PRODUCTION TREND AND RELATIVE PROFITABILITY OF MAJOR RABI CROPS UNDER GROUNDWATER IRRIGATION DYNAMICS IN BARIND AREAS OF RAJSHAHI AND CHAPAI NAWABGANJ DISTRICTS

A Thesis
By

MD. MIZANUR RAHMAN

Examination Roll No.:16AEP JD-34M
Registration No.: 39057
Session: 2011-2012
Semester: January-June/2018

MASTER OF SCIENCE (MS)
IN
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ABSTRACT

This study was undertaken to assess the production trend, growth rate and comparative profitability of major Rabi crops (Boro rice, lentil and wheat) in Barind region. Both primary and secondary data were collected for the study. Primary data were collected through face to face interview method using structured questionnaire. Secondary data covered from the period 1979-80 to 2015-16. Two sub periods (1979-80 to 1999-00 and 2000-01 to 2015-16) and an overall time periods were considered for growth rate calculation. The growth rates of production area, production and yield of Boro rice for the entire periods (1979-80 to 2015-16) in Chapai-Nawabgonj district were 6.6, 8 and 1.4 percent, respectively. In Rajshahi district the growth rates of production area, production and yield of Boro rice for whole periods (1979-80 to 2015-16) were 6.2, 7.9 and 1.6 percent, respectively. In Chapai-Nawabgonj district the growth rates of production area, production and yield of lentil for the entire periods (1979-80 to 2015-16) were -0.6, 0.3 and 0.9 percent, respectively and the growth rates of production area, production and yield of lentil for whole periods (1979-80 to 2015-16) in Rajshahi district were -0.7, 0.6 and 1.3 percent, respectively. Negative sign shows that there is a decrease in growth rate. The growth rates of production area, production and yield of wheat for whole periods (1979-80 to 2015-16) in Chapai-Nawabgonj district were 4.3, 5.8 and 1.5 percent, respectively. In Rajshahi district the growth rates of production area, production and yield of wheat for whole periods (1979-80 to 2015-16) were 1.6, 3 and 1.4 percent, respectively. The Boro rice and wheat production area and production had an increasing trend for Chapai-Nawabgonj and Rajshahi districts. The overall trend of lentil area coverage and production had a decreasing trend for Rajshahi district over the time periods but in Chapai-Nawabgonj district the trend was continually and slowly uprising. The yield of Boro rice and wheat in Chapai-Nawabgonj and Rajshahi districts were sharply fluctuated over time. In case of lentil production, the trend of yield was more steady then the other two crops.

The cultivation of Boro rice, lentil and wheat was profitable from the view point of farmers. The total return per hectare for Boro rice, lentil and wheat were Tk. 190692.40, Tk. 67014.36 and Tk. 91811.95, respectively. The gross cost of Boro rice, lentil and wheat were Tk. 152233.28, Tk. 51247.30 and Tk.65506.81, respectively. Again the net profit of Boro rice, lentil and wheat were Tk. 38459.12, Tk. 15767.05 and Tk. 26305.14, respectively. The Benefit Cost Ratio (BCR) was 1.25, 1.31 and 1.40 for Boro rice, lentil and wheat production, respectively. The results indicated that wheat production was more profitable than the Boro rice and lentil production. The study also showed that farmers faced some problems during Rabi seasons, mainly related to water scarcity and many others. It may be clinched that the farmers should be encouraged to grow more wheat and lentil rather than Boro rice as a means of increasing farm income through diversification of crop production in the area under study.

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ABBREVIATIONS

BAU	: Bangladesh Agricultural University
BBS	: Bangladesh Bureau of Statistics
CSIRO	: Commonwealth Scientific and Industrial Research Organisation
DAP	: Di-Ammonium Phosphate
et al.	: Et alia (and others)
etc.	: Etcetera
Fig	: Figure
FY	: Fiscal Year
GDP	: Gross Domestic Product
GOB	: Government of Bangladesh
ha	: Hectare
HIES	: Household Income and Expenditure Survey
i.e.	: that is
Kg	: Kilogram
Ln	: Natural Log
MoF	: Ministry of Finance
MoP	: Murate of Potash
MS	: Master of Science
MT	: Metric Ton
No.	: Number
pp.	: Page
R^2	: Coefficient of Determination
SDIP	: Sustainable Development Investment Portfolio
SPSS	: Statistical Package for the social Science
Tk.	: Taka
Tonne	: 1000 kg
TSP	: Triple Super Phosphate
USDA	: United States Department of Agriculture
UNESCO	: United Nations Educational Scientific and Cultural Organization

Chapter 1

INTRODUCTION

1.1 Prologue of the study

Water is one of the utmost central inputs indispensable for the production of crops. Plants require it for their life and in enormous amounts. The lack and abundance influences the development and advancement of a plant straightforwardly and, thus, its yield and quality. But this vital resource is not unlimited. Rice production requires abundance of water supply but in our country specially the Barind area has scarcity of this core resource. For the Barind area it is now the demand of situation to produce less water consume crop which has high economic profitability so that farmers would be encouraged to practice that.

A report on 'Bangladesh Integrated Water Resources Assessment: land use, crop production, and irrigation demand' by Mainuddin *et al.* (2014) suggests that net cropped area is decreasing rapidly at a rate of 30,000 ha per year according to the data available from the Bangladesh Bureau of Statistics though some literature suggest a much faster rate recently. Cropping intensity is gradually increasing and recently there are areas where even 4 crops are grown within a year. Aus, Aman and Boro rice together covers about 80% of the total crop area of the country in a year. Wheat and other minor cereals cover about 4% of the total cropped area. Seventy percent of the net cropped area is under Aman cultivation. For Boro and Aus, this is about sixty percent and thirteen percent, respectively. Boro area at the country level appears to have reached the pick as there is no growth in area over the last few years. The area of Aus is gradually declining and the area of Aman is more or less steady. There is significant growth in the area of maize, potato and tomato in the northwest region. The area of other crops at the country level declined due to rise in Boro cultivation. There is a linear growth in the yield of Aus, Aman and Boro rice. Irrigation requirements vary due to the variation in planting date. For Boro rice, transplanting from January onwards would be the most suitable. Due to climate change net irrigation requirements of Boro rice may increase by maximum of about 3% for 2050 dry climate condition. Ninety percent of the total irrigation demand is for Boro rice. The total irrigation demand is not expected to increase much from the current condition as there is no growth in Boro cultivation area in recent years. There is no appreciable impact of climate change on irrigation water demand. Irrigation demand can be reduced significantly by replacing some Boro area with wheat and other non-rice crops such as maize and potato. Further studies are required to understand the impact of reduced irrigation water pumping on the groundwater resources in the context of the regional water balance.

Enlarged groundwater convenience resulting from the enlargement of deep and shallow tube wells helped Bangladesh attain near self-sufficiency in rice, with national output increasing over 15 million tons in the last two decades. Available evidence suggests increasing energy prices are also threatening the sustainability of Bangladesh's groundwater irrigated economy. The attention must be given to the development and management of surface water resources to ease pressure on groundwater. In addition to supply-side solutions, water demand will also need to be curtailed by increasing water use efficiency through the adoption of water conserving management practices, for example reduced tillage and raised bed planting, and the right choice of appropriate crops (Qureshi *et al.,* 2014).

For achieving sustainable agricultural outgrowth and to support ecological poise, the Barind Integrated Area Development Project (BIADP) under the Barind Multipurpose Development Authority (BMDA) was inaugurated during late eighties of the last century in Chapai-Nawabganj, Naogaon and Rajshahi districts which include 25 Upazila (sub-district) in the 'Barind area' at the northwestern part of Bangladesh, covering an area of 7500 km^2 . Out of 5.4 million population 14% were to be the beneficiaries of BIADP irrigation facilities (Kranti Associates Ltd., 2000).

In the area narrow scope to maintain rainwater for irrigation, and dearth of modern agricultural technology resulted in agricultural and socioeconomic backwardness. Groundwater has been the source of irrigation in the agro-based Barind area, with absorption through Deep Tube wells (DTWs) and Shallow Tube wells (STWs). The multi cropping agricultural practices boosted the crop intensity. Certainly, it has been an aspirant task for the BMDA to apply a tremendous program like BIADP with goals like poverty mitigation, human resources development, food security etc.

1.2 Cropping status in Bangladesh

It is known to all that our farmers are the soul of our agriculture. Though they are soul but they don't get the real parity of their hard work. They are unable to break the chain of traditional agricultural practice. Behind this, there are many causes related such as lack of knowledge, information gap, fear about taking new technology etc. Though agriculture sector had also achieved moderately well in the last decade due to enlarged productivity, emerging diversification into value added products. The chief employment sector in Bangladesh is agriculture. The presentation of this sector has an inescapable inspiration on grave macroeconomic objectives like employment generation, poverty mitigation, human resources development, food security etc.

A diversity of Bangladeshis spends their living from agriculture. Though rice and jute are the primary crops, wheat is assuming greater ponderous. Tea is grown in the northeast. Because of Bangladesh's prolific soil and normally plenty water supply, rice can be grown and harvested three times a year in many areas. Due to a number of factors, Bangladesh's labor-intensive agriculture has achieved steady increases in food grain production despite the often unfavorable weather conditions.

Population density continues to place a penetrating burden on productive aptitude, generating a food shortage, especially of wheat. Foreign support and saleable imports fill the gap. Underemployment remains a serious problem, and a growing concern for Bangladesh's agricultural sector will be its capacity to absorb additional manpower. Finding alternative sources of employment will continue to be a daunting problem for future governments, particularly with the growing numbers of landless peasants who already excuse for about half the rural labor force.

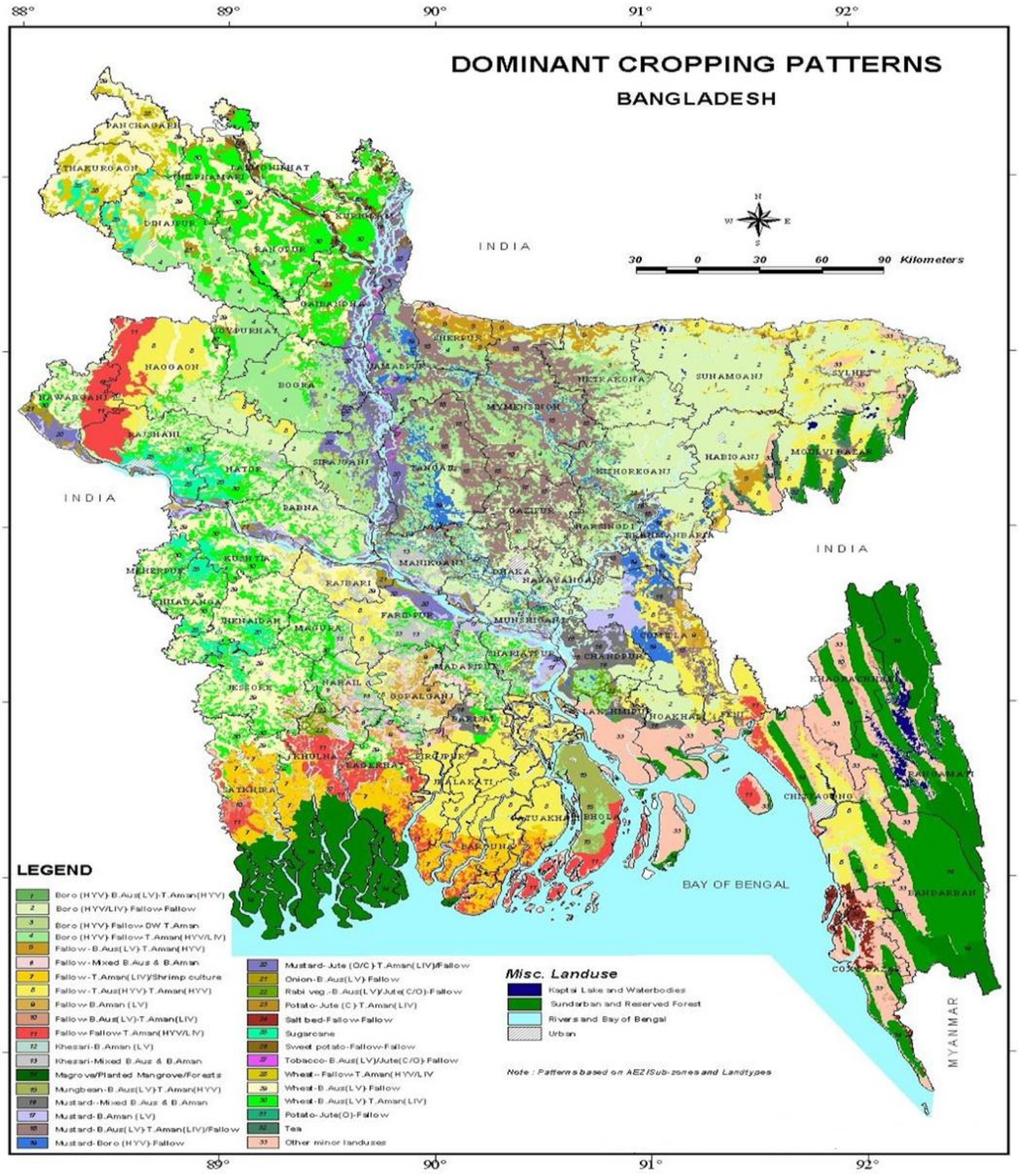
A large percentage of farmers tangled in Boro rice production in dry season which is highly water consuming crops. With the scarcity of water, Boro rice production may not be so much appropriate with response to depleting underground water resource. Therefore, farmers should look forward searching other Rabi crops with high profitability.

1.2.1 Cropping patterns in Bangladesh

The dominant cropping patterns of Bangladesh are shown in the Map 1.1. Most areas allow three crops a year with the exception of the Sylhet hoar basin, the drought-prone areas in the west and the coastal areas. Rice is grown throughout the country with the exception of the Chittagong Hill Tracts. Wheat is predominantly grown in the north-west and in districts along the Padma river. The main vegetables producing areas are in the west around the town of Jashore. The availability of fresh vegetables here may be an important factor for the low incidence of child malnutrition in this area. Cropping pattern is influenced by a host of factors. It is not that the decision about choice of land and crop hinges only on the size of the land owned by a farmer. The other important factors are: subsistence pressure, infrastructural facilities, information base and marketing opportunities (Huq *et al.*, 2013).

It was observed that the dominant cropping pattern decade back was somewhat as follows: production of paddy later followed by keeping the land fallow. This pattern claimed about one-thirds of the total cultivated land in a year. Land under this pattern is much lower in recent years.

Map 1.1: Dominant cropping patterns in Bangladesh



Source: Bangladesh Agricultural Research Council, 2018

Another pattern to notice is paddy followed by paddy. In the past, the proportion of land under this pattern, on an average, hovered around one-thirds of the cultivated land. But there has been a significant decrease in the case of land under triple crops and, possibly, for this reason cropping intensity index has declined over time. Overall, it could be observed that the share of fallow land (after paddy or other crops) has increased from 39 percent to 47 percent in recent years. This is also an interesting development because; (a) farmers have learnt that land also need some rest and (b) economic solvency has reduced the urgency to pursue the earlier pattern. In any case, our discussions on cropping pattern clearly forestall that 70 per cent of the cultivated land in rural Bangladesh is used only for paddy production and only 18 per cent goes to non-paddy crops. It shows that crop diversification till now could not emerge as an attractive option for farmers engaged in the war of food security (Mahmud, 2015).

1.2.1.1 Cropping pattern with land size

Cropping patter can also be looked at from the angle of farm size. First, in comparable periods of 1988 and 2008 for example, the main cropping pattern for small farmers was paddy followed by paddy. That means, after harvesting one paddy crop, farmers used to prepare for growing another paddy crop. But by 2008, marginal departure from the traditional pattern could be observed: instead of going for another paddy, farmers began to leave the land fallow. Of course, this pattern had been a favorite for medium and large farmers for a pretty long time. It appears that small farmers, for the sake of food security, have been tilting towards paddy followed by fallow option rather than paddy followed by paddy option. Second, triple-cropped land seems to be almost on the verge of non-existence.

