than that of rail or water ways.

7.1 Transport Management System

Jessore has well communication links with nearby districts and the whole country. The district having a flat plain land, all three modes of surface transport, i.e. road, railway and airway are widely used in carrying both passengers and cargo.

There has been a dramatic expansion of road network in recent years. Road transport in Jessore is a private sector affair operating predominantly in domestic routes and neighboring country in India routes. Jessore is the junction of the south-west part of eighteen inter district road of the country. Jessore district is well communicated by road among all the districts of Rajshahi, Rangpur and Barisal divisions. Express and non stop services are available to principal towns from other former neighboring districts and new districts. Distance from principal district and other districts like Khulna, Satkhira, Narail, Magura, Jhenidah, Kustia, Chuadanga and Maherpur is 61 km, 71 km, 34 km, 41 km, 43 km, 84 km, 76 km and 94 km respectively. From Jessore to Dhaka, Chittagong and Barisal distance is 273 km, 402 km and 204 km respectively (Figure 7.1).

Figure 7.1 Road Network of Study Area

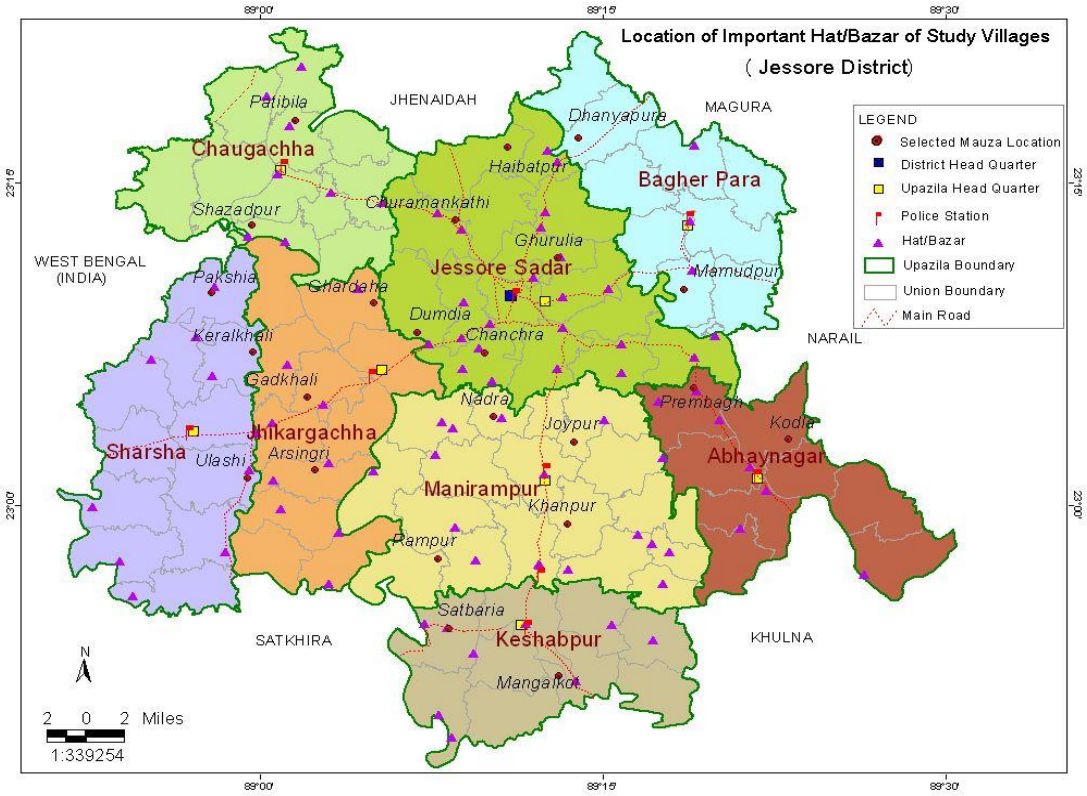


Source: Field Survey from July 2010 to December 2011

About 32% of the total area of Bangladesh is effectively covered by the railways. State-owned Bangladesh Railway operates a track of 2,706 kilometer through 505 stations. Jessore is well connected with rail way in North part of the

country and Capital Dhaka and Khulna. It is easy to carry cargo and passengers from principal city to other cities in the country.

Figure 7.1.2 Location of Hat, Bazar of Study Area



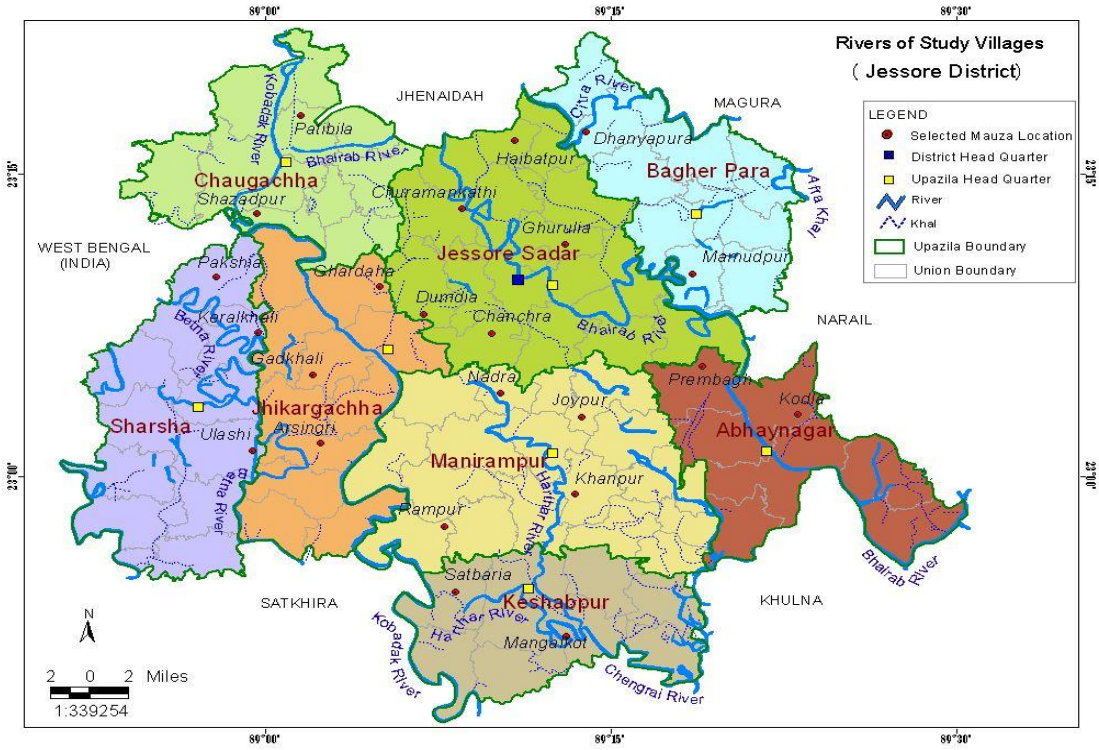
Source: Field Survey from July 2010 to December 2011

About two-thirds of Bangladesh is a wetland laced with a dense network of rivers, canals and creeks. Water transport is the only means available in nearly 10% of' the total area. There are two major ports in the country like Chittagong and Mongla port. The Mongla port in Khulna region serves the western part of Bangladesh.

Jessore stands on the Bhairab River. At present only Bhairab River is active for tidal activities which continues in a small part of the district. This waterway is well connected to Noapara Municipality the important business hub in Jessore district (Figure 7.3).

There are now 11 operational airports in Bangladesh. Jessore is one of them. Jessore airport plays an important role to carry vegetables, shrimp and flower and agriculture materials to abroad especially Middle East and European countries.

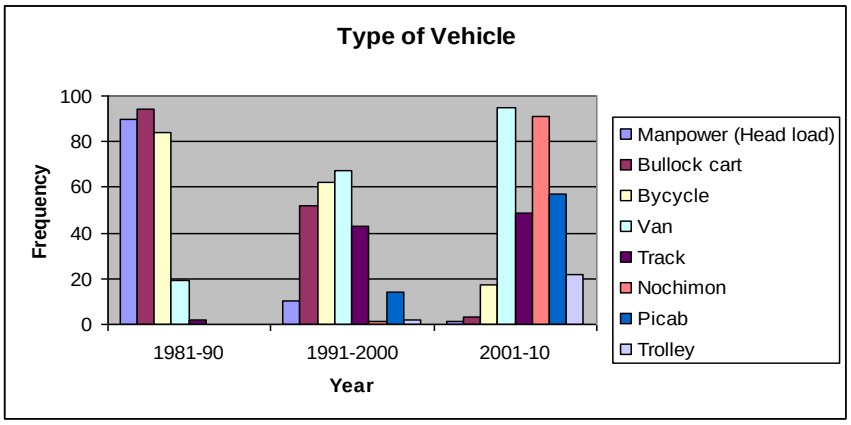
Figure 7.1.3 River of Study Area in Jessore



7.2 Type of Vehicle Use

It is observed from the Table 7.2 that the inhabitants in this area have used different vehicles in order to carry their agriculture materials from field to home or bazaar. In the period of 1981-90, 90% respondents used Manpower (Head load) to carry their agriculture materials, after few years this position has decreased tremendously, in 1991-2000 this trend has gone down in the lowest point which is 10%. In course of time, it is about to misplace in our society, in 2001-10, it is 1%. Once upon a time it was a common practice to use Bullock cart to carry agriculture materials from crop field and marketplace. Bullock cart was a popular vehicle to carry materials and travels before 1990. It shows that in the period of 1981-90, 94% respondents have used Bullock cart to carry their agriculture materials, day by day people were less interested to use this traditional vehicle. In 1991-2000, 52% respondents have used Bullock cart to carry their agriculture materials (Figure 7.2). After ten years the trends of this practice have changed dramatically, in 2001-2010 only 3% respondents have used it.