In the past, there was a trend to grow another non-paddy crop after two consecutive paddy crops. The departure is definitely a sign of improvement as land are not being cultivated as intensively as before with adverse impacts on soil fertility. Third, we notice that, cropping diversification is till now largely a "golden deer". Whatever feeble attempts at crop diversification have been made so far, those were mostly by the small and medium farmers. And finally, an inverse relationship between farm size and cropping intensity can be observed. For small farmers, the intensity declined from 174 in 1988 to 163 in 2004; for large farmers, the index moved down from 169 to 139, respectively (Hossain *et al.*, 2015).

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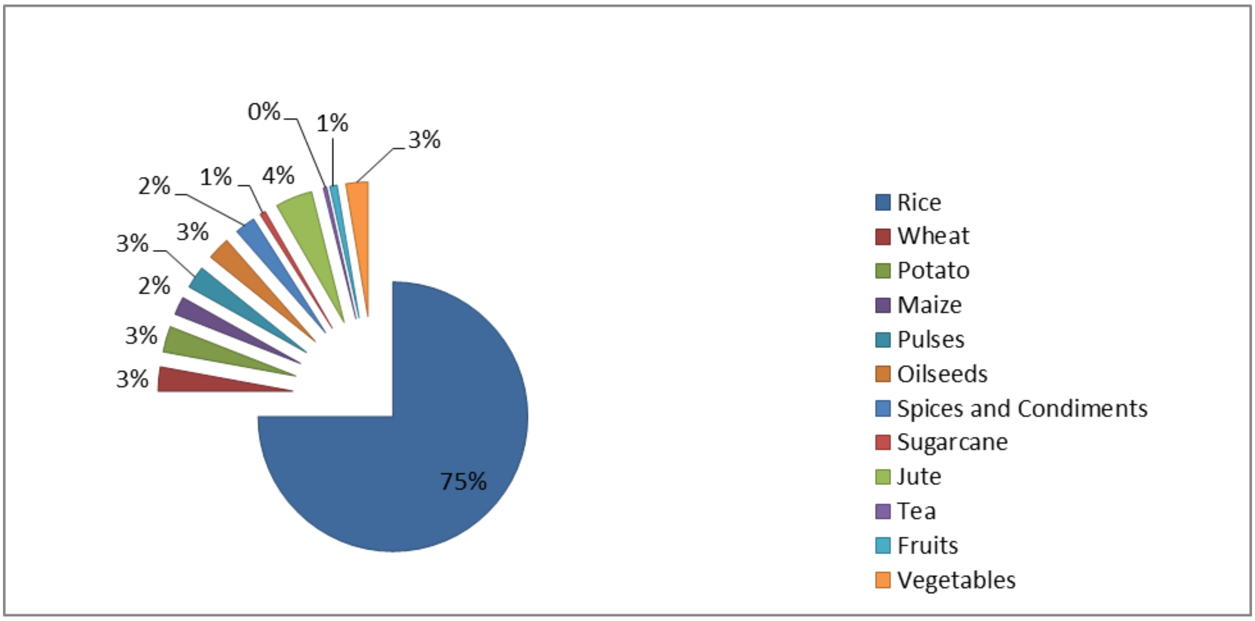
Figure 1.1: Percentages of crop production (Area) in Bangladesh



Source: Yearbook of Agricultural Statistics-2015.

1.2.1.2 Cropping pattern with irrigation

An examination of the cropping pattern and cropping intensity by irrigation status would provide another dimension to the issue under discussion. In areas where the main sources of irrigation are rainfalls and surface water, the cropping pattern is paddy cultivation followed by no cultivation of crop. For example, in 2008, this pattern has claimed 57 per cent of the cultivated land as against 36 per cent in 1988. But this pattern does not seem to suit areas where underground water is mostly used for irrigation purposes (Mahmud, 2015).

The difference between the two areas in terms of cropping patterns is mainly caused by the timely availability of water for irrigation. Second, consecutive two paddy crops are the pattern mainly for users of underground water, although over time the trend has diminished somewhat. For example, in 1988, 60 per cent of the land embraced this pattern - paddy followed by paddy - as against 46 per cent in recent times. In sharp contrast, however, in areas where rainfalls or surface water is used, the pattern of paddy followed by paddy claims 15-20 per cent of land.

Third, possibly for the reasons mentioned just before, a favourite pattern for the users of rainfalls and surface water is paddy followed by a non-paddy crop. Fourth, triple-cropped land had always been low and over time it reduced further. And finally, cropping intensity had always been highest in irrigated land, although it has been declining over time. The tendency to grow only one paddy in irrigated land has been declining but increasing in other modes.

1.2.1.3 Cropping pattern with land topography

In the very low-lying areas, the cropping pattern is paddy cultivation followed by leaving the land fallow, although the pattern is changing over time. The reason behind such pattern could be the early arrival of flood - called early flood. In medium and high land, the main pattern is consecutive two paddy crops i.e. paddy followed by paddy. On the other hand, in all topographic condition, the general pattern is to keep land fallow after growing one non-paddy cop. Crop diversification, in whatever degree takes place, is evident in high and medium land as early flood is unfriendly to vegetables, fruits and cash crops. That is why crop diversification is the lowest in low land and relatively high in medium and high land (Mahmud, 2015).

In existing situation, most of the agricultural production is still condensed on a narrow number of crops and rice continuing to be the most important crop. While cash crops, like sugarcane and jute, have seen their production stagnating or declining over the past decades (BBS, 2016). On the other hand, production of spices and tea has been increased. Production of fruits and vegetables is in good condition.

1.3 Cropping seasons

Because of its tropical location, Bangladesh is able to plant several crops on the same in each year. The crop-growing period is divided into two main seasons, Kharif and Rabi. Crops (such as rice, jute, millets, etc.) which are grown during the Kharif season are called Kharif crops and those (such as wheat, mustard, chickpea, lentil etc.) grown during the Rabi season are called Rabi crops. The Kharif season extends from May through October, while the Rabi seasons starts from November and continues up to April. In addition to these two main seasons, another transition season called Pre-kharif has been identified. This season starts from March-April and ends in May-June.

The major characteristics of the cropping seasons of Bangladesh are described below:

The pre-kharif season is characterized by unreliable rainfall and varies in timing, frequency and intensity from year to year, and provides only an intermittent supply of moisture for such crops as jute, broadcast Aman, Aus, groundnut, amaranths, teasel gourd, etc. During this transition period, soils intermittently become moist and dry. The relative lengths and frequency of such periods depend on the timing and intensity of pre-monsoon rainfall during this season in individual years.

With the expansion of irrigation facilities, some of the pre-kharif crops are now grown under irrigated conditions. These include sugarcane, maize, jute, amaranths, groundnut, banana, sesame, lady's finger, teasel gourd, sweet gourd, white gourd, bitter gourd, balsam apple, ribbed gourd, Indian spinach, ginger, turmeric etc.

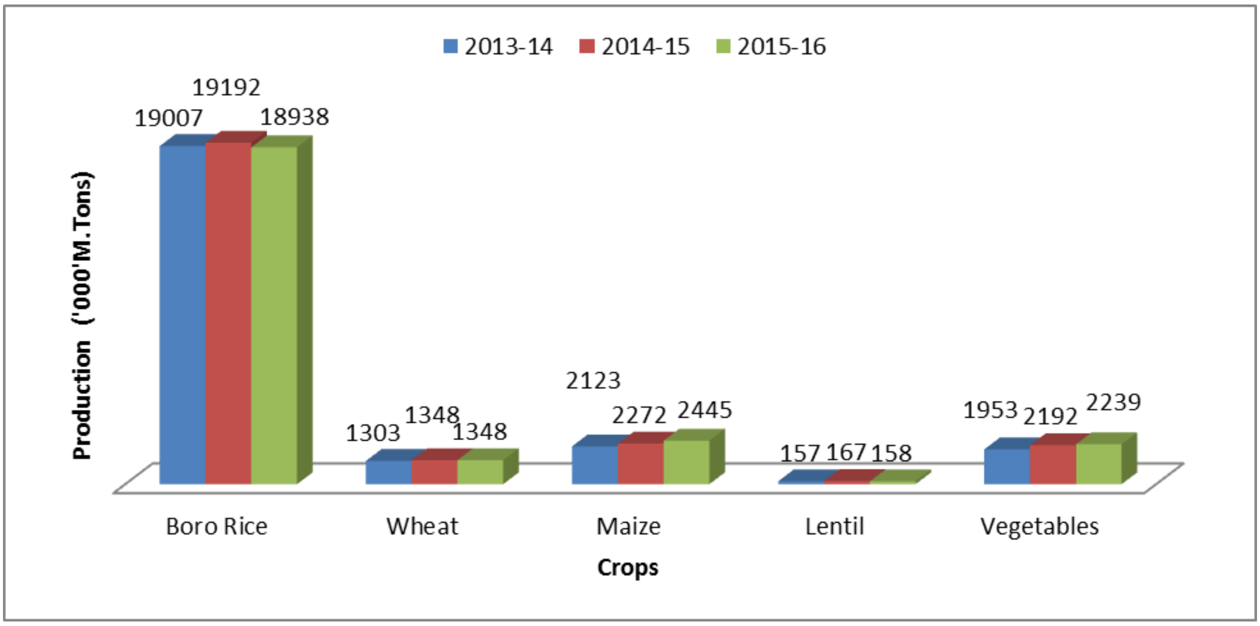
The Kharif Season starts from May when the moisture supply from rainfall plus soil storage is enough to support rain fed or un-irrigated Kharif crops. The season actually begins on the date from which precipitation continuously exceeds 0.5 Potential Evapotranspiration (PET) and ends on the date when the combination of precipitation plus an assumed 100 mm of soil moisture storage after the rainy season falls below 0.5 PET. During the greater part of this season, precipitation exceeds full PET and water can be held on the surface of impermeable soils by bunds. The period of excess precipitation is called the humid period.

The crops most extensively cultivated during the Kharif season are jute, Aus, broadcast Aman, transplanted Aman, sesame, different kinds of summer vegetables, ginger, turmeric, pepper, green chilli, different kinds of aroids, cotton, mungbean, black gram, etc. Most Kharif crops are subject to drought and flood in areas without water control.

The Rabi season starts at the end of the humid period and lasts to the pre-kharif season. The mean length of the Rabi growing ranges from 100-120 days in the extreme west to 140-150 days in the northeast of the country. The mean starting date of the Rabi season ranges from 1 to 10 October in the extreme west, 1 to 10 November in the Northeast, and in central and eastern coastal areas. The mean end dates range from 1-10 February in the following year in extreme west to 20-31 March in the Northeast. Most common Rabi or winter crops are wheat, maize, mustard, groundnut, sesame, tobacco, potato, sweet potato, sugarcane, lentil, chickpea, grass pea etc. On lowlands, very lowlands and bottomlands where flooding continues even after the end of rainy season, the Rabi season starts from the date when flooding ends (Banglapedia-2018).

Rabi crop production from 2013 to 14 to 2015 to 16 given below

Figure 1.2: Rabi crop production in Bangladesh



Source: Yearbook of Agricultural Statistics, 2016.

1.4 Justification of the study

It is eternally true that water scarcity problem is one of the biggest problems in Bangladesh and probably the scenario is the worst in agricultural sector. In most of the cases we are not conscious enough about the real situation at all. Though Bangladesh has large groundwater resources but resources are not unlimited. Every year a large quantity of groundwater is being propelled, mainly for irrigation, domestic and industrial uses. Accessibility of groundwater for irrigation has backed to a manifold upsurge in crop productivity in Bangladesh. Over the past few decades, most of the rivers and canals of the expanse have dried up during the dry season and the people switched their water supply from surface to groundwater. Bangladesh government enthused groundwater development for irrigation in the northwest part of Bangladesh, the Barind tract (Rajshahi expanse) both in the public and the private sectors. Barind Multipurpose Development Authority has accelerated the use of groundwater, installing deep tube wells. Due to the lack of surface water resources, the use of groundwater resources is higher compared to other parts of the country. In case of crop production, food production is dominated by irrigated Boro rice. Boro rice production required large quantity of water and in Barind area, this requirement is meet up with the ground water irrigation. But farmers may have opportunities to make higher benefit by alternative Rabi crops compared with Boro production in response to groundwater irrigation. The present study will help to develop our understanding on the interrelated aspects of major Rabi crop cultivation and choice making in production of alternative Rabi crops rather Boro rice by providing a picture of the benefits and costs of these initiatives. This study will be helpful for the individual farmers for taking effective operation and management of their farms and for the planners for proper planning and policy making. Therefore, this study will be an attempt to see the changing behaviour of major Rabi crops and to undertake a relative profitability analysis of major Rabi crops cultivation with respect to groundwater irrigation in the study areas. The study may be helpful to the extension workers to learn about various problems related to major Rabi crops production and to suggest the farmers for coping with those problems. Researchers who will conduct further studies of the similar nature will be encouraged in conducting more comprehensive and detailed investigation in this particular field of the study.

1.5 Objective of the study

The specific objectives of the study are as follows:

- To identify the socioeconomic characteristics of the sample farmers;
- To examine the changes in major Rabi crops production behaviour in the study area;
- To estimate the comparative profitability of major Rabi crops and
- To examine the potential challenges of crop diversification during Rabi season.

1.6 Materialization of the study

The whole study is consigned in a sound categorization into eight chapters. Chapter 1 designates the introduction of the thesis. In Chapter 2, a brief description of related works is presented. Chapter 3 deals with the methodology of the study. Socioeconomic characteristics of the sample farmers are given in Chapter 4. Production trend of major Rabi crops in the study area are investigated in Chapter 5. Chapter 6 deals with the comparative profitability of major Rabi crops. In Chapter 7, the potential challenges of crop diversification during Rabi season are deliberated. Finally, in Chapter 8, summary and conclusion are revealed.

Chapter 2

REVIEW OF LITERATURE

A study principally begins with the review. The more we make review the more we have the transparent scenario for the whole picture. In case of any research the previous literature, journals, papers or any kinds of books make the required research easy and have good idea about the research. This chapter aims at represent some review of the past research works that are related to the present study. The researcher made an elaborate search of available literature for the above purpose. A few researches have been done on Rabi crops production in Bangladesh partly. Some important studies related to this study have been conducted in the recent past, are discussed below:

Sujan *et al.* (2017) analyzed the profitability and resource use efficiency of Boro rice cultivation in Bogura district of Bangladesh using farm level survey data of April-May, 2016. In total 103 farmers were selected randomly from the study area. Result based on Farm Budgeting model showed that per hectare variable cost and total cost of production was BDT 57,583 and BDT 71,208 respectively. Average yield was found 4.112 ton which was more than the previous year's national average yield of 3.965 ton. The average gross return, gross margin, and net return were BDT 86,548, BDT 28,965 and BDT 15,340 respectively. Benefit-Cost ratio (BCR) was found 1.22 and 1.50 on full cost and variable cost basis. Cobb-Douglas production function analysis showed that the key production factors, that is, human labour, irrigation, insecticide, seed and fertilizer had statistically significant effect on yield. MVP and MFC ratio analysis showed that growers allocated most of their resources in the rational stage of production.

The study conducted by **Sumiya (2016)** examined the scenario of groundwater level with respect to rainfall mutability and its use for irrigation purpose for rice production in Bangladesh. The groundwater level is drowning at a higher rate in northern parts of the country than the southern parts. On the behalf of climatic variability, excessive use of groundwater can trigger the lowering of groundwater level which will require more energy to uptake water for irrigation and so the input cost of production of rice will be increased. Exploration shows the increasing dependency on groundwater than on surface water for irrigation purpose at varied range across the country.

Kirby ***et al.*** **(2014)** found that the overall use of groundwater by irrigation, except in a few small districts has not been quantified in Bangladesh and this use has not been compared to recharge to test notions of sustainability. Climate change projections are uncertain, with increased rain in the wet season likely, but decreased rain also possible. The projections with more rain may lead to increased recharge and runoff, and increased water availability. However, increased projected potential evapotranspiration may also lead to increased irrigation requirement. Climate variability, at least to 2050, is projected to have a greater impact on regional water balances than climate change. The increased use of surface water, particularly when combined with an increase in irrigation overall, may lead to greater recharge and some restoration of groundwater levels.

Qureshi ***et al.*** **(2014)** cited in a study that at present, 35,322 DTWs are working in Bangladesh to provide water for irrigation purposes. Thus groundwater irrigation is of vigorous significance as an input to the agricultural economy and for food security. He also mentioned that the major supply of groundwater for irrigation is from shallow tube wells, the figures of which have grown from around 100,000 in the early 1980s to more than 1.5 million in 2010.

Dey ***et al.*** **(2013)** mentioned in a study that groundwater has been used extensively since before and this increasing rate of groundwater use may threaten the prevailing groundwater source. They also found a waning trend of groundwater table over the last 30 years (1981-2011) in their study, which point toward groundwater use is not sustainable in northwest region. They recognized the increase of irrigation cost if the rate of enslavement on groundwater for irrigation purpose increases. It is also clearly conclude that severely depleted district as Rajshahi followed by Pabna, Bogura, Dinajpur and Rangpur.

Shyful (2012) examined the price behaviour of rice in Bangladesh. This study attempted to analyze the price behavior of rice in terms of price fluctuation, price instability, price trends and spatial price relationship of rice in different markets in Bangladesh. It identified the causes of price movements on the basis of data on the variations of area, yield and production of rice. This study was entirely based on secondary data which were collected for 1974-75 to 2010-11 from different sources and especially from DAM. Correlation coefficient and Engle-Granger co-integration tests were used as a tool for studying integration among selected surplus and deficit district markets. It was observed from the study that annual price of rice fluctuated to a great extent and was higher than area, yield and production fluctuations. Price fluctuation was highest (-36.70 to 34.29 per cent) in the period IV (2001-02 to 2010-11) and lowest (-7.0 to 8.54 percent) in the period II (1981-82 to 1990-91). The extent of annual fluctuation of production was found to be highest (-6.70 to 15.89 percent) in period III (1991-92 to 2000-01).Annual rice area fluctuation was high (-8.39 to 8.32) in period IV (2001-02 to 2010-11) and the yield fluctuation was high (-3.70 to 11.84) in period II (1981-81 to 1990-91). Relatively most stable period for prices was found in the period II (1981-82 to 1990-91). For every trend line it was found that for the period III (1991-92 to 2000-01) and IV (2001-02 to 2010-11) deviation from the trend line was high. This study said that higher price instability influenced area instability and higher area yield instability influenced production instability.

Rahman ***et al.*** (**2012**) conducted a study in Jhenaidah and Jashore districts to determine the adoption status and profitability of BARI lentil production and to examine the factors affecting the yield of BARI lentil during 2010-2011. Cobb-Douglas production function was used. The study revealed that 98% of the total lentil cultivated areas were occupied by BARI lentil varieties in the study areas. The average level of adoption of BARI Masur-3, BARI Masur-4, BARI Masur-5 and BARI Masur-6 were 49%, 47%, 1% and 1%, respectively at farm level. The cultivation of BARI lentil was profitable to the farmers since the per hectare total cost, gross return and net return of BARI lentil cultivation were Tk. 52,734, Tk. 80,572 and Tk. 27,838, respectively. Functional analysis revealed that seed, urea, mechanical power cost and pesticides had positive effect on the yield of lentil production. Unavailability of latest BARI lentil seed, lack of technical know-how, lack of training, and diseases (root rot and stemphylium blight) were the main constraints to BARI lentil cultivation at farm level. BARI Masur-3 and BARI Masur-4 were the highly adopted varieties. The lentil production was profitable to the farmers in the study areas.

The study conducted by **Gogoi and Bordoloi (2011)** in Asam indicates that Rabi crops have enormous potential in the study area despite a number of constraints being faced by the farmers. It is found that in order to achieve the desired level of productivity of Rabi crops the Government of Assam must come up in an effective way in creating basic infrastructural facilities and in co-ordination with related departments. A selective 'area approach' has been considered more effective to consolidate the situation and to boost up the production of Rabi crops. The study highlighted that major thrust should be given on progress of irrigation, dissemination of new technology and assured input supply with strong marketing support.

John and Maanikuu (2011) conducted a study to presents an analysis of the responsiveness of rice production in Ghana over the period 1970-2008. Annual time series data of aggregate output, total land area cultivated, yield, real prices of rice and maize, and rainfall were for the analysis. This study found that the land area cultivated for rice was significantly dependent on output, rainfall, real price of maize and real price of rice.

Hossain (2010) conducted a study to determine the growth rate and measure the change and instability of area, production and yield of rice, wheat, maize, potato, tomato and jute in Bangladesh. In order to examine the nature of change, instability, and degree of relationship in area, production, and yield of different cereal and vegetable crops in Bangladesh, various statistical measures, such as mean, correlation co-efficient and co-efficient of variation were work out. Time series data on area, production, and yields of different cereal crops for 26 years from 1980-81 to 2005-06 were collected from BBS record. In order to examine the nature of change, instability, and degree of relationship in area, production, and yields of different cereal crops in Bangladesh, various statistical measures, such as mean, correlation co-efficient and co-efficient of variation were worked out. Simple liner regression model were fitted to examine the change of production by the change of area.

Shahid (2010) portrayed that to attain sustainable groundwater use, it is necessary to go for an action plan such as groundwater recharge using various structural and non-structural measures, use of drought tolerant crop variety, crop rotation or cropping pattern change, uplift of technical performances of existing technologies, introduction of apposite technologies, social interventions such as awareness development, etc. He also mentioned that there would be no appreciative changes in total irrigation water requirement due to climate change. As groundwater is the core source of irrigation in northwest Bangladesh, higher daily pumping rate in dry season may exasperate the situation of groundwater scarcity in the region.

Jahan *et al.* (2010) found that the northwest region of Bangladesh approximately covers the whole Rajshahi and Rangpur divisions entailing of 16 districts with a total cultivable area of about 1.45 million acres. BMDA has been operating about 13,000 DTWs together with other STWs (about 1,34,884) for supporting irrigation facilities in the region. Different studies have documented that groundwater levels have declined substantially during the last decade causing threat to the viable use of water for irrigation in this region impacting other segments too.

Rahman and Hasan (2011) conducted a study and found that wheat production is very sensitive to environmental production conditions and managerial practices. The present chapter first provides a detailed account of the profitability and production practices of wheat cultivation in Bangladesh using a sample survey of 293 households from three regions. The chapter then examines the effect of environmental production conditions and managerial factors on wheat yield using a reduced form regression analysis. Results reveal that wheat cultivation is profitable as indicated by Benefit-Cost Ratio of 1.41 with significant variation among regions. There are significant variations in production practices of wheat cultivation across regions as well. A host of environmental and managerial factors adversely affect wheat yield explaining a substantial 77% of variation in its yield performance. Wheat yield is significantly lower in low lying areas and poor soils. Also, yield is significantly affected by pest infestation and weather variations. Among the managerial factors, farmers' education and access to various sources of agricultural information significantly improves wheat yield, whereas a delay in sowing and fertilization significantly reduces yield. Farm size category as well as geography does matter. Productivity of wheat is significantly higher for large farmers whereas it is significantly lower in Jamalpur region. Policy implications include soil fertility improvement; development of wheat varieties that are suitable for low lying areas and are resistant to insect/pest attacks as well as can withstand weather variations; improvement in managerial practices through extension services; and investment in farmers‘education.

Rashid *et al.* (2009) conducted a study in the Barind area and found that on an average, the evapotranspiration rate was 5.1 mm/day and the seepage and percolation (S&P) rate was 4.2 mm/day in Boro season. These two values validate that 55% of the applied water was needed for ET and the rest 45% is lost from the field as seepage and clarification. Irrespective of seasons and years around 50% of the irrigation water is needed for ET and the rest 50% is lost through S&P annually from the double cropped rice fields. The water productivity was 0.58 kg/m3 of water in Boro season and 0.49 kg/m3 in *transplant Aman* season. The relative water supply (supply: demand) was 1.15 and 0.90 in Boro and *transplant Aman* seasons correspondingly.

Ahmed *et al.* (2009) found that the cultivation of Boro rice and potato was lucrative from the sight point of farmers. The per hectare total return from Boro rice and potato were Tk. 83,320.00 and Tk. 2,62,625.22 correspondingly. The gross cost of Boro rice and potato production were Tk. 54,202.74 and 1,20,221.71 respectively. Again the net return from Boro rice and potato were Tk. 24,117.26 and 1,42,403.51 respectively. The Benefit Cost Ratio (BCR) was 1.41 and 2.18 respectively for Boro rice and potato production. The results specified that potato production was more profitable than Boro rice production. It was also found that per hectare net returns were influenced by most of the factors comprised in model.

Mazid and Haque (2007) conducted a study on Monga mitigation for employment and food security increase through early Aman rice production and crop diversification in greater Rangpur region of Bangladesh). They mentioned that early Aman Rice-Potato-Mungbean gave lower productivity than Rice-Potato-Relay Maize/Maize but Mungbean added some biomass in the soil for soil health. It is also found that ushering of cash crop in potato growing time (early to late November) contributed more productivity (32.4-39.3 MT/ha) than Rice-Non-Rice system as Rice-Rice (13.2 MT/ha.

Islam *et al.* (2007) carried out a study to give it a try the income and price elasticities of demand for various types of rice in Bangladesh. The total budget for cereal field allocated to aromatic, fine, course rice and wheat was 4.0%, 23.3%, 65.2% and 7.5% respectively. It is also calculated that expenditure elasticities of demand for those types of cereal were 0.85, 0.79, 0.29 and 0.55 correspondingly. It was also found that the expenditure elasticities of demand for aromatic and coarse rice were higher for rural households compared with urban households, while the expenditure elasticities of demand for fine rice and wheat were higher for urban households. Considering all other factors remaining unchanged, the uncompensated and compensated own-price elasticities of demand for coarse rice would fall by 7.7% with a 10% increase in its price. These falls were 7.4%, 11.170, and 4.6% for aromatic, line rice, and wheat, respectively. The estimates of uncompensated cross-price elasticities between coarse-to-fine rice showed that a 10% increase in absolute income associated with a 10% increase in real income due to fall in coarse rice price would increase the actual demand for fine rice by 4.6%.

Awal ***et al.*** (2007) carried out a research at farmer's field in Sherpur district to gauge the comparative performance of two hybrid rice varieties, Sonarbangla-2 and Sonarbangla-3 with three conventional modern commercial varieties BRRIdhan32, BRRIdhan33 and BR11 in Transplanted Aman season of 2003. It is revealed that the hybrids and conventional rice varieties differed significantly among themselves with respect to different parameters under study. The highest grain yield (6.20t/ha) was recorded from the hybrid Sonarbangla-3 followed BRRIdhan-32 (5.70 t/ha) and the lowest in BRRIdhan-33 (4.17t/ha) and these differences were statistically significant. However, BRRIdhan-32 obtained significantly higher yield compared to the hybrid Sonarbangla-2. Further, it produced the maximum amount of straw (8.6 t/ha), which varied significantly with all others. Minimum days to 1st flowering (92) and maturity (108) were noticed in Sonar bangla-2 followed by Sonarbangla-3 (95 and 115), respectively. Both the hybrid had heavier grain weight (28.33-31.00g) than those of the conventional varieties (22-25g). It is noted that the hybrids maintained distinct statistical edge over the conventional varieties with regard to most of the parameters.

The study conducted by **Wahid** ***et al.*** **(2007)** showed that due to spatial variation in abstraction, nine out of 21 *thanas* (sub-districts) in the Teesta Barrage project area may still be able to expand groundwater-irrigated cropland and a groundwater use potential of 40 mm/year may be created if deep-set shallow tube wells are used by the farmers to abstract groundwater. A structured obtainment, based on zoning of potential areas, is recommended for groundwater improvement and use. It is also found that the economically alluring high-yielding variety (HYV) Boro (dry season) rice cultivation during the groundwater irrigation season might not sustain in remarkable parts of the project area (Teesta Barrage Project in Bangladesh), if the current trends in abstraction are continued.

Shishir (2006) conducted a study on production and marketing of aromatic rice in selected areas of Mymensingh district to evaluate the profitability of production and marketing system of aromatic rice. A total 90 farmers and 35 traders were selected purposively as sample from the selected areas of Mymensingh district. Among the aromatic rice varieties Kalijira, Chinisagor and BR-34 were selected. Costs and returns were calculated separately to find out the financial profitability of these varieties. Per hectare total cost for kalijira, Chinisagor and BR-34 rice were estimated at TK. 24850.02, Tk. 19368.69 and Tk. 26861.33 respectively. Farmers needed comparatively less amount of fertilizers, insecticides, irrigation care to produce aromatic rice varieties. Per hectare yield of Kalijira, Chinisagor and BR-34 were 2367.34 kg., 2275.23 kg, and 2878.26 kg separately. It should be mentioned that the yield was comparatively lower than the HYV varieties. The high market price and low production cost of these varieties, made the farmers satisfied moderately. The study also identified some problems faced by the farmers and intermediaries in marketing of aromatic rice.

Shahabuddin and Dorosh (2002) conducted a study on comparative advantages of crop production in Bangladesh. In their study, the economic profitability analysis exhibits that Bangladesh has a comparative advantage in native production of rice for import substitution. However, at the export equivalence price, economic profitability of rice is generally less than economic profitability of many non-rice crops, suggesting that Bangladesh has more profitable options other than production for rice export. Numerous non-cereal crops, including vegetables, potatoes and onions have financial and economic proceeds then rice production.

Ali (2000) endeavored to measure and compare resource use and land productivity within tenure groups. Total gross cost for producing Aman, Boro and Aus were the highest in owner farms and the lowest in tenant farms. It detected that owner operators used higher level of inputs than owner-cum-tenant and tenant operators. Rice owner-cum-tenant operators obtained higher yield in Aman and Aus production then owner and tenant operators. In Boro paddy production tenant operators obtained maximum net return than owner operators and owner-cum-tenant operators in owner land. Finally, it was clinched that tenancy distresses positively on resource use and production in a expectable manner even in small scale farmer agriculture.

The growth of production area, production and yield had been estimated in some previous studies mostly on national basis, but this study has provided these indicators with latest data in district level.

There were some studies that compared the profitability of different seasons' rice, different varieties of rice or different crops. But there was no such study found that addressed the comparative analysis of Rabi crops which compete with each other for using groundwater, especially in the Barind tract. This particularly motivated the researcher to undertake the current study. However, the review of previous studies helped the researcher to understand the overall groundwater utilization picture and crop economy of Bangladesh. This research also helped in materializing the research concept and methods for the current research. Therefore, the researcher acknowledges this literature review as a useful part of his research.

Chapter 3

METHODOLOGY OF THE STUDY

3.1 Introduction

Research design is an arrangement of the essential conditions for collection and analysis of data relevant to research purposes. The design aspect of a research study especially in the field of social sciences is very complex. This chapter discussed the methodology used for the study. Methodology is an indispensable and integrated part of any research. It needs very careful and sincere consideration. For the present study, both desk research and farm survey methods were used to collect data. The methods and approaches that followed in this study are described below.

3.2. Design of the study

The research design refers to the overall strategy that one chooses to integrate the different components of the study in a compatible and logical way which ensures that the research problem has effectively addressed. It constitutes the blue print for the collection, measurement and analysis of data. Research problem determines the type of research design that should be used.

3.2.1 Selection of the study region

"The area in which a farm business survey is to be carried out depends on the particular purpose of the survey and the possible cooperation from the farmers" (Yang, 1965).

Selection of the study region is an important phase for the farm management research. Barind Tract envisages the largest Pleistocene physiographic unit covering an area of about 7,770 sq km of the Bengal basin. It has long been avowed as a unit of old alluvium, which dissent from the condensed flood plain. In Bangla, it is spelled and pronounced as *Varendra Bhumi*. Geologically this unit lies roughly between latitudes 24'20'N and 25'35'N and longitudes 88'20'E and 89'30'E. This physiographic unit is circumscribed by the Karotoya to the east, the Mahananda to the west, and the northern bank of the Ganges to the South. An inferior fault scarp marks the eastern edge of the Barind Tract, and the little Jamuna, Atrai and Lower Punarbhaba rivers occupy fault troughs. The western part of this unit has been slanted up; parts of the western edge are more than 15m higher than the rest of the tract and the adjoining Mahananda floodplain (Banglapedia-2018).