Figure 7.2 Type of Vehicle Use of Different Periods in Jessore



Source: Field Survey from July 2010 to December 2011

Bicycle is a common popular vehicle in the period of 1981-90, 84% respondents have used it to carry their agriculture materials, gradually this trend is decreasing very swiftly, in 1991-2000, 62% respondents have used Bicycle to carry their agriculture materials. After ten years this trend has changed tremendously, in 2001-2010, it is 17%. In 1981-90, 19% respondents have used Van to carry their agriculture materials (Figure 7.2). It has increased tremendously day by day; this trend seems to be popular to the respondents because it is easy for movement in the field or narrow place and narrow road. In the period of 1991-2000, it has reached 67% and further it has reached 95% in 2001-10. In 1981-90, Track use to carry materials in rural area is a rare case, 2% respondents used it. In course of time, this trend has changed rapidly, in 1991-2000, it is 43%. For improving the technology and road communication, Track use become popular day by day. In 2001-2010; the trend of Track use is 49% (Table 7.2).

Table 7.2 Type of Vehicle Use of Different Period in Jessore

SL.No	Vehicle Type	1981-90	1991-2000	2001-10
1.	Manpower (Head load)	90.0	10.0	1.0
2.	Bullock cart	94.0	52.0	3.0
3.	Bicycle	84.0	62.0	17.0
4.	Van	19.0	67.0	95.0
5.	Track	2.0	43.0	49.0
6.	Nochimon	0	1.0	91.0
7.	Pickup	0	14.0	57.0
8.	Trolley	0	2.0	22.0
Total (Multiple %)		289.0	251.0	335.0
Total		**465**	**465**	**465**

Source: Field Survey from July 2010 to December 2011

igure 7.2.1 Photograph of Transport Used in Carrying Agriculture Commodity in Different Period in Jessore


(a) Collecting by Headload


(b) Collecting by Shoulder


(c) Collecting by Bullcart


(d) Collecting by Troller


(e) Collecting by Nocimon


(f) Collecting by Lota


(g) Collecting by Truck


(h) Collecting by the Bycycle


(i) Collecting by the Alamsadu


(j) Collecting by the Bullcart

In 1981-90 there was no existence of *Nochimon* but in 1991-2000, it is 1%. In the period of 2001-10, this transport demand has increased tremendously; 91% respondents used it to carry their agriculture materials from field to home or local and district market. *Nochimon* is more popular among poor people for lower cost and easy entrance in crop field and any type of road. Pickup is introduced in 1991-2000; this time 14% of the farmer used it to carry their agriculture materials. This trend has rapidly changed in 2001-10, 57% used it. Trolley did not exist in 1980-90, after a few years this trend has changed, in 1991-2000, it is 2%. Trend of Trolley use has increased and in 2001-10, it is 22% to carry their agriculture materials. Day by day the transport management system has changed and improved. For improving the transport management system in carrying agriculture goods, easy from one place to another and the farmers have got high market price of their goods which inspired them to produce more crops. So the transport management system has played an important role to influence the agriculture patterns change.

7.3 Place of Marketing

In the period of 1981-90, 94% respondents have used in local market and on the other hand, 6% has used in district market to sell their products. District market is defined here as the market which is located in district or division or capital. With the development of road, transport, communication and technological improvement farmers have got facilities to sell their agriculture products at district market. In 1991-2000, 57% respondents sold their products at local market and 43% sold their products at district market (Table 7.3).

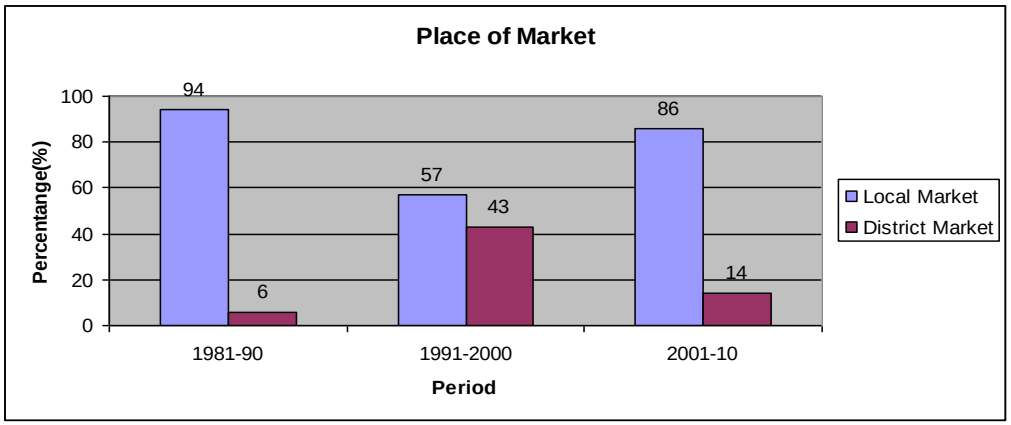
Table 7.3 Use of Place for Marketing (in Local or District) of Different Periods in Jessore

Use of Place for Marketing	1981-90	1991-2000	2001-10
Local Market	94%	57%	86%
District Market	6%	43%	14%
Total	**465**	**465**	**465**

Source: Field Survey from July 2010 to December 2011

In 2001-10, because of development of communication and technological facilities, farmers have got news about the market prices and they have sold their agriculture product in local market as wholesalers have come to local market and field level. In course of time, the trend of local marketing is increasing. In 2001-10, 86% respondents have used local market and 14% have used district market (Figure 7.3). For improving marketing system, the local agriculture products has transferred to another place easy way and farmer has cultivated profitable crops which has great influence to change the agriculture pattern.

Figure 7.3 Place of Market of Different Period in Jessore



Source: Field Survey from July 2010 to December 2011

7.4 Chain of Marketing

Agricultural commodity marketing is mainly dominated by the middlemen. Middlemen's control on agricultural commodities markets does not let the farmers get fair price, thus the existing marketing chain seemed discouraging to produce the commodities. The investigation into the chain of marketing revealed four fold chain of marketing involving minimum three to maximum six tiers each to reach the commodity to the consumers from producers. In the period of 1981-90, out of 465 respondents, 156 respondents have changed their hand in three tier systems which are 34.0%. In the period of 1991-2000 and 2001-10, marketing chain of three tiers stands (Producer⟶ Retailer ⟶ Consumer) at 4% and 18% respectively (Table 7.4). In the three tier systems middlemen collect the produces from the field or farmers home. Then the middlemen sell the produces to the consumers.

Table 7.4 Chain of Marketing of Different Periods in Jessore

	1981-90		1991-00		2001-10	
	Respondent	**Percent**	**Respondent**	**Percent**	**Respondent**	**Percent**
3 Chain	156	34.0	19	4.0	81	18.0
4 Chain	209	45.0	84	18.0	149	32.0
5 Chain	0	0	3	1.0	3	1.0
6 Chain	100	21.0	359	77.0	232	49.0
Total	**465**	**100.0**	**465**	**100.0**	**465**	**100.0**

Source: Field Survey from July 2010 to December 2011

In 1981-90, 209 respondents changed their hand in four tier systems which are 45%. (Producer⟶ *Aroutdar* ⟶ Retailer ⟶ Consumer). In the period of, 1991-2000 and 2001-10, 84 and 149 respondents changed their hand in four tier systems which are 18% 32% respectively (Table 7.4). Four tier systems have changed from farmers to local hat/bazar after those middlemen to consumers. In the period of 1981-90, there is no respondent mention about change their hands in five tier systems. Out of 465 only 3 respondents have answered about five tier system in the period of 1991-2000 and in 2001-10. Five tier systems have changed from farmers to middleman to local hat/bazar middleman to consumers. In 1981-90, 100 respondents expressed that they have changed after that their hand in six times which is 21%. This time goods price (Producer ⟶ Small businessmen⟶ Aroutdar ⟶ Retailer⟶ Consumer) becomes

high for middlemen. In 1991-2000 and 2001-10, 359 and 232 respondents answered that commodities have changed from producer (farmer) hand in six times which is 77% and 49% respectively (Table 7.4). Under the six tier systems farmers handed over (Producer → Local Aroutdar → Small businessmen → Aroutdar → Retailer → Consumer) their produces to local hat/bazar to middlemen then to hat/bazar after that middlemen to consumers. The changing of hands from producer to consumers was high and as a consequence the price of commodity is generally high.

Agriculture marketing in Bangladesh is a multiple stage procedure. There is a large difference between the price that the farmers get and the retail price of the product. There are many small farmers who are not able to achieve economies of scale from their production. Most of the farmers produce in a small scale. As a result the quantity of the produces comes too small to earn fair prices after bearing carrying cost. Whereas the farmers are not able to bear the high input cost and there is not sufficient credit available to them. The farmers hardly enjoy the benefits of their hard earn income. Farmers never get their share of increased price in the market. On the other hand, due to the various negative aspects prevailing in the product market leads to a fall in the income of the farmers from their products. In both cases farmers' real income falls, thereby reducing the quality of their social and financial assets, which in turn leads to continuous poverty and livelihood distress resulting in the changes of agricultural pattern.

Chapter 8

SUMMARY AND RECOMMENDATIONS

8. Introduction

Agriculture sector encompasses crops, fisheries, livestock and forestry sub-sector. Agriculture land has been decreasing gradually in Jessore. Land use patterns as well as cropping patterns are changing in Jessore due to a range of factors: in response to changing social and environmental issues including improved technology, communication, marketing system, competent networking system, new and high yielding varieties of seed, availability of agriculture inputs, irrigation facilities, soil quality. In order to meet the demand of large population, as a way to increase the economic returns of farm enterprises farmers are trying their best to achieved the optimum out put and eventually changed their cropping pattern.