The areas (Godagari upazila and Nachole upazila) have been identified by the SDIP-II project as high groundwater scarce areas and therefore, the present study selected Godagari upazila of Rajshahi district and Nachole upazila of Chapai-Nawabgonj district as the study areas to achieve the objectives of the present study.

The other reasons for selecting the study region were as follows:

i. The area represented the same agro-ecological characteristics under Barind areas.

ii. These were typical Rabi crops growing areas with representative soil condition, topography and same irrigation pattern.

iii. Co-operation from the respondents along with Agricultural Extension Officer (AEO), Sub Assistant Agricultural Officer (SAAO) were expected to be high.

iv. Easy accessibility and good communication system existed in the selected villages.

3.2.2 Brief description of the study areas

Godagari upazila (Rajshahi district) consists of 472.13 sq km, located in between 24°21' and 24°36' north latitudes and in between 88°17' and 88°33' east longitudes. It is bounded by Chapai- Nawabgonj and Tanore upazilas on the north, West Bengal of India and Ganges river on the south, Paba and Tanore upazilas on the east, Chapai-Nawabganj Sadar upazila on the west. Godagari thana was formed in 1865 and it was turned into an upazila in 1983. The upazila consists of 9 union and 398 villages. Total population is 279545; male 143202, female 136343; Muslim 242733, Hindu 20944, Buddhist 9476, Christian 186 and others 6206.

Map 3.1: Godagari upazila of Rajshahi district.

Source: LGED, Bangladesh

Average literacy rate is 42.1%; male 43.6%, female 40.5% besides there had 12 College, 60 secondary schools, 140 primary school, 20 madrasha. People are involved with various occupations. The sources of income are Agriculture 69.98%, non-agricultural labourer 3.95%, industry 0.57%, commerce 11%, transport and communication 1.99%, service 4.61%, construction 1.15%, religious service 0.16%, rent and remittance 0.27% and others 6.32%. 11.58% (rural 9.85% and urban 23.26%) of dwelling households of the upazila use sanitary latrines and 40.99% (rural 38.40% and urban 59.16%) of dwelling households use non-sanitary latrines; 47.43% of households do not have latrine facilities. (Sources: Bangladesh Bureau of Statistics, Banglapedia- 2018).

Nachole upazila (Chapai-Nawabganj district) consists of 283.68 sq km, located in between 24°38' and 24°51' north latitudes and in between 88°15' and 88°21' east longitudes. It is bounded by Gomastapur upazila on the north-west, Chapai-Nawabganj sadar upazila on the south-west, Tanore upazila on the south-east, Niamatpur upazila on the north-east. The soil of this region is very congenial to the production of paddy.

Map 3.2: Nachole Upazila

Source: LGED, Bangladesh

Nachole thana was formed in 1918 and it was turned into an upazila in 1984. It has 4 union, 201 mouza and 197 villages. Nachole has a population of 146,627. 72,895 of them are males and 73,732 of them are female. Males constitute 49.71% of the population, and females 50.29%. This Upazila's eighteen up population is 89,267. Nachole upazila has an average literacy rate of 45.5% (7+ years). It has 7 college (including 1 government college), 3 technical college, 34 secondary school (including 1 government school), 77 primary school and 18 madrasha. People are involved with various occupations. The sources of income Agriculture 73.27%, non-agricultural labourer 4.91%, industry 0.29%, commerce 9.38%, transport and communication 1.25%, service 3.54%, construction 0.67%, religious service 0.09%, rent and remittance 0.08% and others 6.52%. Main agricultural crops are Paddy, wheat, pulse, vegetables. Sources of drinking water may mentioned as Tube-well 94.32%, tap 2.41%, pond 0.45% and others 2.82%. 9.77% (rural 7.65% and urban 35.84%) of dwelling households of the upazila use sanitary latrines and 42.19% (rural 42.16% and urban 42.62%) of dwelling households use non-sanitary latrines; 48.04% of households do not have latrine facilities.(Sources: Bangladesh Bureau of Statistics, Banglapedia, 2018)

3.2.3 Sampling technique

In selecting samples for a study two factors need to be taken into consideration. The sample size should be as large as to allow for adequate degrees of freedom in the statistical analysis. On the other hand, administration of field research, processing and analysis of data should be manageable within the limitation imposed by physical, human and financial resources (Mannan, 2001).

It was not possible to include all the farmers in the area studied due to limitation of time, money and personnel. A simple random sampling technique was followed in the present study for minimizing cost, time and to achieve the ultimate objectives of the study. Two unions of Godagari and Nachole upazilas were selected purposively. Two lists of farmers who cultivated Rabi crops, were collected with the help of agricultural extension personnel of the study area. A total number of 149 farmers, 23 farmers for lentil, 16 farmers for wheat and 110 farmers for Boro rice were then randomly selected from the lists. Since, most of the farmers in the study area produce Boro rice, the number of farmers for Boro rice was comparatively higher than lentil and wheat. The researcher tried his best to increase the sample size for lentil and wheat but could not find enough farmers who cultivate lentil and wheat. Therefore, a compromising sample size had to take to fulfill the research objectives.

3.2.4 Preparation of survey schedule

From the pilot study it was found that Boro rice, lentil and wheat are the major Rabi crops in the study area. Therefore, a comprehensive survey schedule was set to collect necessary information from the farmers in such a way that all the factors in the production of Boro rice, lentil and wheat could be included in conformity with the objectives of the study.

As the survey mainly depends on the preparation of the survey schedule, it was, therefore, pretested to verify the relevancy of the question and nature of response of the respondents. The necessary adjustments were made and a final survey schedule was developed.

3.2.5 Period of study

Since farming is a seasonal practice, a farm business survey should cover a whole crop year in order to have a complete sequence of crops. The researcher must determine to what extent the information for a particular year represents normal or average conditions, particularly for crop yields, annual production and price level.

The data collection period was January to March of 2018. Besides these, secondary data were collected from different published and un-published sources between the whole research period.

3.2.6 Collection of data

Both primary and secondary data were needed for the present study. Secondary data were collected from BBS and different project reports. Primary data were collected through field survey. Collection of accurate and reliable data and necessary information from field is not an easy task. Reliability of data mostly depends on the methods of data collection. For accuracy of the survey, schedules must be explicit.

After the preparation of the final schedules, data were collected as part of project's survey, with other enumerators, the researcher himself also worked as enumerator in data collection. Interview schedules mainly designed to collect information from farm owner through direct interviews. Before asking questions, the aim and objectives of the study was explained to the respondent. When they were convinced that the study was purely an academic one and had no adverse effect on their business, the interview was started. In order to minimize errors, data were collected in local units and these were subsequently converted into appropriate standard units.

3.2.7 Accuracy of the data

Adequate measures were taken during the period of data collection to minimize the possible errors.

The measures taken were:

i. Built-in-check in the interview schedule

ii. Field checking and

iii. Independent re-interviewing of the respondents.

In case of any inconsistency and lapse, the neighboring farmers were asked for necessary verification and data were checked and corrected through repeated visits. In order to ensure consistency and reliability of the parameters being generated out of the data, follow up visits were also made to the field to obtain supplementary data. Data were collected at farmer's house as well as in the field when they were not busy.

3.2.8 Data processing

The collected data were entered into MS Excel sheet and necessary cleaning and coding were done. After that the collected data were summarized and scrutinized carefully before the actual analysis was done.

3.3 Analytical technique

To eliminate compensating, and non-compensating errors and biasness, all data were carefully checked for completeness and summarization. Then it was transferred to MS excel sheet and SPSS in a systematic way for analysis. Necessary perambulation tasks were accomplished before finalizing of tabulation. Then data were analysed on the basis of the aims and objectives of the research using various tools and techniques. To meet particular research objective, several analytical methods were employed in the present study. Tabular and graphical methods were used for a substantial part of data analysis. This technique is intensively used for its inherent quality of purporting the true picture of the farm economy in the simplest form. Percentage and arithmetic mean or average were employed to analyze data and to describe socioeconomic characteristics of lentil, wheat and Boro rice growers. The specific statistical techniques used in the present study are described below.

3.3.1 Growth analysis

Growth rates of production area, production and yield were estimated for examining the growth performance of the Boro rice, lentil and wheat. To know the growth of production area, production and yield of Boro rice, lentil and wheat of Rabi season in Rajshahi and Chapai-Nawabganj districts for the period of 1979-80 to 2015-16, the following exponential growth (semi-log) model (Gujarati, 2003) was used:

$Y_t = ae^{bt}$

In linear form this can be written as

$\ln Y_t = a + b_t + u_t$ ……………..(1)

Where, Y_t = production area/production / yield of selected Rabi crops in year t

a= intercept

b = coefficient, refers the growth rate in ratio scale when multiplied by 100, it expresses percentage growth.

t= independent variable (time) and

u_t = disturbance term

This model was used by many researchers (i.e. Qureshi, 2015; Barua, 2001; Jahan, 2002) for measuring the growth rates.

3.3.2 Trend analysis

Trend refers to persistent and systematic upward (or downward) movements in economic variables (Tomek and Kaiser, 2014). So, upward and downward movement of annual time series data of production area, production and yield can be treated as production area, production and yield trend respectively. Analysis of trend component in annual series involves ascertaining the general direction of the movement over a period of several years. The general direction should be such that movements in one or two years away from this direction have the tendency to return in subsequent years. The trend is generally expressed in terms of a straight line. In some cases it becomes necessary to divide the series in two or more parts so as to represent varying trends during different sub-periods. In terms of statistical or econometric analysis, any shape of the curve which best fits under consideration should be selected and estimated.

3.3.3 Profitability analysis

To run the profitability analysis information on amount and price of different inputs and outputs related to Boro rice, lentil and wheat production were used.

3.3.3.1 Gross return

The following equation is used to examine the costs and returns of major Rabi crops production.

$GR_i=\sum_{i=1}^{n}(Qm_i Pm_i) + \sum_{i=1}^{n}(Qb_i Pb_i)$

Where,

GR_i = Gross return from ith product (Tk./ha)

Qm_i = Quantity of the ith main product (kg/ha)

Pm_i = Average price of the ith main product (Tk./kg)

Qb_i = Quantity of the ith by product (kg/ha)

Pb_i = Average price of the ith by product (Tk./kg)

i = 1,2,3, … n

3.3.3.2 Net return

Net return was calculated by deducting all costs (variable and fixed) from gross return. To determine the net return of major Rabi crops the following equation will be used in the study

$\pi = P_y Y - \sum_{i=1}^{n} (Px_i X_i) - TC$

Where,

π = Net return (Tk./ha)

P_y = Per unit price of the product (Tk./kg)

Y = Quantity of the product per hectare (kg)

Px_i = Per unit price of ith inputs (Tk.)

X_i = Quantity of the ith inputs per hectare (Kg)

TC = Total cost (Tk.)

i = 1,2,3, …, n (number of inputs).

3.4 Problems faced in collecting data

In conducting a field survey, a researcher faced some problems during the period of data collection.

- A problem was that the researcher had to depend exclusively on the commemoration of the farmer for collecting necessary information, as they do not keep written records. Therefore, some information were found inconsistent and needed to be checked again with the farmer.
- It was often occurred that farmers were involved in irrelevant talking instead of giving necessary information.
- In the area most of the farmers are involved in Boro rice production than other crops so other Rabi crops producers were difficult to find.

- Farmers were so busy in their field that it was often happened that they were not interested to give enough time for the questionnaire. The researcher had to spend significant time to motivate farmers.

Chapter 4

SOCIOECONOMIC CHARACTERISTICS OF SAMPLE FARMERS

4.1 Introduction

The aim of this chapter is to present a brief description of the socioeconomic characteristics of the farmers. Socioeconomic characteristics have a very important issue to a great extent. It is the reflection of individual's positive and negative qualities. Socioeconomic aspects of the farmers can be looked at from different points of view depending upon a number of variables related to their level of living, the socioeconomic environment in which they live and the nature and the extent of the farmers' participation in farm activities. It was not possible to collect all the information regarding the socioeconomic characteristics of the sample farmers due to limitation of time and resources. Socioeconomic characteristics of the farmers affect their production pattern and the decision-making behaviour is also determined to a large extent by it. It affects the adoption of innovations. The socioeconomic background of the sample farmers particularly the family size and composition, age, literacy level, occupation, land ownership pattern and its distribution etc. are discussed in this section.

4.2 Composition of the family size

Family size is important in relation to production of enough food grain for farm family. In this study, a family has been defined as a unit in which a number of persons live together under the administration of one family head and take meal from the same kitchen. It includes wife, children, brother, sister and parents. If any person of a family is employed outside but takes meals from the same kitchen while at home and shares income and expenditure of the family, he or she has been considered to be a family member. The family members considered as wife, sons, unmarried daughter, father, mother, brother and other relatives who live permanently in the family.

Table: 4.1 Family composition of sample farmers

Family Composition	Boro rice Grower			Lentil Grower			Wheat grower		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Family size	2.64	2.35	4.98	3.17	2.13	5.09	2.25	2.31	4.56
Working Family Member	1.58	0.78	2.36	1.61	0.86	2.43	1.56	1.44	3.00
School going children	1.08	0.74	1.80	1.56	0.44	2.00	0.83	0.92	1.75

Source: Field Survey 2018

From the Table 4.1 we can see that the average family sizes for Boro rice, lentil and wheat growers were 4.98 persons, 5.09 persons and 4.56 persons respectively. For Boro rice growers 2.64 members were male and 2.35 members were female. On other hand in case of lentil growers 3.17 persons were male and 2.13 persons were female and in case of wheat growers 2.25 persons were male and 2.31 persons were female.

According to household income and expenditure survey (HIES) conducted by Bangladesh Bureau of Statistics (BBS-2016) the average family size in Bangladesh is 4.09 which is lower than the result obtained from the present study. Probable reason for the variation may be the survey conducted all over the country but in this study survey was confined in rural area as till now combined family is more popular in rural area than urban.

The result also shows that average working members for Boro rice, lentil and wheat growers were 2.36 persons, 2.43 persons and 3 persons, respectively. For Boro rice growers 1.58 members were male and .78 members were female. On other hand in case of lentil growers 1.61 persons were male and 0.86 persons were female and in case of wheat growers 1.56 persons were male and 1.44 persons were female (Table 4.1).

Average school going children for Boro rice, lentil and wheat growers were 1.80 persons, 2 persons and 1.75 persons respectively. For Boro rice growers 1.08 members were male and .74 members were female. On other hand in the case of lentil growers 1.56 persons were male and 0.44 persons were female and in case of wheat growers 0.83 persons were male and .92 persons were female (Table 4.1).

4.3 Age distribution of the sample farmers

Age of Boro rice, lentil and wheat farmers was calculated from their birth to the time of the interview. Farmers were grouped into three categories according to their ages (Table 4.2). In case of Boro rice growers, it can be seen that 10.91 percent farmers belonged to the age group of 15-30 years, 61.82 percent farmers were in the age group between 31 -50 years and 27.59 percent of the farmers were above 50 years of age.

The scenario for lentil growers revealed that 21.74 percent farmers belonged to the age group of 15-30 years, 65.22 percent farmers were in the age group between 31-50 years and 13.04 percent of the farmers were above 50 years of age (Table 4.2). In case of wheat growers, it can be seen that 12.50 percent farmers belonged to the age group of 15-30 years, 56.25 percent farmers were in the age group between 31-50 years and 31.25 percent of the farmers were above 50 years of age (Table 4.2).

Table 4.2 Age distribution of the sample farmers

Age groups	Boro rice grower		Lentil grower		Wheat grower	
(Years)	Number	Percent	Number	Percent	Number	Percent
15-30	12.00	10.91	5.00	21.74	2.00	12.50
31-50	68.00	61.82	15.00	65.22	9.00	56.25
>50	30.00	27.27	3.00	13.04	5.00	31.25
Total	110.00	100.00	23.00	100.00	16.00	100.00

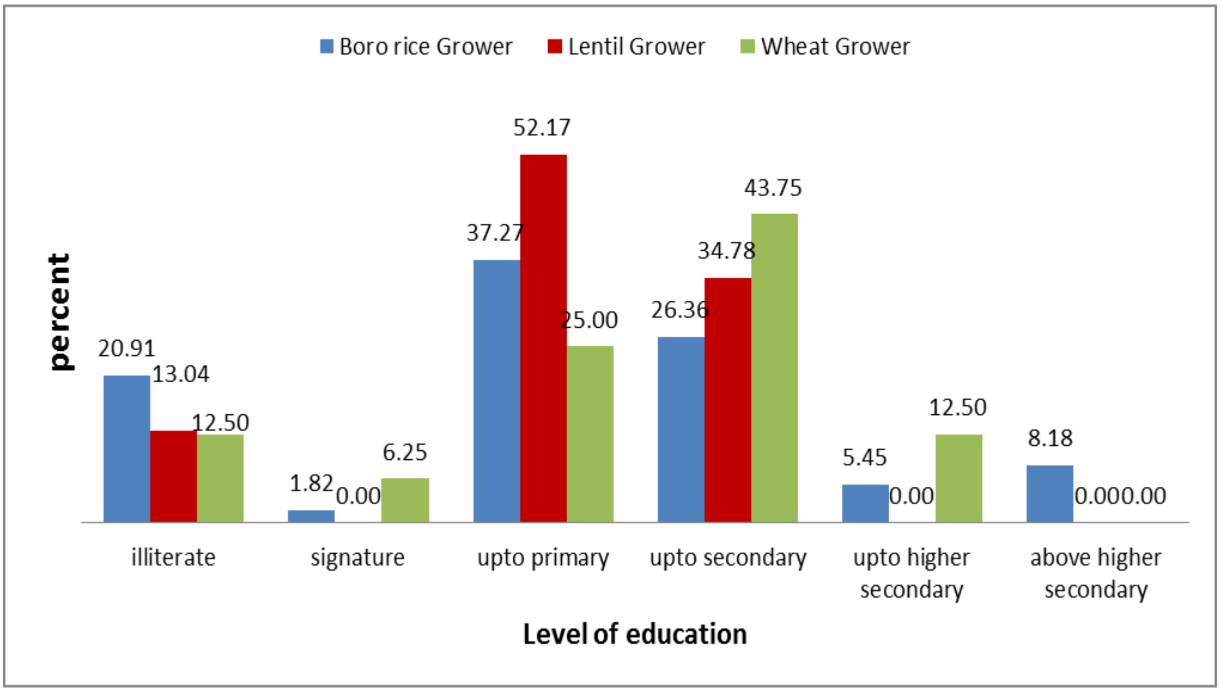
Source: Field Survey, 2018.

In case of all crops growers farm families the highest number of family members were in the age group between 31 to 50 years.

4.4 Educational status of the farmers

Education has its own merits and it contributes to economic and social development, as education is the backbone of a nation. Education is the fifth basic need of human life and is the first and foremost step of progress. Education is the most potent tool for socioeconomic mobility and a key instrument for building a just and equitable society. Proper education not only enhances efficiency but also augments the overall quality of life. Although education is not in itself a sufficient condition for development of agriculture, it is certainly a necessary condition (Mellor 1974). It plays a vital role in the acquisition of information about the innovation in various production processes of agriculture. It helps person to make right decision regarding his farm business. It makes a man more capable of managing scarce resource and hence to earn maximum profit (Miah , 1990). The educational status of Boro rice, lentil and wheat growers is given in Figure 4.1.

Figure 4.1 Educational status of the farmers



Source: Field Survey, 2018.

In case of Boro rice growers, it can be seen from the Figure 4.1 that 20.94 percent farmers were illiterate, 1.82 percent capable to sign, 37.27 percent had primary education, 26.36 percent had secondary education, 5.45 percent had higher secondary education and 8.18 percent had above education.

The scenario for lentil farmers depicted that 13.04 percent family members were illiterate, 52.17 percent had primary education, 34.78 percent had secondary education and 17.80 percent had higher secondary education (Figure 4.1).

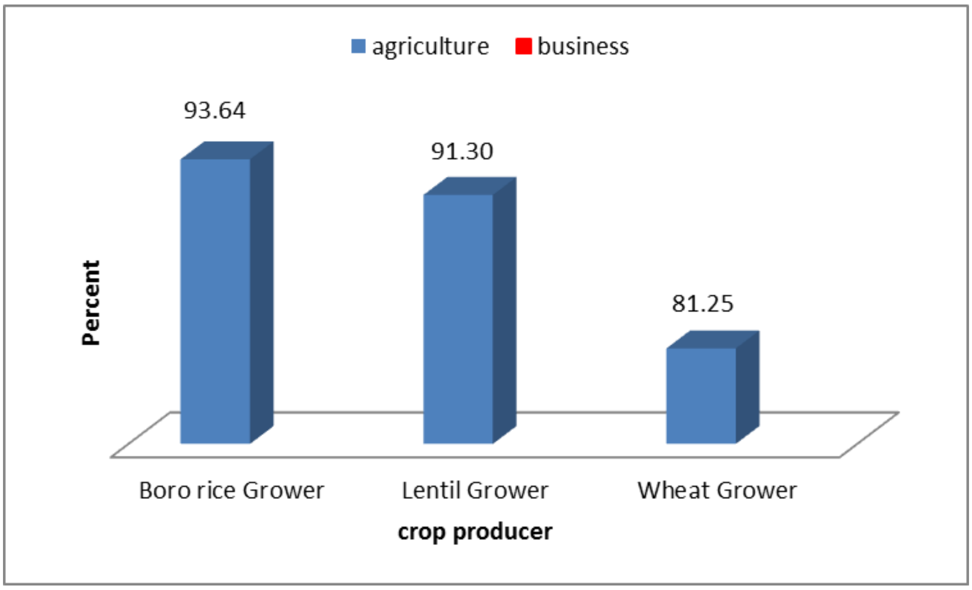
For wheat farmers, it can be seen from the Figure 4.1 that 12.50 percent farmers were illiterate, 6.25 percent capable to sign, 25 percent had primary education, 43.75 percent had secondary education and 12.50 percent had higher secondary education. It was found that combined literacy rate of Boro rice, lentil and wheat farmers was 79.09 percent, 86.96 percent and 87.50 percent, respectively.

According to UNESCO the literacy rate in Bangladesh is 72.76 percent which is largely similar with the study though the area has more literacy rate than the result by UNESCO and it is a positive sign for the study area.

4.5 Occupational status of the farmers

The selected farmers of the study area were engaged in various type of occupations, although agriculture was the main source of employment for the people of the study area. The work in which a person engaged throughout the year is known as the main occupation of that person (Roy 1999). Besides agriculture, some farmers were engaged in small enterprise; some were engaged in services like government, semi-government, non-government schools, madrashas; some of them were engaged in rural non-farm activities like, weaving, rural transportation, shop keeping and other wage earning activities. The occupational status of the farmers has been categorized into six groups as agricultural work, business, labour selling, job, student and others.

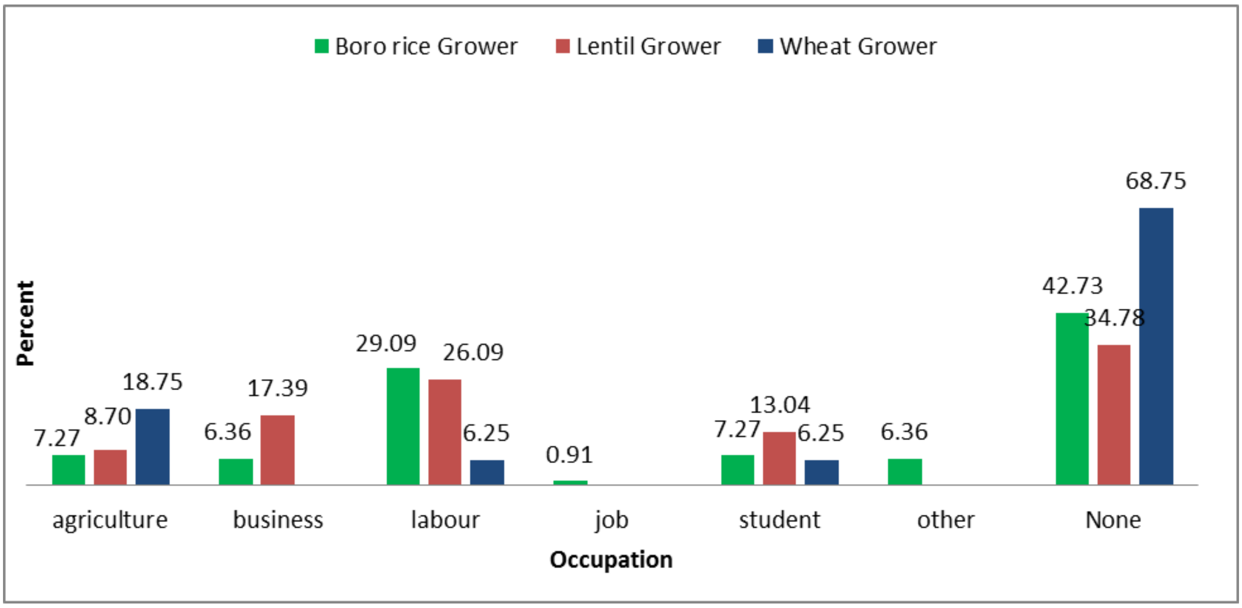
Figure 4.2 Main occupations of the farmers



Source: Field Survey 2018

It is shown from the Figure 4.2 that in case of Boro rice growers 93.46 percent of the farmers were engaged in agriculture as their main occupation. In case of lentil and wheat growers 91.30 percent and 81.25 percent farmers were engaged in agriculture as their main occupation, respectively. Boro rice, lentil and wheat growers were engaged in labour selling as their main occupation by 6.36, 8.70 and 18.75 percent, respectively.

Figure 4.3 Subsidiary occupations of the farmers



Source: Field Survey 2018.

Figure 4.3 shows the subsidiary occupation of the sample farmers. From the figure it can be said that 7.27 percent, 6.36 percent, 29.09 percent, 0.91 percent, 7.27 percent and 6.36 percent Boro rice farmers were involved in agriculture, business, labour selling, job, student and others, respectively as their subsidiary occupation. It is also noted that 42.73 percent Boro rice growers were not engaged in any subsidiary occupation.

On the other scenario, 8.70 percent, 17.39 percent, 13.04 percent and 6.36 percent lentil farmers were involved in agriculture, business, labour selling and student, respectively as their subsidiary occupation. It is also noted that 34.78 percent lentil growers were not engaged in any subsidiary occupation (Figure 4.3).

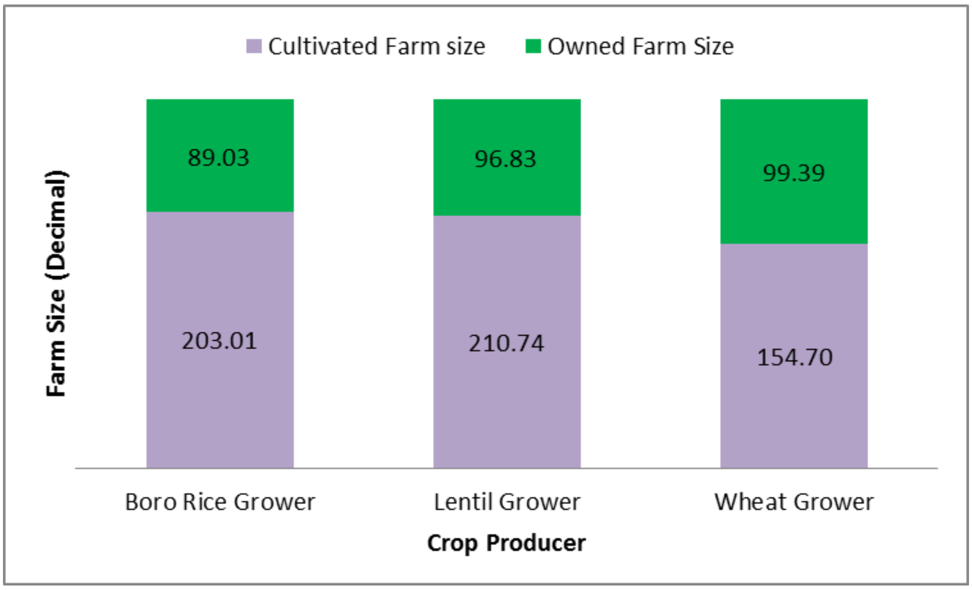
In case of wheat growers, 18.75 percent, 6.25 percent and 6.25 percent farmers were involved in agriculture, labour selling and student, respectively as their subsidiary occupation. It is also noted that 68.75 percent wheat growers were not engaged in any subsidiary occupation (Figure 4.3).

4.6 Land ownership pattern

Land tenure refers to the possession of land and right to the use the land. People hold varying kind of rights in the use of land and are said to belong to the different tenure classes (Bishop and Toussaint 1958). According to Yang (1965), farm size is being computed by the entire land operated by the farmers. Cultivated farm size is calculated by adding the area rented and mortgaged in from others with owned land. Therefore, cultivated farm size can be measured by using the following formula:

Cultivated Farm Size = Own Land + Rented in + Mortgaged in – Rented out – Mortgage out

Figure 4.4 Farm size of the farmers



Source: Field Survey 2018.

It appears from Figure 4.4 that the average cultivated farm size of Boro rice, lentil and wheat growers was 203.01 decimal, 210.74 decimal and 154.70 decimal respectively. Average owned farm size of Boro rice, lentil and wheat growers was 89.03 decimal, 96.83 decimal and 9.39 decimal, respectively.

4.7 Farming experience

Farm experience of Boro rice, lentil and wheat farmers was calculated from their involvement in field agriculture to the time of the interview. Farmers were grouped into five categories according to their experiences (Table 4.3). In case of Boro rice growers, it can be seen from the table that 26.36 percent farmers belonged to the group between 5-15 years, 20.91 percent farmers were in the group between 16 -25 years, 30.91 percent farmers were in the group between 26 -35 years, 14.55 percent farmers were in the group between 36 -45 years and 7.27 percent of the farmers had above 50 years of experiences.

In case of lentil growers, 47.83 percent farmers belonged to the group between 5-15 years, 30.43 percent farmers were in the group between 16 -25 years, 17.39 percent farmers were in the group between 26 -35 years, 4.35 percent farmers were in the group between 36 -45 years and none of the farmers had above 50 years of experiences (Table 4.3)

Table 4.3: Farming experience of the farmers

Farm experience	Boro rice growers		Lentil growers		Wheat growers	
(Years)	Number	Percent	Number	Percent	Number	Percent
5-15	29	26.36	11	47.83	4	25
16-25	23	20.91	7	30.43	2	12.5
26-35	34	30.91	4	17.39	7	43.75
36-45	16	14.55	1	4.35	1	6.25
>45	8	7.27	-	0.00	2	12.5
Total	110	100	23	100	16	100

Source: Field Survey 2018.

In case of wheat growers, 25 percent farmers belonged to the group between 5-15 years, 12.5 percent farmers were in the group between 16 -25 years, 43.75 percent farmers were in the group between 26 -35 years, 6.25 percent farmers were in the group between 36 -45 years and 12.5 percent of the farmers had above 50 years of experiences. (Table 4.3)

In case of Boro rice and wheat growers, highest experience farmers belonged to the group between 26-35 years and in case of lentil growers, highest experience farmers belonged to the group between 5-15 years (Table 4.3). That means lentil farming is comparatively a new farm practice in the study area.