8.1 Summary

Rice is the most important cereal crops in Bangladesh. Since early 1981, the study area has cultivated three crops in high land and medium high land; broadcast Aus, transplant Aman and Rabi crops. After 1985, cropping pattern has changed significantly. Broadcast Aus area has reduced from 80% in 1981-90 to 15% in 2001-10. Broadcast Aus rice yield has increased a little. Per ha yield increased from 1.78 mton to 2.37 mton in 1981-90 to 2001-10 respectively. Broadcast Aus rice cultivation area has tremendously decreased but its yield has little increased in 1981-2010. Transplanted Aus rice cultivated area and yield has little increased in 1981-2010. Whereas broadcast Aman rice cultivated area has gradually decreased but its yield per unit has increased slightly in 1981-2010. Transplanted Aman rice cultivated area and yield has little increased in 1981-2010. Boro rice cultivated area and yield has increased rapidly in 1981-2010. This pattern is going on forward continuously. In 1981-90, cultivation area of Boro rice was 25%. In 2001-10, this trend has increased sharply and reached 98%. In early 1981, the study area has cultivated three crops in high land and medium high land like broadcast Aus, transplant Aman and Rabi crops with moderate yield. The average Boro rice yield was 1.56 mton per ha in 1981 which increased drastically and it was found that 2.64 mton per ha in 2001-10. In 1981-

2010, local seed use trend has been decreasing continuously for improving technology and replaced by HYV seed. In 1981-90, it is 95% and in 2001-10, it has gone down 65%.

In 1985-86, Transplant Aman pajam rice cultivated area was 2,336.03 ha and yield was 7.19 mton. The Transplant Aman pajam area has decreased continuously during 1985-2010. In 2009-10, its area is 291.50 ha and yield is 0.84 mton. Expenditure of rice cultivation has increased over time due to high price of input material. The average expenditure of rice cultivation (Boro & transplanted Aman) is Tk. 5,044 per ha in 1981-90 which has increased to Tk.17, 221 per ha in 2001-10. However, return of yield value of Rice has also risen dramatically from 1981-2010. The average yield of rice was Tk. 7,625 per ha in 1981-90 which increased rapidly to Tk. 35,731 per ha in 2001-10. The average rice yield has gone up sharply to meet the large population demand which that is possible for modernization of input materials.

Wheat is the second cereal crop in our country. For improved HYV seed, modern technology and climate change the cultivation of wheat has changed gradually. In 1981-90, land area is 0.20 ha; yield is .54 mton in a ha and local seed use is 1.0%. Wheat cultivation area has gone down and yield has little increased. In 2001-10, average area is 0.03 ha; average yield is 0.56 mton in a ha and local seed has misplaced in the study area. Otherwise HYV seed use is 100%. Total crop area has decreased but total yield has little increased for good seed quality, irrigation, cultivation method and proper management.

Vegetable is important for nutritional, financial, and food security in Bangladesh. Jessore is one of the largest vegetable growing areas covering 14% of the country's arable land. The availability of abundant high and medium-high land, excellent soil and climatic conditions and early and late seasonal harvests give Jessore a headstart in the cultivation of vegetables. Farmers in Jessore have strong traditional skills. They are innovative and receptive to new ideas, which mean that modern technologies are being adopted to meet local needs. In Jessore vegetable cultivated area has increased from 68,826 ha to 1,44,939 ha in 1986-2004 and yield has increased from 28,000 mton to 51,000 mton in 1986 to 2004. And further it has increased an area of 2,80,972 ha and yield is 71,000 mton in 2010.

Average sugarcane cultivated area is 0.16 ha to 0.03 ha in 1981-90 to 2001-10 respectively. Sugarcane cultivated area is decreasing gradually from 1981-2010. It is an annual crop; sugarcane keeps the land occupied throughout the year. For the climate having changed, the farmers have changed their cultivation pattern for more profit. They prefer to cultivate more than one crop for higher return. In 1981-90, average banana cultivated area is 0.11 ha and yield value is Tk. 12,017. Banana cultivated area is declining gradually and yield value is increasing slightly with cultivation of high value banana. In 2001-10, area is 0.04 ha and yield value is Tk. 34,343.

Jute is the most important cash crop for the country. Seed is an important input for jute cultivation. For modern technology and climate change, the pattern of jute cultivation has been changing. In 1981-90, average jute cultivated area is 0.29 ha and local seed use is 0.60%. Whereas in 2001-10, average jute cultivated area is 0.19 ha and use of local seed is 0.10%. In three decades, jute cultivation area has gone down due to climate change and respondent's situation demand. Jute production and processing expenditure is high on the other hand Boro rice cultivation is more profitable than that of jute. Whereas, jute yield have increased for good seed quality, irrigation, cultivation method and proper management but area has reduced gradually.

Jessore is the basket of cotton cultivation in Bangladesh. In 1981-90, average cotton cultivate area is 0.21 ha. Whereas, in 2001-10 average cotton cultivated area is 0.03 ha. Cotton area has declined continuously because of adverse climate and regarding more input of high irrigation for Boro cultivation. In early 1981-90 most of the farmers of the study area have cultivated cotton. After 1995, cotton cultivation has decreased in the study area for climate change, Boro rice cultivation and huge irrigation.

Flower cultivation has introduced in Jessore in 1984. The ideal climatic and soil conditions combined with strong traditional and innovative skills enable the sector to make good inroads into the market. The flower producers in Jessore are very motivated as flowers generate higher returns than other crops. The labor-intensive flower sub-sector has contributed to poverty alleviation by creating more jobs and income. In 1981-90, average flower cultivation area is 0.07 ha; and average yield value is Tk. 7,146. After 1991, flower cultivation has risen rapidly. Farmers left the traditional crops like broadcast Aus, broadcast Aman, Jute and Rabi crops, started to

cultivate flower. In 2001-10, flower area and yield value has increased in 0.21 ha and Tk. 54,451 respectively.

For local demand fruit gardening pattern has been changing gradually in the study area. Fruit gardening area is 0.04 ha in 1981-90, In 1981-90, all land has used for fruit tree for family consumption purpose, not used for commercial purpose. After 1990, farmer have started mango and lichi gardening commercially and after 2000 massive amount land have used for *Baukool* gardening. Fruit gardening is increasing rapidly and in 2001-10, it has reached 0.18 ha.

Bangladesh is a small thickly populated country. Because of high population density and shrinking natural resource base there is enormous pressure on the natural resources of the country. For more profitable and climate change the timber tree cultivation has been changing. In 1981-90, timber tree area is 0.28 ha. For change and improve technology, increase home and abroad demand and climate change timber tree cultivation has increased rapidly. In 2001-10, timber tree cultivation area has reached 0.13 ha.

One of the most important industries in the district is the cultivation and manufacture of date-sugar or *khajur-gur*. Jessore district ranks first in yield of khajur-gur in Bangladesh. In 1981, Date tree plantation was very profitable in this district. Date tree contribute many ways to a family. It is the main source of fuel and earning source of income. In 1981-90, it is the time to start decrease of date tree cultivation and this trend is existing till date. In 1981-90, date tree plantation average each family is 26. Gradually date tree cultivation is decreasing rapidly because of lack of fuel and skill manpower, greatly hampered for irrigation and it is not profitable. In 2001-10, Date tree plantation average each family is 4.

In 1981-90, rabi crops cultivated area is 0.45 ha and yield value is Tk. 2,902. Rabi crops cultivation has fallen continuously because of adverse weather, more irrigation, Boro cultivation and for non profit. In 2001-10, average Rabi crops cultivate area reduced to 0.29 ha and yield value is Tk. 9,875.

Fish and fisheries are equally important for the livelihoods, food and income generation of the people of Bangladesh. In mitigating the adverse effects, fish yield in Jessore has tremendously increased for favorable environment. Jessore is the best position for fish cultivation in Bangladesh and this trend has gone upward after 1985. In 1981-90, average fish cultivated land is 0.17 ha. More fallow and wet land has been used for it. Fish cultivation is increasing rapidly for respondent's modern and traditional knowledge, suitable climate, marketing system, strong networking and home and abroad demand. In 2001-10, average fish cultivated land has reached 1.48 ha.

Livestock is an integral component of agricultural economy of Bangladesh which has multifarious functional aspects as food, nutrition, income generation, savings, foreign currency earning, draft power, manure, fuel, transport, etc. Jessore district has livestock and poultry of 2,873 million in 1984. The amount has increased in 1996 and 2008, and reached 3,522 million and 3,853 million respectively.

Soil organic matter (OM) is the residue of living and non-living origins of plant, animal and microorganisms. A good soil should have at least 2.5% organic matter but in Jessore district the organic matter recorded 1.80% in 1996 and 1.35% in 2010. In 2010 OM is much lower due to excessive use of land, more use of chemical fertilizers, not maintaining crop calendar, lack of organic fertilizer and soil erosion. The lower trend is more prominent in Jhikargacha, Avaynagar and Bagharpara Upazila. Soil pH is the most important factor of nutrient availability in soils. At Bagharpara, the soil pH has found 8.4 in 1996 and 8.1 in 2010 which has decreasing trend for more use of ground water.

The country has an almost uniformly humid, warm, tropical climate. The daily maximum and minimum temperature in Jessore district has recorded in 1981-90. In 1989, the daily temperature has recorded with 41.50^0C as maximum and 5.9^0C as minimum. Maximum trend is increasing and minimum trend is going down. The daily maximum and minimum temperature in Jessore district has recorded in 2001-10. In 2009 and 2003, the daily temperature has recorded with 43.20^0 C as maximum and 5.0^0 C as minimum. Maximum temperature increases slightly and minimum temperature decrease little slightly. Daily temperature of last 30 years (1981-2010) have also been rapidly changed which greatly influences the agriculture pattern

change in the study area. The yearly maximum and minimum rainfall in Jessore district has recorded in 1981-90. In 1986 and 1982, the yearly rainfall has recorded with 2,073 CM as maximum and 1,265 CM as minimum. The yearly maximum and minimum rainfall in Jessore district has recorded in 2001-10. In 2004 and 2010, the yearly rainfall has recorded with 2,477 CM as maximum and 1,371 CM as minimum. There is yearly slight difference in rainfall in thirty years from 1981-2010 and last decades November, December and January has recorded less rainfall and June, July and August has recorded more rainfall than other periods. Variation of rainfall in last three decades influences to change the agriculture pattern.

At present groundwater contributes irrigation to 77% of total irrigated area in Bangladesh. The groundwater irrigation increased with the expansion of High Yielding Variety rice cultivation. About 80% of groundwater is used for crop production of which Boro paddy alone consumes 73% of total irrigation in Bangladesh because there is becoming little rain and weather is warm than other month.