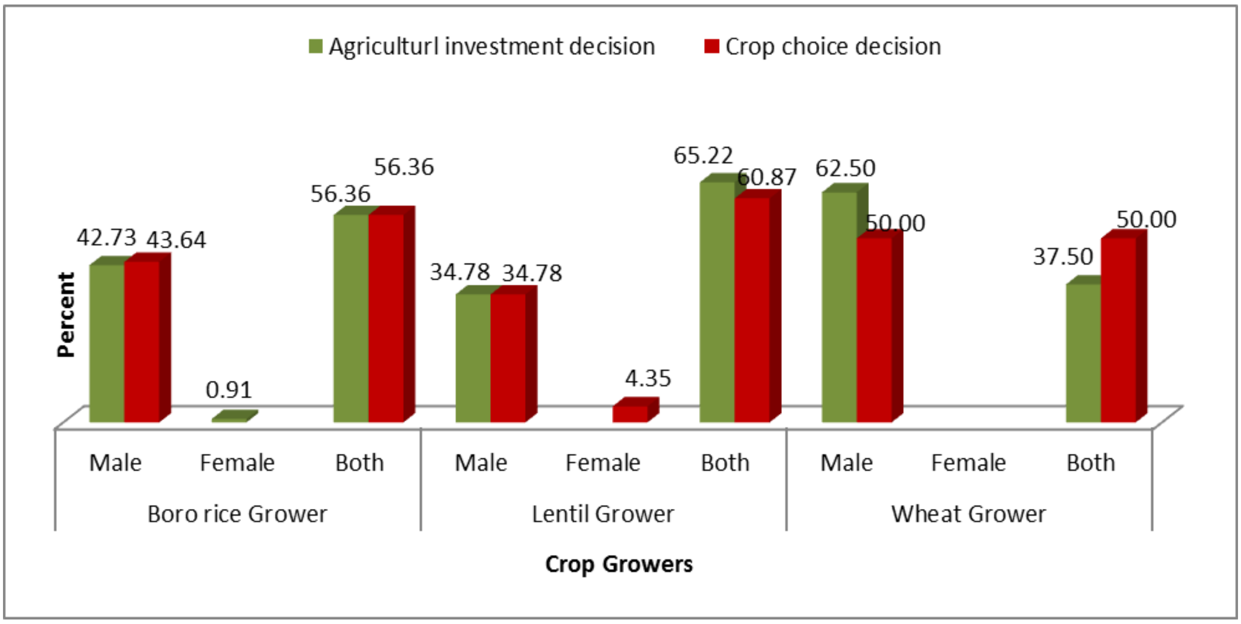
4.8 Agricultural decision

"I always say, decisions I make, I live with them. There's always ways you can correct them or ways you can do them better. At the end of the day, I live with them" -**LeBron James**

The key to success is to make a right decision at the right time but making right decision is crucial at every level. For agriculture, right decision at right time is definitely the most important and crucial task as agricultural goods are highly perishable and a small mistake can turn all efforts into ashes.

The decision making percentage by the male, female and both are shown in this section according to the selected crops. Here two types of decisions are considered: Agricultural investment decision and Crop choice decision.

Fig: 4.5 Agricultural decisions making by gender



Source: Field Survey 2018.

Figure 4.5 shows that in case of agricultural investment decision, male took 42.73 percent, 34.78 percent and 62.50 percent decision for Boro rice, lentil and wheat growers, respectively. Female took 0.91 percent agricultural investment decision for Boro rice only. On the other hand, 56.36 percent, 65.22 percent and 37.50 percent decision about agricultural investment are taken by male and female both for Boro rice, lentil and wheat growers respectively.

In case of crop choice decision, male took 43.64 percent, 34.78 percent and 50 percent decision for Boro rice, lentil and wheat growers, respectively. Female took 4.31 percent crop choice decision for lentil only. On the other hand, 56.36 percent, 60.87 percent and 50 percent decision about crop choice are taken by male and female both for Boro rice, lentil and wheat growers, respectively (Figure 4.5).

This chapter provides an evidence of real picture of the society. From the above discussions it is clear that there are some variations in socioeconomic characteristics among the Boro rice, lentil and wheat growers. But the magnitude of the variations was not large. There are substantial indications suggesting that rice, lentil and wheat growers were progressive.

Chapter 5

GROWTH AND TREND ANALYSIS

5.1 Introduction

Positive growth rates of production, production area and yield of a crop indicate the development of that sector obviously. In this chapter, annual growth rates were computed by using time series data of Boro rice, lentil and wheat for area, production and yield by fitting semi-log model (log-lin model) to the year since 1979 to 2016 for Chapai-Nawabgonj and Rajshahi districts. The performance of Boro rice sector has considerable bearing on the rate of growth of the economy. In Bangladesh, the performance of the Boro rice crop sector is the most important determinant of the growth in agricultural production and to a large extent the growth of the economy. Thus the variability of Boro rice crop production can have serious destabilizing consequences on the country's national income, employment and its balance of payment. Besides Boro rice, some other Rabi crops also have considerable bearing on the rate of growth of the economy. In this chapter, growth rates and trend analysis of major Rabi crops (Boro rice, Lentil and Wheat) in Chapai-Nawabgonj and Rajshahi districts are shown.

5.2 Growth and trend of Boro rice

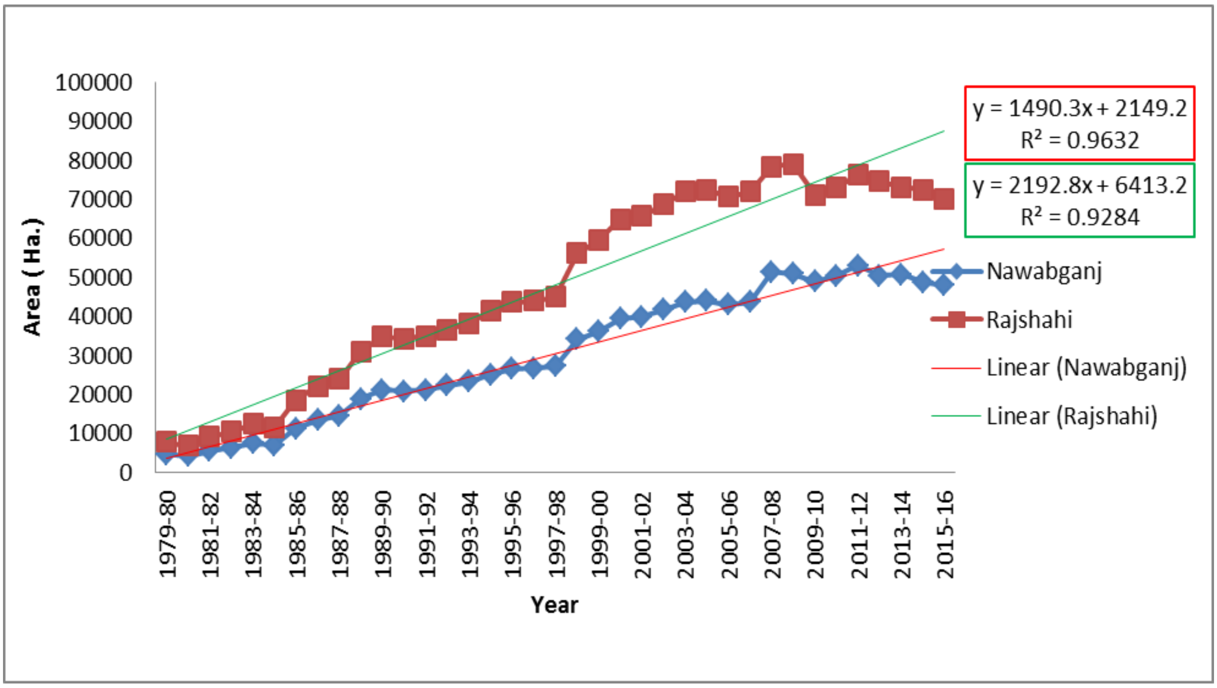
Table 5.1 presents the growth rate of Boro rice production area in Chapai-Nawabgonj and Rajshahi over time periods 1979 to 2016. The growth rates were calculated in two sub periods considering the year 2000 as base periods.

Table 5.1 Growth of Boro rice production area

District	Period	Fitted regression function	Growth rate
Chapai Nawabgonj	1979-80 to 1999-00	4699.91+.105t	10.5
	2000-01 to 2015-16	41112.66+.014t	1.4
	All periods	6997.56+.066t	6.6
Rajshahi	1979-80 to 1999-00	7738.54+.105t	10.5
	2000-01 to 2015-16	69707.34+.003t	0.3
	All periods	11955.08+.062t	6.2

From Table 5.1 it is observed that in the periods 1979-80 to 1999-00 and 2000-01 to 2015-16, the co-efficient for production area in Chapai-Nawabgonj and Rajshahi showed a positive sign which implies that production area had increased in this time periods in both districts. In the periods 1979-80 to 1999-00 the growth rate of Boro rice production area was 10.5 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of Boro rice production area was 1.4 and 0.3 percent in Chapai-Nawabgonj and Rajshahi respectively which is lower than previous time periods. The growth rate of Boro rice production area for all time periods (1979-80 to 2015-16) was 6.6 and 6.2 percent in Chapai-Nawabgonj and Rajshahi, respectively.

Figure 5.1 Trend of Boro rice production area



Trend of Boro rice production area in Chapai-Nawabgonj and Rajshahi districts is presented in Figure 5.1. The figure shows that Boro rice production area has increased over the time for both districts. In Chapai-Nawabgonj and Rajshahi districts the trends of production area for Boro rice are more or less constant for the time period 1979-80 to 1984-85. After the period Boro rice production area had an upward rising trend and had a sudden rising in the time period 1988-89 for both districts. After the time period 2007-08 and 2008-09, there is a downward trend of Boro rice production area in Chapai-Nawabgonj and Rajshahi district, respectively. From the Figure 5.1 it is also seen that Boro rice production area is continuously decreasing after the time period of 2011-12 and 2012-13 in Chapai-Nawabgonj and Rajshahi district, respectively. The Boro rice production area was the highest at the time period of 2008-2009 in Chapai-Nawabgonj and in Rajshahi district Boro rice production area was the highest at the time period of 2011-2012. The overall trend line shows the slight uprising trend of Boro rice production area over the year.

Table 5.2 Growth of Boro rice production

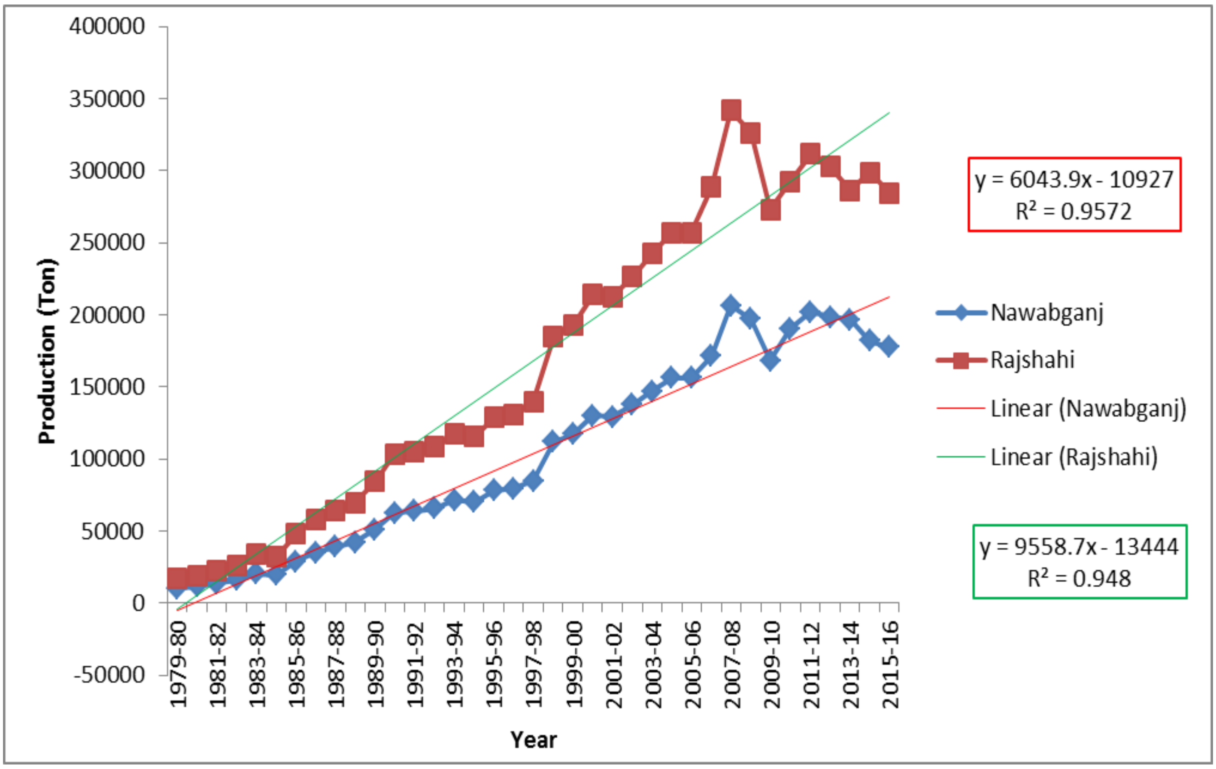
District	Period	Fitted regression function	Growth rate
Chapai Nawabgonj	1979-80 to 1999-00	1172.92+.119t	11.9
	2000-01 to 2015-16	137993.50+.023t	2.3
	All periods	16608.92+.08t	8
Rajshahi	1979-80 to 1999-00	18396.55+.119t	11.9
	2000-01 to 2015-16	231847.25+.018t	1.8
	All periods	27755.55+.079t	7.9

Table 5.2 presents the growth rate of Boro rice production in Chapai-Nawabgonj and Rajshahi over time periods of 1979 to 2016. The growth rates were calculated in two sub periods considering the year 2000 as base period.

Table 5.2 shows that in the periods 1979-80 to 1999-00 and 2000-01 to 2015-16, the co-efficient for production in Chapai-Nawabgonj and Rajshahi showed a positive sign which implies that production had increased in this time periods in both districts. In the periods 1979-80 to 1999-00 the growth rate of Boro rice production was 11.9 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of Boro rice production was 2.3 and 1.8 percent in Chapai-Nawabgonj and Rajshahi, respectively which is lower than the previous time periods. The growth rate of Boro rice production for all time periods (1979-80 to 2015-16) was 8 and 7.9 percent in Chapai-Nawabgonj and Rajshahi, respectively.

Trends of Boro rice production in Chapai-Nawabgonj and Rajshahi districts are presented in Figure 5.2. The figure shows that Boro rice production has increased over the time for in both districts. In Chapai-Nawabgonj district the trend of production for Boro rice is more or less constantly uprising for the time period 1979-80 to 1983-84. But after the time periods of 1984-85, there had a sudden rising and continuity rising up to the periods 1997-98. There had a dramatic decrease in the periods of 1998-99 then the production continue to increase at a slow rate. After the time periods of 2003-04 there had a fluctuation mostly decreasing trend of Boro rice production in Chapai-Nawabgonj district. Boro rice production in Rajshahi district had a continue but uprising trend from the time period 1979-80 to 1997-98 then had a slightly uprising trend to the next year and continue the trend but the uprising was slow up to periods 2007-08. After that period, there was a continue decreasing trend up to the periods 2009-10. Then the trend fluctuated over the periods in Rajshahi district for Boro rice production (Figure 5.2).

Figure 5.2 Trend of Boro rice production



5.3 Growth and trend of Lentil

Table 5.3 presents the growth rate of lentil production area in Chapai-Nawabgonj and Rajshahi over time periods 1979 to 2016.