The level of ground water has fallen drastically in Jessore in April-May which is 32 feet from the surface. As a result, pulling of tubewell water has become extremely difficult. Maximum depth has recorded 26 feet in April-May at Sarsa and Bagharpara Upazila in 1989. In 2009 maximum depth has recorded 32 feet at sadar Upazila. For climate change and excessive use of ground water, reduce of open water sources; the ground water level has fallen down gradually. For excessive use of ground water average 40% tubewell affected by arsenic in Jessore district. Thus it is seen that the ground water level has been falling to the lowest level to an alarming proportion which has great influences our agriculture pattern change.

Therefore, the above results summarized that rapid and frequent natural dynamic changes are taking place in the hydrological and river systems, soil fertility, ground water level condition and they are also subject to the influence of various human interventions. This situation has remarkably affected Jessore district. This in turn influence land use patterns and overall influences of cropping pattern in Jessore.

Fertilizer is one of the main inputs required for increasing crop production. The expansion of modern agricultural practices together with intensified cultivation

has led to an increasing demand for fertilizers. During 1981-90, use of organic fertilizers was 86%. This trend has fallen down dramatically. In 2001-10 it has gone down 5%. Whereas, in 1981-90, use of chemical fertilizer was 14% and this trend has risen up gradually to 95% in 2001-10.

Agricultural production has increased tremendously in many parts of the world in the last few decades through the increased use of modern pesticide and new appliances. In 1981-90, average 12% respondents have used pesticide to control insecticide in order to increase production. The amount of pesticide has increased gradually. In 2000, the volume of pesticide use has rapidly increased which is 37% and this figure has gone up very swiftly which is 51% in 2010.

Therefore, it can be concluded that increased use of inorganic fertilizers, insecticides and pesticides has led to contamination of water bodies and the spread of diseases, which have adversely affected aquatic life, life stock and people. Indiscriminate use of pesticide causes many adverse effects, including soil and water pollution, and sickness among farmers. As a consequence, they are facing problems that include earthworms, fish and frogs dying, diarrhoea, skin diseases, headaches and declining soil fertility. The same condition exists in the study area which is more affected in last decades. Likewise excessive use of ground water is suspected to be the cause of the presence of high levels of arsenic in ground water in Bangladesh.

Seed is the basic and only live input in agricultural industry and plays a crucial role in boosting up the agricultural production as well as economy of the country. In 1981-90, use of local and HYV seed is 88% and 12 % respectively. Use of HYV seed has risen up rapidly and otherwise use of local seed has gone down sharply. In 2001-10, use of HYV seed has gone up top most point and local seed use has gone down very low point. In 2001-10, use of HYV seed is 83% and local seed is 17%. To adapt the HYV seed, farmers have changed agriculture pattern which increased the overall production.

The rural non-farm sector has covered the rural industries and services. In 1981-90, use of traditional cultivation method was used by 97% of the respondents and modern method was used by 3%. Population pressure is increasing sharply and local food demand is increasing highly. So the cultivation methods have changed rapidly. Use of modern method has risen up gradually and traditional method has

gone down sharply. During 2001-10, use of modern method is 98% and traditional method is 2%. For the changing of cultivation method, agriculture pattern has changed very swiftly. In 1996 use of tractor and power tiller numbers are 556 and 1,236 respectively and in 2008 tractor and power tiller numbers are 207 and 3,804 respectively in Jessore. Tractor numbers have decreased gradually for high value and power tiller numbers has increased rapidly for reasonable price and easy handle. The result showed that modernization of transport and agricultural in put materials have changed agricultural pattern and yield per ha.

Land productivity very much depends on irrigation facility. In 1981-90, 10% farmers have used Shallow Tube Well for irrigation and an average 3% and 2% respondent have used Deep Tube Well and Local method respectively. The use of STW and DTW trend is increasing which is 85% and 8% in 2001-10 respectively. The use of DTW trend has increased very slowly because to install it, farmers have to make a cooperative society and it is very costly and difficult. Otherwise use of STW trend has increased tremendously as its installation does not need any cooperative society and its prize is reasonable and easy portable. By improving the machinery appliances local method has misplaced in our society in 1991 because local method is costly and very slow, skill labor is not available to handle local instrument. Whereas most of the water source of the study area is not capable to provide water. In order to get more yields more use of modern appliances is there which lead to the agriculture pattern change in the study area.

The labor intensity is 63% in 1981-90. Population pressure has gone up sharply and home and abroad food demand is increasing rapidly. So the labor intensity has changed rapidly. In 2001-10, it has reached 32%. In 1981-90, labor worked ten hour and average wages was Tk. 20-25 per day. Population pressure is increasing sharply and high population pressure affects the appropriate supply of food grain and overall economy. In 2001-10, average labor wages was Tk. 200 per day and works six hour per day. Labor intensity and labor wages is related to each other. The overall situation has influenced to change the agriculture pattern.

In Bangladesh, being a traditional Muslim society, women in Bangladesh hardly participate in agricultural activities outside home. Women participation, particularly in agriculture as entrepreneurs has been increasing in Bangladesh. The progress is attributed to poverty, empowerment of women by NGOs, and migration of male members from agriculture to non-farm occupation. In the absence of male members, women's role is changing from unpaid family worker to farm managers, a phenomenon termed as "feminization of agriculture". In 1981-90, women involvement in agriculture (sowing, pre & post harvesting and marketing) is very little but this trend is rising very slowly and gradually. In 2001-10, women involvement in agriculture is rapidly changed for urbanization, education, modernization and communication and networking transformation. Women involvement in agriculture of different stage is increasing rapidly and this trend is going on continuously which has greatly influenced the agriculture pattern change.

About 40% farmers have attended secondary schools. Otherwise 23% have finished S.S.C and above. Seven percent have no formal schooling; they can not read and write, they can only sign in order to resolve their problem. Eight percent farmer has attended adult literacy and learned how to read and write. About two-fifth farmers have achieved secondary level of education. With their level of education and long experience people gathered vast knowledge about agriculture and they have no hesitancy to involve agriculture which acts as a machine to change agriculture pattern. Business and service related activities are major secondary occupations of their own. More than two-third farmers have no secondary occupation and they fully involved in agricultural activities which has encouraged the agriculture pattern change.

The average yearly income of 19% and 20.6% of the respondent is up to Tk. 72,000 and Tk. 205,000 & above in 2010. Average yearly income of Tk. 72,000 is identified on poor farmer and 205,000 & above is rich farmer. The poor farmers are capable to hard work and rich farmer have invested more amounts which influence to change agriculture pattern.

Average age of the sample farmers is 51.8 years. Majority farmers are from the age group of 46-50 years and 56 years and above. All of them are involve with agriculture from their childhood. As a result they have long experienced in the field of

agriculture. At this stage of the age group people are in more matured level with long experience and they have taken bold and wise decision which act as a machine to change agriculture pattern.

Agricultural related training is very much needed to develop efficient manpower in agriculture disciplines and in order to increase the rate of yield on a sustained basis. In 1981-90, 2.2% farmers have received training from GoB and in 2010 it has reached 32.7%. In 1981-90, no body has received training from NGO and in 1991-2000, it is 2% and further in 2010, it has reached 2.2%. GoB and NGO have delivered different skill development training program which greatly influenced the farmer knowledge on availability and optimum utilization of modern agricultural appliances and management practices.

By receiving training on agriculture technology, they utilize the input material appropriately than before receiving the training. Before receiving training, they used input materials by using their traditional knowledge which created many problems that is why they did not get high yield. The trained farmers are also the role model for the other farmers in the study area. As a result through limited number of trained farmers almost all of them are now using modern knowledge of agriculture to get high yield and changed the agriculture pattern in the study area. Respondents have got credit from GoB of 20% to 37% in 1981-90 to 2001-10. They have received credit and have provided all input in the field in right time. So, they have kept full concentration on cultivation which influences to change agriculture pattern.

Jessore City is still growing as an economic hub in the south western part of Bangladesh. Jessore has well communication links with nearby districts and the whole country. The district having a flat plain land, all three modes of surface transport, i.e. road, railway and airway are widely used in carrying both passengers and cargo.

The respondents have used different vehicles in order to carry their agriculture materials from field to home or market. In 1980-90, 90% of the respondents have used manpower (head load) to carry their agriculture materials from field to home or market. This trend has declined in the lowest point during 1991-2010. In course of time, it is about to misplace in our society, in 2001-10 it came down to approximately

1%. Bullock cart is a popular vehicle to carry agriculture materials from crop field to house or marketplace. In 1981-90, 94% have used it and after ten years this trend has reduced gradually to 3% in 2001-10. In 1981-90 use of Truck in rural area was a very rare case which was about 2%. With improved technology and road communication truck use has become popular dramatically and being used by 49% of farmers in 2001-10. In 1981-90, there was no existing of *Nochimon* but in 1991-2000 1% farmers used it. In 2001-10, this transport demand has increased tremendously, 91% used it to carry their agriculture materials from field to home or local and district market. *Nochimon* is more popular among poor people for lower cost and easy entrance in crop field and any type of road. Pickup & Trolley is new transport which is introducing in 1991-2000; day by day this transport becomes more popular and this trend exists till date. For improving and changing the transport management system carrying agriculture goods is easy from one place to another and the farmers have got fair price of their goods which inspired them to produce more crops. So the transport management system has made an important role to influence the agriculture patterns change.

In 1981-2010, the economy of Bangladesh has developed gradually. As a result the road transport facilities, communication (telephone, cell phone) and other technologies have been developing in 1981-2010. These development influences the marketing system and the local agriculture products has transferred to district market easily. Therefore, the farmers have sold their products more in district market in 2001-10 rather than 1981-90. In 1981-90, 94% have used local market and in 2001-10 it has gone down 14%. On the other hand in 1981-90, 6% have used district market to sell their products and in 2001-10, it has reached 86%.

For improving irrigation system, availability of modern appliances, input materials, modern technology and climate change has affected greatly on agriculture pattern in Jessore. Marketing system, transport management and well communication system has acted as a machine to change agriculture pattern. Local, national and abroad demand has influenced greatly to change agriculture pattern. The above mentioned social and environmental aspects have played vital role to change agriculture pattern in the study area. This might be more or less common scenario for other parts of Bangladesh.

8.2 *Conclusions*

The agricultural sector in Bangladesh is the traditional sector that existed for thousands of years. It was largely subsistence oriented, based on family farming with some amount of paid work, and used traditional technology. Its technology-use means to dependent on muscle power of people and farm animals (cows and bullocks). Since last three decades there is significant transformation of the sub sectoral structure of agriculture in Jessore. Per unit area and yield of cereal crops (transplanted Aus & Aman, Boro and Vegetables) have been increasing gradually. On the other hand per unit area and yield of few cereal crops (broadcast Aus & Aman and Banana) have been decreasing gradually. Per unit yield of non-cereal crops (Jute, Flower and Cotton) have been increasing and area has been decreasing gradually except flower. Wheat area is decreasing but yield is increasing gradually. Sugarcane yield and area are decreasing continuously. Timber tree area is increasing and fruit gardening area is decreasing. Date tree cultivation and average number of date trees per family has rapidly declined.

Rabi crops area is decreasing but yield is increasing for better management. Whereas per unit area and yield of fish cultivation is increasing steadily and replaced by HYV and other improved fish fry. Local seed has been replaced by HYV varieties for all the cereal and non-cereal crops over time. Increase yield per unit area of land has been achieved mostly through improved water control, better soil preparation, better seed quality and better harvesting and post-harvesting processing and timeliness of cropping. With the increase of yield cropping intensity has also being increased in the study area.

Use of modern appliances in agriculture reduced cost of cultivation, production and saved management cost. The credit facilities from different institutional sources have gone up over the period from public & private bank and NGOs. Financial condition of the farmer has improved to receive credit from GoB and NGO. By receiving technical training farmer's quality has improved so that they can use input materials in proper proportion and on right time. Overall an increase in agricultural production is observed in Jessore (crops, livestock, fisheries and forestry) based on modern agriculture technology and a supply chain link of farmers with consumers in the domestic as well as overseas markets. Marketing system, transport

management and communication have been remarkably improved and helped the farmers to get the fair price of their products which led to change in agriculture pattern.

The increased use of inorganic fertilizers, insecticides and pesticides has led to contamination of waterbodies and the spread of diseases, which have adversely affected aquatic life, life stock and people. The above condition has been found in last decades by the study. Likewise excessive use of ground water is suspected to be the cause of the presence of high levels of arsenic in ground water in Jessore. Ground water level has fallen down 32 feet which greatly hampered irrigation and drinking water in Jessore. Jessore agriculture is now in the process of transforming from subsistence farming into commercial farming.

Climatic parameters of the study area are changing especially average rainfall is declined and average temperature is increasing gradually. Soil nutrient is gradually declining in Jessore for excessive use of land, not maintaining crop calendar, more use of chemical fertilizer, pesticide and herbicide, less use of organic fertilizer, more use of adulteration of fertilizer etc. These adverse trends are considered to be due to intensive cropping through indiscriminate use of fertilizers, pesticides, water for irrigation and total removal of biomass from the agriculture fields.

But now fisheries and livestock sub sectors have grown significantly faster and commercial cultivation has been shown remarkable growth. The dairy component of the livestock subsector is a growing sector. The forest sub sector has largely grown after nineties when commercially used lichi and mango and *baukool* cultivation have been introduced. In addition to Modernization, (the green revolution and mechanization) the growth of fisheries and poultry, the rural economy and society have undergone very significant transformations. Use of tractors has increased sharply in later decade than the traditional method. (i.e. wooden plough pulled by cows). The rural non-farm sector covers the rural industries and services. A significant element of the rural non-farm sector is the technology-based services of agro machinery and the rapid spread of electrical appliances with the progress of rural electrification. Various rural growth centers have emerged around commercial hubs. The advent of cellular phone has added to the tempo of this transformation. Use of HYV seeds, chemical

fertilizers, pesticides, better irrigation, machinery appliances and cropping techniques influenced the agriculture pattern in Jessore and shows rapid change.

8.3 Recommendations

Based on the study following recommendation are made.

- As the agricultural pattern is changing in last three decades, Government, NGOs and farmers should make their future plan by adopting this trend.
- Huge amount of Agriculture products were lost for lack of preservation. Storage facilities need to be ensured along with easy access facilities.
- Vegetables and flower are the most rising sectors of agriculture which need to be promoted by facilitating preservation of the commodity through construction of adequate cold storage. Incentive should be provided from GoB and private sector needs to be encouraged to invest in this sector.
- With the flexible terms and conditions Government and Private sectors' facilitation is imperative for the development of agro-based small and medium industries.
- As the global climate change affect the agricultural pattern, researchers have to develop new varieties susceptible in changing environment. GoB, NGOs and farmers should make their future plan by adopting this trend.
- Generally, the soil nutrients are not being tested by the farmers. As a result the farmers do not know what type of fertilizer is appropriate for the soil. Soil test in every three years can help farmers reducing the unnecessary use of fertilizer. This practice can improve crop production without increasing the expenditure.
- Government need to play vital role for timely supply of agricultural inputs at affordable prices to the farmers, as private sectors tend to supply high profit earning inputs.
- Large scale initiative must be taken to educate and encourage farmers to use organic fertilizer and IPM method so that environmental degradation can be checked.

- With regard to providing credit to the farmers, GoB should take effective initiative in making greater co-ordination among the banks (public & private), NGOs and private sectors.
- With the improvement of technology, modern appliances have been available in the market, but farmers are still not well oriented on how to handle the modern equipment. So necessary training for the farmer should be arranged by the government and NGOs to maximize the benefit out of those modern technologies in production, preservation, storage and marketing.
- Emphasis on ensuring fair price of agricultural produces should be the way to protect the interest of the farmers.
- Government must have an appropriate action plan for agricultural credit and marketing of agricultural products.

8.4 Future Research

Future research should focuses on the development of climate & soil adaptation crops in the study area together with the designing of capable institutions for facilitating environmental friendly agricultural production.

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Annexure 01

Table of Maximum, Minimum and Average Temperature Degree Celsius

Year	Maxi Tem	Mini Tem	Aver
1981	37.5	8.7	30.60
1982	39.4	8.6	31.55
1983	40.0	7.5	31.66
1984	40.1	7.3	31.23
1985	40.6	9.2	31.75
1986	40.8	8.5	29.15
1987	40.3	7.9	31.67
1988	41.0	6.7	31.63
1989	**41.5**	**5.9**	31.50
1990	37.0	7.4	31.02
1991	38.5	7.2	31.65
1992	41.8	8.0	31.75
1993	38.0	6.4	31.31
1994	41.7	7.5	31.76
1995	**42.7**	**6.0**	31.59
1996	41.4	7.8	31.67
1997	39.8	7.0	31.25
1998	38.80	6.2	31.48
1999	41.0	8.6	32.34
2000	39.2	6.4	29.43
2001	39.5	5.8	31.95
2002	41.8	9.2	31.71
2003	40.8	**5.0**	31.85
2004	41.4	7.8	31.89
2005	41.8	8.8	32.31
2006	40.5	6.2	32.65
2007	39.7	7.0	31.75
2008	40.0	8.0	31.80
2009	**43.2**	6.0	32.89
2010	40.6	6.7	32.61

Source: BMD

Annexure 02

Maximum, Minimum and Average Rainfall (cm) of Jessore District 1981-2010

MONTH /YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
JAN	35	0	20	51	14	9	1	0	0	0
FEB	107	4	21	1	4	0	0	27	3	5
MAR	88	51	55	0	50	1	58	93	2	189
APR	292	233	61	19	4	90	165	148	41	19
MAY	246	71	327	304	177	136	52	298	273	163
JUN	103	**313**	152	**821**	**311**	337	327	**518**	202	342
JUL	**376**	171	188	292	244	338	389	257	**282**	392
AUG	290	183	**417**	321	206	177	**714**	312	120	106
SEP	244	212	238	167	238	**637**	193	117	161	202
OCT	15	5	15	54	189	183	136	87	234	94
NOV	0	21	0	0	0	159	14	100	0	126
DEC	148	1	15	0	0	6	10	0	7	10
TOTAL	1929	1265	1509	2030	1437	2073	2059	1957	1325	1648

MONTH /YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
JAN	24	38	0	12	17	21	15	44	0	2
FEB	24	66	33	29	25	20	33	26	0	19
MAR	33	**0**	115	1	18	22	51	141	0	7
APR	54	20	147	51	5	90	70	130	31	71
MAY	87	204	142	175	88	146	110	**222**	141	172
JUN	**408**	303	294	**371**	196	350	232	158	262	**500**
JUL	220	**312**	**335**	220	281	289	**393**	184	**448**	283
AUG	335	147	210	255	**286**	**362**	240	209	251	276
SEP	216	203	333	89	270	195	348	168	301	413
OCT	145	36	103	64	95	257	12	88	151	145
NOV	0	3	4	2	113	5	15	118	1	0
DEC	76	0	0	0	3	0	19	0	0	0
TOTAL	1622	1332	1716	1269	1397	1757	1538	1488	1586	1888

MONTH /YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
JAN	0	18	0	3	32	0	0	70	0	0
FEB	38	0	13	0	15	0	83	38	7	22
MAR	37	22	119	10	129	1	21	38	34	11
APR	39	134	55	72	33	52	62	38	0	50
MAY	347	267	66	176	57	302	159	213	198	274
JUN	**475**	**539**	**457**	303	181	231	351	268	240	**297**
JUL	277	519	419	398	**468**	**479**	**738**	**415**	279	168
AUG	109	258	142	400	113	318	274	200	391	211
SEP	141	224	145	**856**	159	366	261	**415**	**417**	186
OCT	165	32	466	259	411	7	142	199	3	116
NOV	14	112	0	0	2	4	100	0	1	4
DEC	0	0	35	0	0	0	0	0	1	32
TOTAL	1642	2125	1917	2477	1600	1760	2191	1894	1571	1371