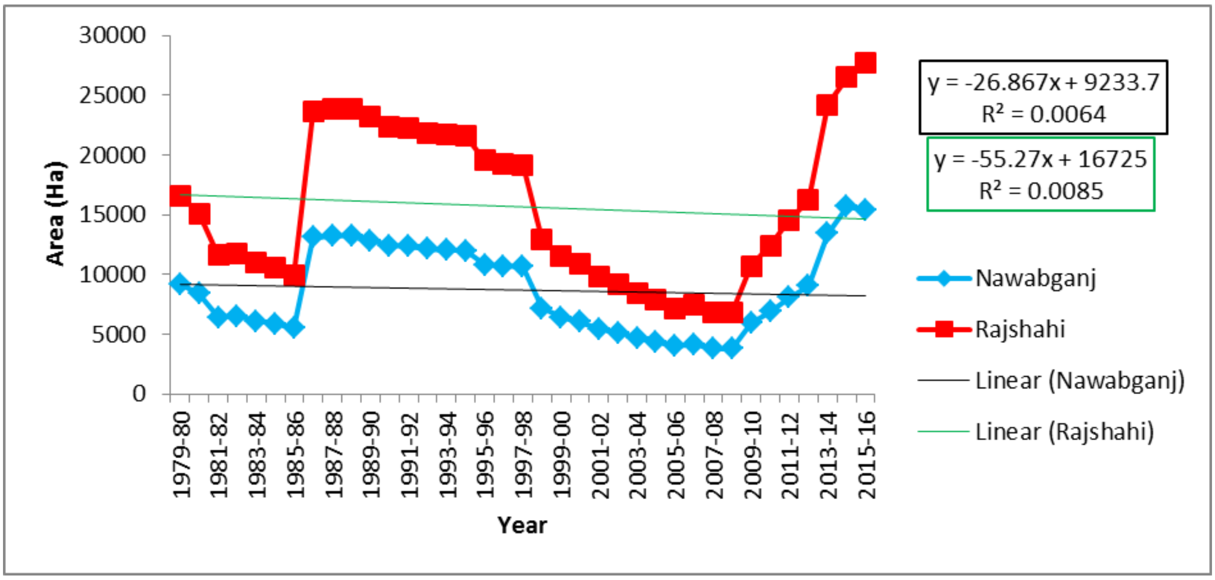
Table: 5.3 Growth of lentil production area

District	Period	Fitted regression function	Growth rate
Chapai Nawabgonj	1979-80 to 1999-00	7917.46+.016t	1.6
	2000-01 to 2015-16	3321.68+.077t	7.7
	All periods	8982.465-.006t	-0.6
Rajshahi	1979-80 to 1999-00	14268.27+.016t	1.6
	2000-01 to 2015-16	6023.41+.076t	7.6
	All periods	16237.469-.007t	-0.7

It is observed from Table 5.3 that in the periods 1979-80 to 1999-00, the growth rate of lentil production area was 1.6 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of lentil production area was 7.7 and 7.6 percent in Chapai-Nawabgonj and Rajshahi respectively

For the all periods it is observed from Table 5.3 that the co-efficient for production area in Chapai-Nawabgonj and Rajshahi showed a negative sign which implies that production area had decreased in this time periods in both district. Now, the growth rate of lentil production area was -0.6 and -0.7 percent in Chapai-Nawabgonj and Rajshahi, respectively for the time periods 1979 to 2016.

Figure 5.3 Trend of lentil production area



In the Figure 5.3, it can be seen that there was a constant slight decreasing trend in lentil production area in both Chapai-Nawabgonj and Rajshahi district from 1985-86 to 1986-87 and then there had a rapid increase in production area in both districts. After this point there had a continue decreasing trend and this become rapid from 1997-98 to 1998-99 and then it followed the decreasing trend up to 2008-09 for both Chapai-Nawabgonj and Rajshahi districts. It is shown in Figure 5.3 that there had a continue uprising trend for both Chapai-Nawabgonj and Rajshahi districts. The overall trend of lentil production area had a decreasing trend over the time periods.

Table 5.4 Growth of lentil production

District	Period	Fitted regression function	Growth rate
Chapai Nawabgonj	1979-80 to 1999-00	5305.23+.017t	1.7
	2000-01 to 2015-16	2278.36+.098	9.8
	All periods	5524.537+.003t	0.3
Rajshahi	1979-80 to 1999-00	9560.74+.017t	1.7
	2000-01 to 2015-16	3799.84+.113t	11.3
	All periods	9553.164+.006t	0.6

Table 5.4 presents the growth rate of lentil production in Chapai-Nawabgonj and Rajshahi over time periods 1979 to 2016. The growth rates were calculated in two sub periods considering the year 2000 as base period.

In the periods 1979-80 to 1999-00 and 2000-01 to 2015-16, it is seen from Table 5.4 that the co-efficient for production in Chapai-Nawabgonj and Rajshahi showed a positive sign which implies that production of lentil had increased in this time periods in both districts. In the periods 1979-80 to 1999-00 the growth rate of lentil production was 1.7 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of lentil production was 9.8 and 11.3 percent in Chapai-Nawabgonj and Rajshahi, respectively which is lower than the previous time periods. Now, the growth rate of lentil production for all time periods

(1979-80 to 2015-16) was 0.3 and 0.6 percent in Chapai-Nawabgonj and Rajshahi respectively which is much lower than previous two sub-periods.

Figure 5.4 Trend of lentil production

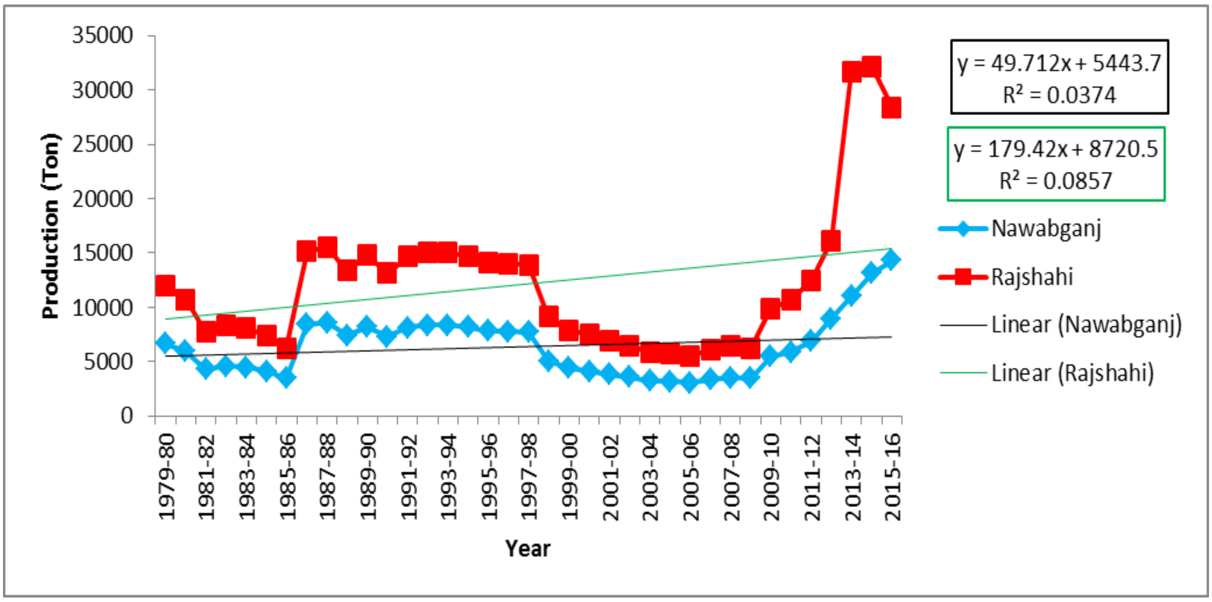


Figure 5.4 shows the lentil production trend over time periods. From the trend lines it can be said that there is a constant and slightly uprising production trend in Chapai-Nawabgonj and Rajshahi district, respectively. From 1979-80 to 1985-86, there had a slightly decreasing and then constant production trend in Chapai-Nawabgonj and Rajshahi, district respectively. After that there had a rapid uprising trend for the next time periods which was more or less constant. Figure 5.4 also shows that after the periods 2008-09 there had an uprising production trend and this became rapid in 2012-13 in Rajshahi district and then decreasing. But in Chapai-Nawabgonj district production trend of lentil production continually uprising.

5.4 Growth and trend of Wheat

Table 5.5 Growth of wheat production area

District	Period	Fitted regression function	Growth rate
Chapai Nawabgonj	1979-80 to 1999-00	4312.25+.028t	2.8
	2000-01 to 2015-16	5485.47.098t	9.8
	All periods	3574.987+.043t	4.3
Rajshahi	1979-80 to 1999-00	15628.006+.028t	2.8
	2000-01 to 2015-16	29577.94-.005t	-0.5
	All periods	17668.667+.016t	1.6

Table 5.5 presents the growth rate of wheat production area in Chapai-Nawabgonj and Rajshahi over time periods 1979 to 2016. It is seen from Table 5.5 that the co-efficient for production area in Chapai-Nawabgonj and Rajshahi showed a positive sign for all the periods which implies that production area had increased in this time periods in both districts but in case of two sub periods the coefficient value for Rajshahi district in the time periods 2000-01 to 2015-16, there is a negative sign which implies in this period growth of wheat production area was decreased and that was 0.5 percent. In the periods 1979-80 to 1999-00 the growth rate of wheat production area was 2.8 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of wheat production area was 9.8 percent in Chapai Nawabgonj. Now, the growth rate of wheat production area was 4.3 and 1.6 percent in Chapai-Nawabgonj and Rajshahi, respectively for the time periods 1979 to 2016.

Figure 5.5 Trend of wheat production area

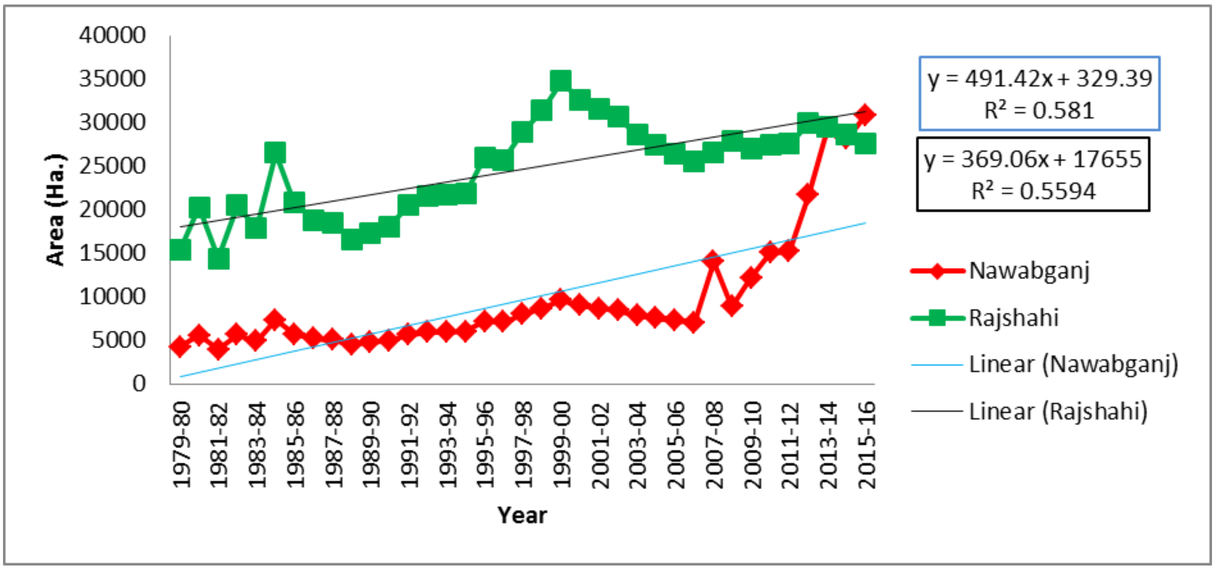


Figure 5.5 shows that there is a fluctuation of wheat production area trend from the period 1979-80 to 1985-86 for both districts and had a continue decreasing trend up to the periods 1989-90. Then the trend was slightly uprising up to the periods 1990-00. After that time period, there had a slow decreasing production area trend for both districts. There had a dramatic uprising in wheat production area in Chapai-Nawabgonj district at the time period of 2007-08 and then had a rapid fall in production area for the next time periods. Then the production area of wheat in Chapai-Nawabgonj district continue to increase and this become rapid after the time period 2009-10. On the other hand in Rajshahi district, there had an overall increasing production area trend over the time periods.

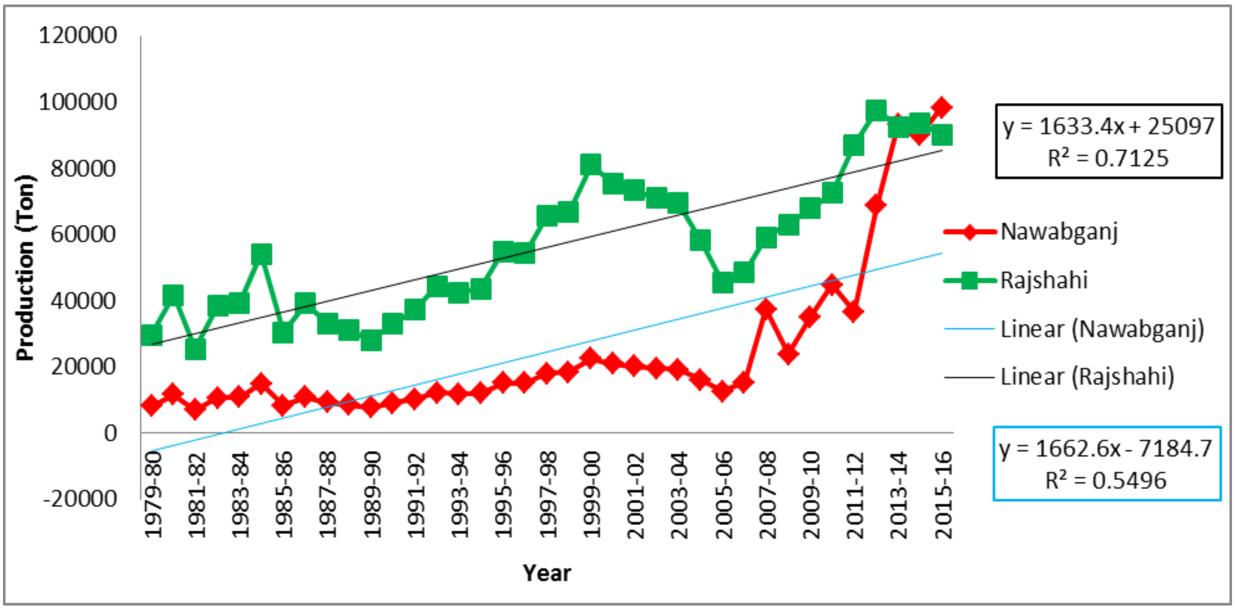
Table 5.6 Growth of wheat production

District	Period	Fitted regression function	Growth rate
Chapai Nawabgonj	1979-80 to 1999-00	7747.830+.035t	3.5
	2000-01 to 2015-16	11045.07+.126t	12.6
	All periods	5958.538+.058t	5.8
Rajshahi	1979-80 to 1999-00	28078.86+.035t	3.5
	2000-01 to 2015-16	56696.25+.027t	2.7
	All periods	29552.397+.030t	3

Table 5.6 presents the growth rate of wheat production in Chapai-Nawabgonj and Rajshahi over time periods 1979 to 2016. The growth rates were calculated in two sub periods considering the year 2000 as base period.

In the periods 1979-80 to 1999-00 and 2000-01 to 2015-16, it is seen from Table 5.6 that the co-efficient for production of wheat in Chapai-Nawabgonj and Rajshahi showed a positive sign which implies that production had increased in these time periods in both districts. In the periods 1979-80 to 1999-00, the growth rate of wheat production was 3.5 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16, the growth rate of wheat production was 12.6 and 2.7 percent in Chapai-Nawabgonj and Rajshahi, respectively. Now, the growth rate of wheat production for all time periods (1979-80 to 2015-16) was 5.8 and 3 percent in Chapai-Nawabgonj and Rajshahi, respectively.

Figure 5.6 Trend of wheat production



From the Figure 5.5, it can be said that production trend had an uprising trend over the time periods but up to the periods 1985-86 there had a continue uprising production trend of wheat for both Chapai-Nawabgonj and Rajshahi district. Up to the time period 1999-00, there had a slight uprising trend for both districts and after that period there had a constant and slight decreasing trend for Chapai-Nawabgonj and Rajshahi districts, respectively. After the time period 2005-06, there had a dramatic up down and continue rising for Chapai-Nawabgonj and Rajshahi district, respectively up to the year 2010-11. Figure 5.5 shows that from this year there had a rapid uprising and slight uprising trend in Chapai-Nawabgonj and Rajshahi district, respectively.