Annexure 03

Relative Humidity Monthly Averaged Relative Humidity (%)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1981	71.20	69.95	**61.90**	72.50	76.15	77.75	**87.00**	83.80	84.50	67.65	71.35	75.55	74.94
1982	68.25	**62.00**	62.55	68.10	77.95	83.90	81.10	**85.30**	83.40	83.00	74.00	69.85	74.95
1983	48.76	**44.62**	48.68	49.60	77.58	73.00	86.49	**87.06**	85.70	83.95	76.70	59.58	68.64
1984	52.20	36.18	**31.49**	56.33	78.91	85.85	**85.78**	84.99	78.77	71.86	51.82	44.06	63.28
1985	50.86	**31.89**	47.15	44.90	71.14	85.30	**86.30**	85.72	85.52	78.53	61.92	52.46	65.37
1986	52.69	40.63	**29.19**	68.61	63.63	67.93	**86.35**	84.21	84.49	80.51	74.09	58.45	66.02
1987	46.72	42.41	**33.33**	40.18	35.85	75.33	**86.72**	84.08	84.86	66.25	51.05	45.52	57.76
1988	41.44	39.66	**36.51**	52.68	73.78	85.75	86.99	**87.85**	84.09	79.19	72.07	63.77	67.06
1989	47.98	35.79	**28.82**	41.81	69.85	84.54	**87.07**	86.06	85.99	83.35	74.89	66.07	66.20
1990	**52.30**	53.07	63.95	77.36	79.58	86.26	**88.08**	84.63	85.02	79.19	74.29	55.32	73.34

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1991	50.39	**45.08**	54.26	66.92	82.55	84.81	84.85	**86.31**	85.91	81.23	69.32	64.79	71.52
1992	61.62	56.65	**43.15**	55.94	76.68	83.02	85.17	**83.67**	82.97	78.41	65.01	57.04	69.15
1993	51.57	50.22	**48.07**	68.49	82.85	83.85	84.60	84.24	**84.71**	79.96	77.34	60.30	71.44
1994	**54.35**	56.13	57.65	68.81	81.34	85.22	**86.60**	85.14	79.04	76.48	71.76	54.41	71.48
1995	48.90	47.13	**42.05**	67.44	81.41	**86.47**	86.24	85.72	84.59	82.47	80.70	70.51	72.09
1996	58.79	**57.58**	57.63	63.20	82.68	85.74	**87.41**	86.72	83.98	80.69	70.34	55.44	72.56
1997	52.60	**48.11**	64.05	77.49	80.50	85.04	**86.05**	85.38	83.62	77.93	68.07	57.75	72.34
1998	54.78	50.05	**49.66**	77.07	81.54	86.64	**87.41**	86.65	85.69	82.17	81.21	62.81	73.91
1999	48.40	44.41	**34.41**	66.11	84.81	85.37	**86.82**	85.48	86.08	82.44	72.51	55.88	69.51
2000	49.10	54.08	**47.34**	76.86	81.94	84.03	83.80	84.54	**85.31**	83.43	72.10	53.58	71.35

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2001	**45.42**	47.01	52.82	74.06	84.69	**88.10**	87.29	86.37	85.21	84.23	78.76	58.95	72.86
2002	54.73	**48.42**	58.97	82.81	85.24	87.08	86.40	**87.37**	85.27	82.79	78.62	63.94	75.26
2003	**57.00**	66.07	67.40	82.58	81.22	87.73	**88.26**	87.04	87.24	82.42	69.05	59.85	76.35
2004	58.95	**42.48**	48.03	83.42	79.50	85.11	86.68	**87.06**	85.40	79.61	68.40	55.79	71.76
2005	54.22	**51.99**	65.06	69.41	83.82	85.34	**86.34**	83.81	82.82	82.47	57.88	48.88	71.13
2006	56.07	**53.76**	63.06	67.04	80.07	86.03	**86.57**	84.74	83.65	82.72	59.07	51.06	71.15
2007	59.06	**54.07**	64.61	68.06	81.09	85.87	**86.69**	86.38	83.75	82.72	58.06	52.07	71.87
2008	85.33	**82.00**	82.00	78.66	78.00	85.66	89.00	87.66	88.66	86.66	86.33	**90.80**	85.06
2009	88.00	80.66	77.00	**76.83**	77.66	80.66	85.00	**88.66**	86.33	85.33	84.00	88.33	83.20
2010	84.33	78.66	75.33	**75.00**	79.33	83.66	83.00	84.00	86.66	86.00	83.66	**87.66**	82.27

Source: BMD

Annexure-04

Ground Water Level of Jessore District in 1981-2010

Upazila	Union						LWL, Feet																						Page no	1
		81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	05	06	07	08	09	10
Avoynagar	Chalishia	8	9	9	10	13	10	10	12	18	22	23	24	19	18	17	17	16	10	11	24	17	18	18	10	15	17	16	16	20	20
Avoynagar	Prembagh	12	12	11	13	15	13	10	12	18	22	23	24	19	18	17	17	16	10	11	24	12	13	15	9	15	17	19	19	21	21
Avoynagar	Sundali	12	12	11	13	15	9	10	12	19	24	24	25	20	19	18	18	16	10	11	24	13	15	18	10	15	17	14	13	16	17
Avoynagar	Bagutia	8	9	9	10	12	12	11	13	20	26	26	26	20	19	18	17	17	10	12	26	17	17	16	11	16	18	19	18	20	21
Avoynagar	Pourashava	9	8	10	11	14	10	11	13	24	26	26	26	20	20	19	17	17	11	12	26	17	18	21	11	16	18	18	17	20	20
Avoynagar	Mohakol	8	10	9	10	12	12	15	15	24	26	26	26	19	22	27	18	19	12	13	26	17	18	20	10	16	18	17	18	16	18
Avoynagar	Noapara	8	9	9	8	10	11	12	14	23	20	25	25	22	20	19	18	19	13	13	25	19	19	19	9	16	17	18	15	15	17
Avoynagar	Payra	7	10	10	9	12	10	11	14	18	26	25	25	20	19	18	19	19	12	13	25	18	17	16	9	15	17	15	14	14	15
Avoynagar	Rajghat	9	9	9	10	13	11	12	13	18	25	25	25	19	19	18	18	18	13	14	25	18	17	17	9	15	17	16	16	15	16
Avoynagar	Shovorara	10	10	11	11	15	12	11	12	19	27	26	26	21	20	19	20	20	13	14	25	19	18	16	10	15	15	16	15	18	19
Avoynagar	Siddipasha	9	9	10	10	14	12	11	12	19	26	26	26	21	21	17	17	19	12	14	25	19	18	15	10	16	15	17	16	20	21
Avoynagar	Sreedarpur	10	11	9	11	15	10	10	11	20	27	26	26	25	23	25	21	20	12	14	26	19	19	15	11	15	16	17	17	19	20
Baghar para	Basuari	9	8	8	9	14	11	11	14	18	20	20	21	21	20	25	21	22	12	15	21	18	20	21	11	16	16	15	16	24	25
Baghar para	Bondobila	9	7	10	11	13	13	14	19	24	19	20	25	23	24	29	28	24	11	15	20	18	20	24	11	16	17	16	26	24	25
Baghar para	Dhalgram	8	8	9	10	12	4	4	5	12	12	13	19	20	19	21	20	23	11	15	19	17	20	20	11	16	17	16	24	24	25
Baghar para	Dohakula	7	7	8	8	12	8	8	11	20	21	16	25	22	19	23	22	22	10	14	20	17	21	19	10	17	16	16	24	24	24
Baghar para	Dorajhat	9	8	9	9	13	16	13	12	16	17	21	23	21	20	27	23	23	10	14	23	17	21	20	10	17	16	16	22	23	24
Baghar para	Jamdia	8	9	10	10	12	13	13	12	19	18	18	20	19	20	22	21	22	11	14	20	18	20	17	9	16	15	15	24	24	25
Baghar para	Johorepur	10	11	11	12	14	17	13	16	23	18	18	24	22	23	27	25	24	11	14	21	18	20	25	9	16	15	15	23	24	25

Upazila	Union						LWL, Feet																						Page no	2
		81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	05	06	07	08	09	10
Baghar para	Narikelbaria	9	10	10	11	15	17	10	17	21	15	16	22	20	22	26	21	22	11	13	22	17	19	20	9	16	17	16	25	24	25
Baghar para	Raypur	9	10	10	11	15	15	9	16	19	17	17	25	21	23	28	21	23	12	13	21	17	19	21	9	16	16	19	27	26	25
Chowgacha	Chowgacha	8	9	9	10	14	15	15	12	18	19	22	16	23	18	26	25	24	11	13	22	14	19	24	9	16	16	19	22	21	19
Chowgacha	Sawrupdah	9	10	10	12	14	15	15	12	18	19	24	24	25	21	26	25	25	11	13	22	19	19	18	10	16	15	19	21	20	19
Chowgacha	Duliani	8	9	9	10	13	15	16	14	20	17	27	25	26	22	26	24	26	12	14	23	27	18	24	10	17	15	18	22	25	20
Chowgacha	Fulsara	7	10	11	12	14	12	12	14	21	24	22	25	20	21	30	31	26	12	14	20	20	18	23	18	10	17	15	18	23	22
Chowgacha	Hakimpur	7	8	8	10	14	16	13	16	17	17	21	25	23	23	26	25	25	13	14	20	18	18	21	10	17	16	18	26	24	21
Chowgacha	Jagadishpur	8	9	9	10	13	18	15	15	20	17	19	20	18	21	24	25	26	13	14	20	21	19	19	10	17	16	19	21	20	21
Chowgacha	Narayanpur	7	9	10	11	14	23	23	22	23	18	22	22	21	22	24	25	26	12	13	23	26	19	18	11	16	17	20	22	20	19
Chowgacha	Pashapol	9	8	9	10	13	11	11	13	20	24	26	28	23	22	32	32	31	11	12	27	14	19	25	11	16	18	20	29	25	23
Chowgacha	Pativila	8	9	9	10	12	12	14	16	18	14	17	20	17	18	24	17	29	11	12	20	15	19	20	11	16	18	21	24	22	21
Chowgacha	Sarashdaha	9	9	10	11	14	16	13	15	16	13	17	16	17	22	22	22	29	10	12	17	27	20	22	11	16	17	21	22	24	22
Chowgacha	Singhajuli	9	10	9	12	13	15	13	13	20	23	22	29	21	25	32	31	30	10	12	29	26	20	25	12	17	16	21	25	27	23
Chowgacha	Sukpukuria	8	8	9	10	14	14	17	16	19	17	22	22	21	22	26	27	31	11	12	22	26	20	16	12	17	16	22	21	21	18
Jessore sadar	Arabpur	9	9	10	11	15	13	15	21	26	21	27	26	16	22	26	28	30	11	11	27	28	20	26	12	17	16	22	27	30	32
Jessore sadar	Basundia	7	8	9	10	12	14	15	16	22	15	20	22	19	22	25	22	30	11	11	22	27	20	26	12	17	17	21	27	32	31
Jessore sadar	Chanchara	8	9	7	9	12	14	15	20	26	21	26	26	20	24	27	29	31	12	11	26	28	22	25	11	16	17	21	28	30	30
Jessore sadar	Churamonkati	9	8	9	10	14	13	15	20	25	21	26	27	21	23	27	27	32	12	11	27	27	22	24	11	16	17	22	27	30	30
Jessore sadar	Deara	8	9	8	10	14	14	15	21	26	20	27	27	21	22	29	30	31	11	12	27	28	22	26	11	16	18	23	27	30	32
Jessore sadar	Fatepur	9	9	9	11	14	13	15	21	26	21	28	27	23	24	29	29	30	12	12	28	27	23	27	11	16	18	23	27	32	31
Jessore sadar	Haibatpur	8	8	10	11	15	14	15	22	24	20	23	27	22	22	28	29	29	11	12	27	27	22	25	12	18	19	24	27	32	32
Jessore sadar	Ichali	9	9	10	11	12	13	10	20	23	19	22	26	23	22	28	29	29	11	12	23	25	22	26	12	17	19	24	27	32	31

Upazila	Union						LWL, Feet																					Page no	3
		81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	05	06	07	08	09	10
Jessore sadar	Kachua	9	10	12	14	16	13	15	17	23	16	22	24	23	22	27	26	30	11	13	24	26	23	26	12	17	19	24	27	32	31
Jessore sadar	Kashimpur	8	10	11	12	16	13	17	21	26	20	27	27	19	24	29	29	30	12	13	27	26	23	26	12	17	18	24	28	32	32
Jessore sadar	Lebutola	9	9	10	11	15	13	12	21	20	19	21	23	21	22	27	29	31	12	13	23	26	24	26	11	16	18	25	28	32	31
Jessore sadar	Narendrapur	9	10	11	12	16	14	15	17	24	17	22	24	23	23	29	31	32	12	12	24	28	24	25	11	16	16	25	27	32	31
Jessore sadar	Nowapara	10	11	12	13	15	13	15	22	24	22	26	27	25	23	28	29	32	13	12	27	27	25	27	11	15	17	24	26	32	32
Jessore sadar	Uposhohore	9	10	11	12	16	13	14	20	24	20	26	26	18	22	29	29	31	13	12	26	27	25	27	11	15	17	24	26	31	32
Jessore sadar	Ramnagar	9	10	11	12	16	14	15	21	26	21	26	26	20	23	27	28	31	13	13	26	27	25	27	11	15	17	24	27	31	31
Jhikorgacha	Bakra	8	9	10	11	13	20	14	16	20	17	25	26	25	21	27	26	31	12	13	26	21	25	21	11	15	17	25	23	26	26
Jhikorgacha	Godkhali	9	10	11	12	13	16	16	16	25	18	16	19	17	17	21	23	30	12	13	25	18	24	16	12	16	17	25	21	25	25
Jhikorgacha	Gonganandapur	10	11	12	13	16	21	20	16	18	17	21	23	21	20	25	24	30	12	12	23	25	20	21	12	16	18	25	25	26	26
Jhikorgacha	Hazirbagh	9	10	10	11	15	14	15	15	19	17	24	24	20	21	23	22	31	11	12	24	19	21	20	12	17	19	24	22	24	24
Jhikorgacha	Jhikorgacha	10	11	11	12	15	14	13	14	24	23	25	24	23	22	25	24	31	11	12	25	24	21	12	17	17	18	25	25	26	25
Jhikorgacha	Magura	10	9	10	11	15	19	18	16	19	17	25	24	23	22	23	23	32	11	12	24	24	22	20	10	18	18	25	24	26	26
Jhikorgacha	Navaron	9	10	11	12	16	14	13	13	23	15	17	25	15	16	24	23	32	11	12	25	22	21	21	10	18	19	25	22	24	24
Jhikorgacha	Nirbashkhola	11	11	12	13	14	15	14	13	21	17	22	21	17	18	21	21	21	22	22	22	21	20	18	9	19	22	25	18	25	25
Jhikorgacha	Panisara	10	12	12	13	15	16	15	14	20	16	18	21	15	16	22	21	21	21	21	21	20	20	19	8	20	22	25	22	24	24
Jhikorgacha	Shankarpur	9	11	11	12	15	15	10	12	21	17	25	28	19	20	27	26	26	27	27	28	23	22	24	10	22	23	25	24	23	24
Jhikorgacha	Shimulia	9	10	10	11	10	10	21	21	25	19	21	19	20	20	22	21	22	22	23	25	19	20	19	10	22	23	27	25	26	26
Keshabpur	B M Kati	7	7	7	9	10	9	8	9	16	6	12	11	12	13	15	14	20	21	22	16	16	15	15	9	21	24	26	17	18	24
Keshabpur	Ghourighona	8	9	9	7	10	7	8	9	16	8	14	14	14	14	16	14	19	20	21	16	13	18	12	8	21	22	24	18	19	25
Keshabpur	Keshabpur	10	11	11	13	15	10	12	13	18	7	14	17	16	16	19	18	20	21	22	18	19	18	16	8	21	22	24	18	20	25
Keshabpur	Majidpur	6	8	7	8	9	11	7	8	12	6	11	13	13	14	16	15	17	19	20	13	14	15	14	9	21	23	25	16	18	24

Upazila	Union						LWL, Feet																						Page no	4
		81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	05	06	07	08	09	10
Keshabpur	Mongolcourt	7	7	8	9	10	10	10	12	19	7	15	15	14	14	18	18	18	20	21	19	18	15	15	9	21	23	25	24	25	25
Keshabpur	Pazia	10	11	12	12	14	12	12	14	20	8	14	15	14	15	18	19	19	19	22	20	21	20	14	10	22	23	25	22	23	24
Keshabpur	Sagardari	11	12	12	13	14	14	9	12	15	8	15	15	17	16	18	18	20	20	21	15	16	18	17	10	21	22	24	22	23	24
Keshabpur	Sufalakati	10	11	11	12	15	9	10	8	13	9	14	14	12	13	14	13	15	16	19	14	12	12	12	9	21	23	25	17	18	23
Keshabpur	Trimohoni	11	11	10	10	13	13	12	14	17	8	15	18	17	18	16	16	17	18	18	18	17	15	13	9	22	24	25	18	19	22
Monirampur	Chaluhati	10	10	12	12	15	15	14	16	17	14	16	17	17	17	18	18	19	19	18	17	15	16	17	8	22	23	24	16	19	22
Monirampur	Dakuria	11	11	10	13	16	16	12	16	20	13	20	23	18	22	25	22	21	21	20	23	23	24	29	8	21	22	24	21	20	23
Monirampur	Durbadanga	10	10	11	11	14	15	13	14	19	13	15	19	19	18	24	21	22	22	21	19	18	20	21	9	20	21	19	18	20	23
Monirampur	Hariharnagar	11	12	12	13	13	15	16	15	19	13	17	18	18	18	21	20	20	21	21	19	17	18	19	9	19	20	22	17	21	22
Monirampur	Horidaskati	10	12	11	11	15	14	9	11	20	9	15	19	14	14	20	21	21	22	22	20	21	18	24	10	18	21	24	17	18	21
Monirampur	Jhapa	11	12	12	13	15	17	15	17	16	15	16	18	16	18	19	19	20	21	21	18	15	17	21	10	18	20	23	19	19	22
Monirampur	Kashimnagar	9	11	10	11	14	20	14	18	26	19	22	26	22	26	28	26	25	25	24	20	22	21	29	11	19	21	24	21	21	21
Monirampur	Khanpur	10	10	11	12	15	15	11	15	21	14	18	22	18	21	23	20	20	21	21	22	22	22	24	11	18	22	24	20	21	21
Monirampur	Khedapara	11	12	12	13	15	15	13	15	20	15	22	23	22	23	25	25	24	24	25	23	21	22	27	12	19	23	23	18	22	22
Monirampur	Kultia	7	7	8	9	10	15	7	8	15	8	12	15	13	13	17	18	19	19	20	15	16	17	18	12	18	20	22	18	24	23
Monirampur	Maswimnagar	10	10	9	10	15	17	16	15	17	14	18	19	18	19	18	22	22	23	24	19	21	20	17	12	17	21	21	18	25	24
Monirampur	Monirampur	12	13	13	15	16	15	12	17	20	14	20	23	20	20	22	14	15	15	16	23	16	17	26	11	16	18	24	24	27	25
Monirampur	Monohorpur	6	8	9	10	12	9	11	15	15	9	10	13	13	12	16	20	20	21	21	15	16	14	17	11	16	19	19	12	20	25
Monirampur	Nehalpur	8	7	6	9	10	10	10	12	16	12	12	16	13	14	19	16	17	17	18	16	16	19	18	12	17	21	22	16	19	22
Monirampur	Rohita	11	12	12	11	14	15	14	16	18	15	19	20	20	21	21	20	19	19	20	20	16	18	18	11	18	19	21	18	18	21
Monirampur	Shamkur	10	11	11	12	14	14	12	15	20	10	18	19	17	18	22	20	21	21	22	20	22	23	24	11	16	15	22	17	19	21
Monirampur	Vozgati	11	12	12	11	15	17	14	16	21	16	20	23	21	22	25	21	22	22	23	23	23	23	29	10	16	15	22	21	22	20

Upazila	Union						LWL, Feet																						Page no	5
		81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	05	06	07	08	09	10
Sharsha	Bahadurpur	10	11	11	10	14	15	12	10	15	12	13	16	15	15	19	20	21	21	22	16	18	19	17	10	17	21	24	14	13	15
Sharsha	Benapol	8	10	10	10	16	13	16	15	24	22	23	23	21	21	27	26	25	25	22	20	25	22	24	9	21	20	23	20	22	23
Sharsha	Bug Archra	9	9	11	11	14	12	14	16	21	13	20	24	24	24	25	26	25	26	22	20	21	21	20	9	20	20	24	21	27	28
Sharsha	Dihi	8	10	10	10	15	12	11	11	17	11	12	15	15	15	16	15	16	17	17	17	14	20	14	9	12	21	25	14	17	17
Sharsha	Goga	10	11	11	12	16	12	15	16	21	20	25	29	29	29	29	31	30	30	31	29	24	22	26	10	25	23	24	24	27	28
Sharsha	Kayba	11	10	10	11	14	11	9	11	17	16	22	27	28	28	30	29	29	28	28	27	24	23	25	10	24	22	23	23	29	29
Sharsha	Lakhanpur	8	8	9	12	13	13	11	12	17	11	13	14	14	14	16	14	14	14	15	17	15	19	22	10	12	20	21	15	17	18
Sharsha	Nizampur	9	9	8	11	14	12	10	12	18	10	13	15	14	14	15	14	15	15	16	18	15	20	14	11	12	19	20	15	17	18
Sharsha	Putkhali	11	10	10	12	13	12	12	12	26	18	21	25	21	19	27	26	25	24	24	20	22	21	24	11	23	21	24	19	19	19
Sharsha	Sharsha	10	9	9	8	12	12	15	12	19	11	15	19	19	16	21	22	22	21	21	19	16	19	17	12	14	20	19	18	19	20
Sharsha	Ulashi	9	8	8	7	12	12	14	12	21	18	16	21	22	22	24	26	25	24	24	21	18	20	19	12	16	19	18	21	21	22

Appendix 01

Analysis of Changing Agricultural Pattern in Jessore: Environment and Social Aspects

Questionnaire for PhD Program

Department of Geography and Environment, University of Dhaka

Information collected through this questionnaire will be used for research purpose only

Date: Time:

Personal Information of the Respondent

Please provide information regarding the following aspects

1. Name:
2. Father's Name:
3. Address: Village: P/O: Union:

   P/S/Upozilla: District:

4. Age? .....years.
5. Educational qualification

   (i) read and write (ii) can sign only (iii) studied up to……

6. Principal occupation?.....

   6.1 Secondary occupation?.....

7. Income yearly (approximately)..... T.k

Changing pattern of environmental characteristics

8. How long have you been living in this area?(i) throughout the life (ii).... .....years (iii) …… months
9. What kind of changes have you observed of the following environmental parameters?

SlNo	Parameters	1981-1990			1991-2000			2001-2010		
1	Soil fertility									
2	Number of water bodies in your union									
3	Water bodies water holding capacity	Win & Spring W S	Sum & Rai Sea S R	Autu & Late Aut A L/A	Win & Spring W S	Sum & Rai Sea S R	Autu & Late Aut A L/A	Win & Spring W S	Sum & Rai Sea S R	Autu & Late Aut A L/A
4	Rainfall	W S	S R	A L/A	W S	S R	A L/A	W S	S R	A L/A
5	Temperature	W S	S R	A L/A	W S	S R	A L/A	W S	S R	A L/A
6	Availability/changing of flora (Natural & Manmade)									
7	Availability/changing of fauna Natural & Manmade)									
8	Small animals									
9	Large animals									
10	Large trees									
11	Others									

Change of Agricultural Pattern

10. What kinds of crops do you cultivate?

SL No	Crop Name	Description of Land According to use	Total Crop Land Local Unit/Decimal	1981-1990 Local Unit/Decimal/Production					1991-2000 Local Unit/Decimal/Production					2001-2010 Local Unit/Decimal/Production					Total Production
				Season			Seed used		Season			Seed used		Season			Seed used		
				Rabi	Kharif - 1	Kharif - 2	High yielding	Local	Rabi	Kharif -1	Kharif - 2	High yielding	Local	Rabi	Kharif -1	Kharif - 2	High yielding	Local	
01.	Rice																		
02.	Jute																		
03.	Wheat																		
04.	Cotton																		
05.	Vegetable																		
06.	Flower																		
07.	Sugarcane																		
08.	Fruit gardening																		
09.	Banana																		
10.	Orchard																		
11	Fish Cultivation																		
12	Others																		
13	How many times did you use in your land in a year?																		

11. Agriculture Input?

Sl No	Parameters	1981-1990	1991-2000	2001-2010	Total amount of seed used
1	Seed	Lo = Hy =	Lo = Hy =	Lo = Hy =	
2	Cultivation method	An = Mod =	An = Mod =	An = Mod =	
3	Fertilizer	Or = Che =	Or = Che =	Or = Che =	
4	Insecticide (%)				
5	Irrigation method	STW = DTW =	STW = DTW =	STW = DTW =	
6	Labor intensity				
7	Wages of labor				
8	Expenditure of cultivation/acre				
9	Return of product/acre				

12. What kinds of vegetable do you cultivate?

Time	**Name of Vegetables**					
	Rabi (Sale price T.k)	Kharif – 1 (Sale price T.k)	Kharif – 2 (Sale price T.k)	Total types		
				80-90	91-20	01-10
1981-1990						
1991-2000						
2001-2010						

(i) Sheem (ii) Papay (iii) Tarmuj (iv) Alu (v) Begoon (vi) Tomato (vii) Jhal marich (viii) Dhedosh (ix) Puishak (x) Kolmi (xi) Gajor (xii) Mankachu (xiii) Misti kumda (xiv) Lau (xv) Shasa (xvi) Jhingga (xvii) Ucche/Karala (xviii) Kakrol (xix) Patal (xx) Chichingga (xxi) other

Vegetable Marketing System

13. Marketing system of vegetable?

Sl. No	Parameters	19811990	1991-2000	2001-2010
1	Amount of sale/acre			
2	Type of vehicle used			
3	In the local market or district			
4	Chin of marketing			
5	Others			

14. Women involvement in the process?

	1981-90	1991-20	2001-2010	Comments
Sowing				
Pre harvesting				
Post harvesting				
Collecting				
Marketing				
Others				

Funding Source of Agriculture

15. Have you received loan from any office/institute?

Yes No,

If yes, please mention.....

16. What is the interest rate of the loan?

Name	**1980-90**		**1991-2000**		**2001-2010**	
	Amount	Interest rate	Amount	Interest rate	Amount	Interest rate
Government Bank						
Private Bank						
NGO Name						
Private						
Insurance						
Others						

17. Did you face any problem in receiving loan?

Yes No, If yes, please mention ……

Training Program Received from Different GoB Offices or NGOs

18. Have you got any training from GoB or NGOs?

Sl no	Parameters	1980-1990		1991-2000		2001-2010	
		GoB	NGOs	GoB	NGOs	GoB	NGOs
1	Name of training						
2	Duration of training						
3	Resource person						
4	Male/female participation						
5	Kind of Benefit from training (knowledge, seed , instrument, fertilizer, irrigation, money and others						
6	No of training						
7	Expenditure of training						
8	Output of training						
9	Satisfaction level of training						
10	Demonstration plot						
11	Receiving training allowance						

Thank you for the cooperation of my research work

Appendix 02

Analysis of Changing Agricultural Pattern in Jessore: Environment and Social Aspects

FGD for PhD Program

Department of Geography and Environment, University of Dhaka

Information collected through this questionnaire will be used for research purpose only

Date: Time:

SL.N	Name	Fathers Name	Address	Profession	Income (Annual)	Signature
01.						
02.						
03.						
04.						
05.						
06.						
07.						
08.						
09.						
10.						
11.						
12.						
13.						
14.						
15.						

01. Describe about changes environmental parameters, Water bodies; River, Bill, Baor

Parameters (Changing)	1981-90	1991-2000	2001-10

02. Availability/changing of flora, Small & Large

Parameters (Changing)	1981-90	1991-2000	2001-10

03. Availability/changing of fauna Small & Large

Parameters (Changing)	1981-90	1991-2000	2001-10

04. Describe about agricultural seasons, yield, and area

a. Broadcast Aus Rice

b. Transplant Aus Rice

c. Broadcast Aman Rice

d. Transplant Aman Rice

e. Transplant Aman Local Rice

f. Transplant Aman HYV Rice

g. Transplant Aman Pajam Rice

h. Boro Rice

05. Describe about changes in Vegetables cultivation

06. Describe about changes in Flower cultivation

07. Describe about changes in Timber Tree cultivation

08. Describe about changes in Rabi crops

09. Describe about Fish, Fish & Paddy cultivation

10. Describe about changes in Forest and Live stock

11. Others

i)

ii)

iii)

Appendix 03

Analysis of Changing Agricultural Pattern in Jessore: Environment and Social Aspects
Key Informant Interview for PhD Program
Department of Geography and Environment, University of Dhaka
Information collected through this questionnaire will be used for research purpose only

1. Name:
2. Father's Name:
3. Address: Village: P/O: Union: P/S/Upozilla: District:
4. Age? .....years.
5. Educational qualification ……
6. Principal occupation..... ……6.1 Secondary occupation?.....
7. Income yearly (approximately)..... T.k

08. Describe about changes environmental parameters, Water bodies; River, Bill, Baor

09. Changing of flora, Small & Large

10. Changing of fauna Small & Large

11. Describe about agricultural seasons, yield, and area

a. Broadcast Aus Rice

b. Transplant Aus Rice

c. Broadcast Aman Rice

d. Transplant Aman Rice

e. Boro Rice

12. Describe about changes in Vegetables cultivation

13. Describe about changes in Flower cultivation

14. Describe about changes in cotton cultivation

15. Describe about changes in Rabi crops

16. Describe about Fish, Fish & Paddy cultivation

17. Others ……

Thank you for the cooperation of my research work