5.5 Growth and Trend of Boro Rice, Lentil and Wheat Yield

Table 5.7 Growth rate of yield (Boro rice, Lentil and Wheat) in Chapai Nawabgonj

Crop	Period	Fitted regression function	Growth rate
Boro rice	1979-80 to 1999-00	2.38+.014t	1.4
	2000-01 to 2015-16	3.34+.010t	1
	All periods	2.374+.014t	1.4
Lentil	1979-80 to 1999-00	0.670+.001t	0.1
	2000-01 to 2015-16	0.686+.021t	2.1
	All periods	0.615+.009t	0.9
Wheat	1979-80 to 1999-00	1.797+.008t	0.8
	2000-01 to 2015-16	2.019+.028t	2.8
	All periods	1.667+.015t	1.5

Table 5.7 presents the growth rate of yield of Boro rice, lentil and wheat in Chapai-Nawabgonj district over time periods 1979 to 2016. It is observed from Table 5.7 that the co-efficient for yield for all three crops in Chapai-Nawabgonj district showed a positive sign which implies that yield of these crops had increased in this time periods in Chapai Nawabgonj. The growth rate of Boro rice, lentil and wheat yield was 1.4, 0.1 and 0.8 percent, respectively in Chapai-Nawabgonj district for the time period 1979-80 to 1999-00 and the growth rate of Boro rice, lentil and wheat yield was 1, 2.1 and 2.8 percent, respectively in Chapai-Nawabgonj district for the time period 200-01 to 2015-16. Now, the growth rate of Boro rice, lentil and wheat yield was 1.4, 0.9 and 1.5 percent, respectively in Chapai-Nawabgonj district for the whole time periods.

Figure 5.7 Trend of Boro rice, lentil and wheat yield in Chapai-Nawabgonj

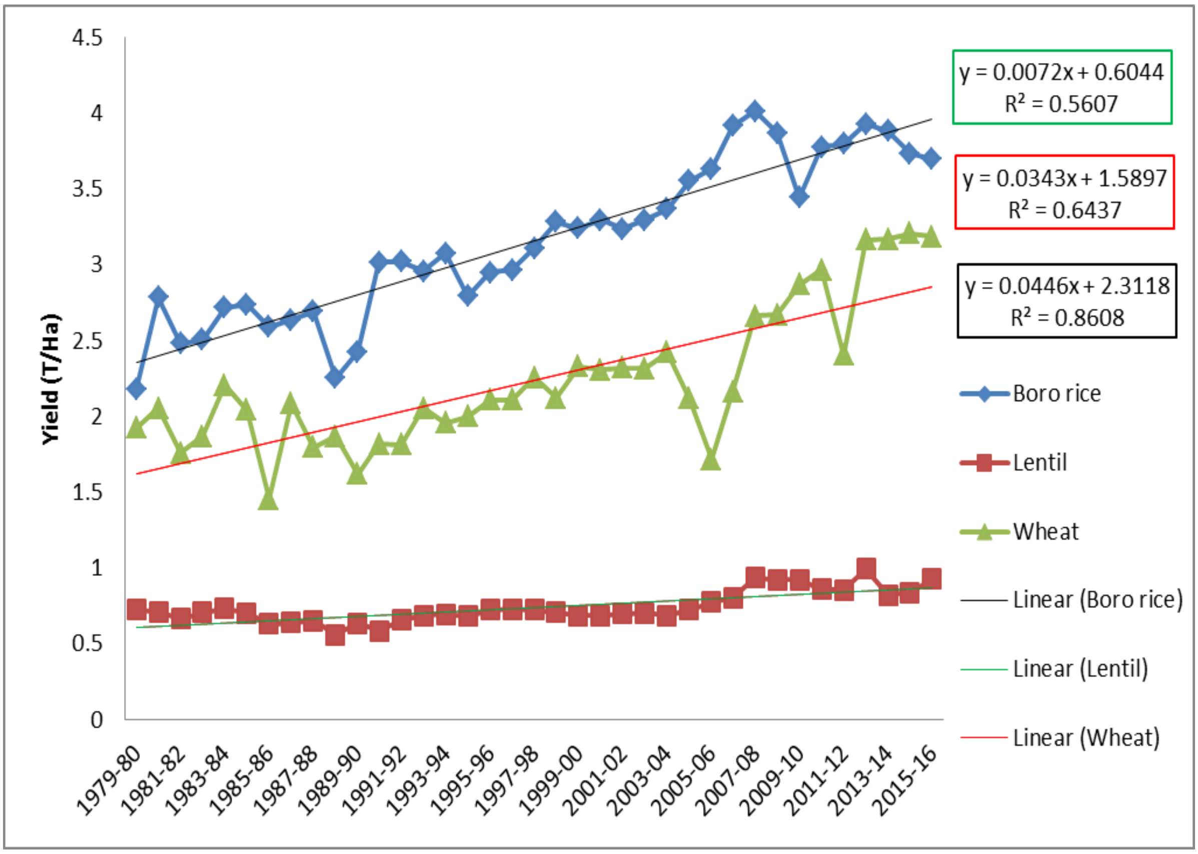


Figure 5.7 shows the trend of yield for Boro rice, lentil and wheat in Chapai-Nawabgonj district. From the figure it can be said that there had an uprising trend of yield for Boro rice and wheat but the trend is much constant for lentil. Form the figure 5.7 it can be noted that Boro rice yield had an uprising trend from 2000-01 to 2007-08, then continue to decreasing trend. The figure also shows that wheat yield had a rapid decreasing trend for the periods 2003-04 to 2005-06, then had an upward trend. From the Figure 5.7 it can be said that the yield of Boro rice and wheat in Chapai-Nawabgonj district was sharply fluctuated over time. In case of lentil yield, the trend was more steady than the other two crops.

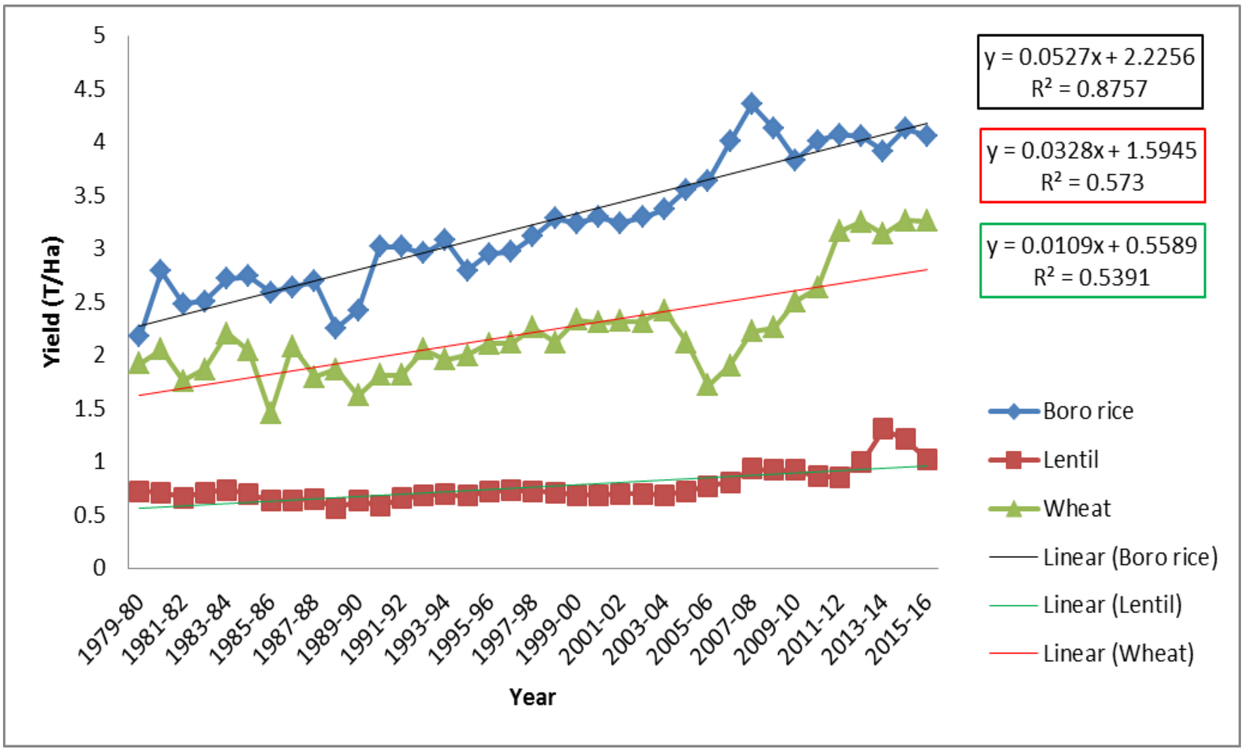
Table: 5.8 Growth rate of Boro rice, Lentil and Wheat yield in Rajshahi

Crop	Period	Fitted regression function	Growth rate
Boro rice	1979-80 to 1999-00	2.4+.012t	1.2
	2000-01 to 2015-16	3.3+.016t	1.6
	All periods	2.322+.016	1.6
Lentil	1979-80 to 1999-00	0.670+.001t	0.1
	2000-01 to 2015-16	0.631+.037t	3.7
	All periods	0.588+.013t	1.3
Wheat	1979-80 to 1999-00	1.79+.008t	0.8
	2000-01 to 2015-16	1.91+.031t	3.1
	All periods	1.673+.014t	1.4

Table 5.8 presents the growth rate of yield of Boro rice, lentil and wheat in Rajshahi district over time periods 1979 to 2016. It can be said from Table 5.8 that the co-efficient for yield in Rajshahi district showed a positive sign which implies that yield had increased in this time periods in Rajshahi. The growth rate of Boro rice, lentil and wheat yield was 1.2, 0.1 and 0.8 percent, respectively in Rajshahi district for the time period 1979-80 to 1999-00 and the growth rate of Boro rice, lentil and wheat yield was 1.6, 3.7 and 3.1 percent, respectively in Rajshahi district for the time period 200-01 to 2015-16. Now, the growth rate of Boro rice, lentil and wheat yield was 1.6, 1.3 and 1.4 percent, respectively in Rajshahi district for the whole periods.

Figure 5.8 shows the trend of yield for Boro rice, lentil and wheat in Rajshahi district. There had an overall uprising trend of yield for Boro rice and wheat but the trend is constant for lentil. There had a slight upward trend of wheat yield from the periods 2005-06 (Figure 5.8). In case of lentil yield the trend was steadier where the trend of yield of Boro rice and wheat in Rajshahi district was sharply fluctuated over time.

Figure 5.8 Trend of Boro rice, Lentil and Wheat yield in Rajshahi



The chapter shows the major Rabi crop production behaviour in Chapai-Nawabgonj and Rajshahi districts. Those two districts are in the same ecological zone and almost have the same production practices. As a result, both districts showed nearly identical production trend. The analysis shows that in the time periods 1979-80 to 1999-00 the growth rate of production area, production and yield is almost same for both districts but there is a variation in growth rate for production area, production and yield for the time periods 2000-01 to 2015-16. There is also a variation in overall time periods but in case of yield the both district have just about the equal trend.

Chapter 6

RELATIVE PROFITABILITY OF MAJOR RABI CROPS

6.1 Introduction

The costs, returns and profitability of Boro rice, lentil and wheat production are projected in this chapter. For calculating the costs and returns of Boro rice, lentil and wheat production, all variable and fixed cost are included in the cost item those are involved in producing Boro rice, lentil and wheat like seed, human labour, tillage, fertilizer and manure, irrigation water and insecticides and pesticides, land use cost, etc. On the return side, gross return, net profit, and Benefit Cost Ratio (BCR) were estimated in this section.

6.2 Input cost

6.2.1 Tillage cost

In the study area power tiller has widely been used. Table 6.1, 6.2 and 6.3 show that per hectare power tiller cost of Boro rice, lentil and wheat production was Tk. 11937.45, Tk. 5066.00 and Tk. 4441.01, respectively that cover 5.49, 9.89 and 6.78 percentage of total cost, respectively (Figure 6.4, 6.5 and 6.6).

6.2.2 Cost of seed

Cost of seed of Boro rice, lentil and wheat varies depending upon the quality and availability of seeds. It can be seen from Table 6.1 that per hectare use of Boro rice seed was 89.60 kg and average seed cost of Boro rice per hectare was estimated Tk. 5405.02. Per hectare use of lentil seed was 44.17 kg and average cost of lentil seed per hectare was estimated Tk. 3754.45 (Table 6.2). Per hectare use of wheat seed was 116.26 kg and

Table 6.1 Per hectare costs of Boro rice

Item	Unit	Quantity	Price per Unit	Total cost
Tillage cost (Power tiller)				11937.45
Seed	Kg	89.60	60.32	5405.02
Labour	Man-days			
a. Family labour (male)	Man-days	76.62	329.27	25228.87
b. Family labour (female)	Man-days	21.86	271.27	5929.11
c. Hired labour (male)	Man-days	87.93	329.27	28952.57
d. Hired labour (female)	Man-days	19.01	271.27	5157.54
Total	Man-days	205.42		
Urea	Kg	253.84	16.46	4177.94
TSP	Kg	87.20	26.45	2306.17
MoP	Kg	112.53	15.86	1784.63
DAP	Kg	163.36	28.03	4579.47
Compost	Tk.			4781.22
Irrigation	Tk.			18455.39
Pesticide	Tk.			7164.22
Weedicide	Tk.			2422.18
Lease cost	Tk.			23951.52
Total				152233.28

average cost of wheat seed per hectare was estimated Tk. 3197.28 (Table 6.3). Seed cost constituted 3.55, 7.33 and 4.88 percent of total cost of producing Boro rice, lentil and wheat respectively (Figure 6.4, 6.5 and 6.6). It was clear that cost of seed was relatively higher for Boro rice than lentil and wheat (Table 6.1, 6.2 and 6.3).

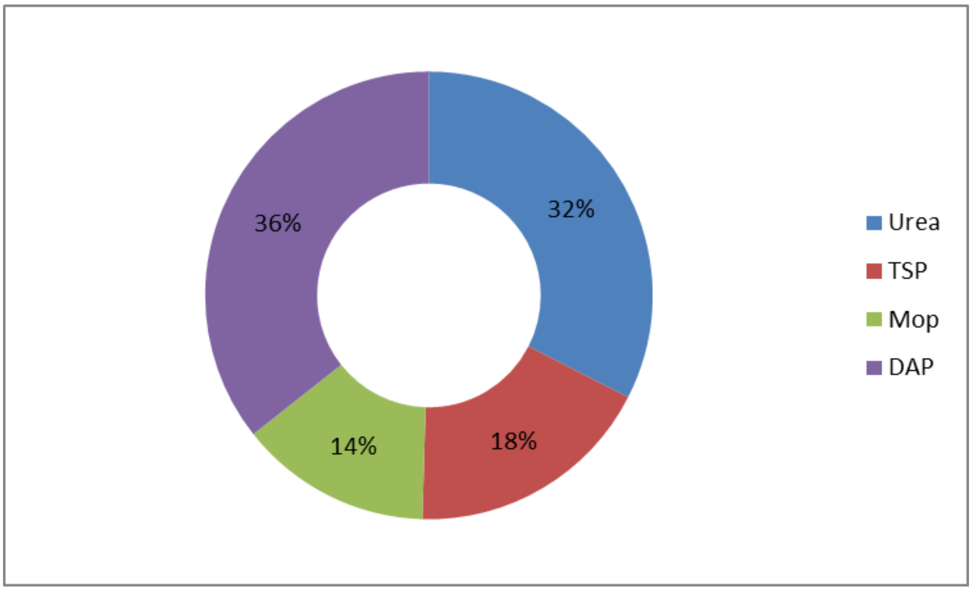
6.2.3 Cost of human labour

Human labour was the most important and largely used input in producing Boro rice, lentil and wheat production. It shared a large portion of total cost of Boro rice, lentil and wheat production. It can be seen from Table 6.1 that the amount of human labour used for Boro rice cultivation was 205.42 (both family and hired labour) man-days per hectare while this was 35.59 and 60.63 man-days per hectare for lentil and wheat production, respectively (Table 6.2 and 6.3). Total cost of human labour was estimated Tk. 65268.08, Tk. 10516.79 and Tk. 18075.91 (Table 6.1, 6.2 and Table 6.4) covering 42.87, 20.52 and 27.59 percent of total cost of Boro rice, lentil and wheat production, respectively (Figure 6.4,6.5 and 6.6).

6.2.4 Cost of fertilizer

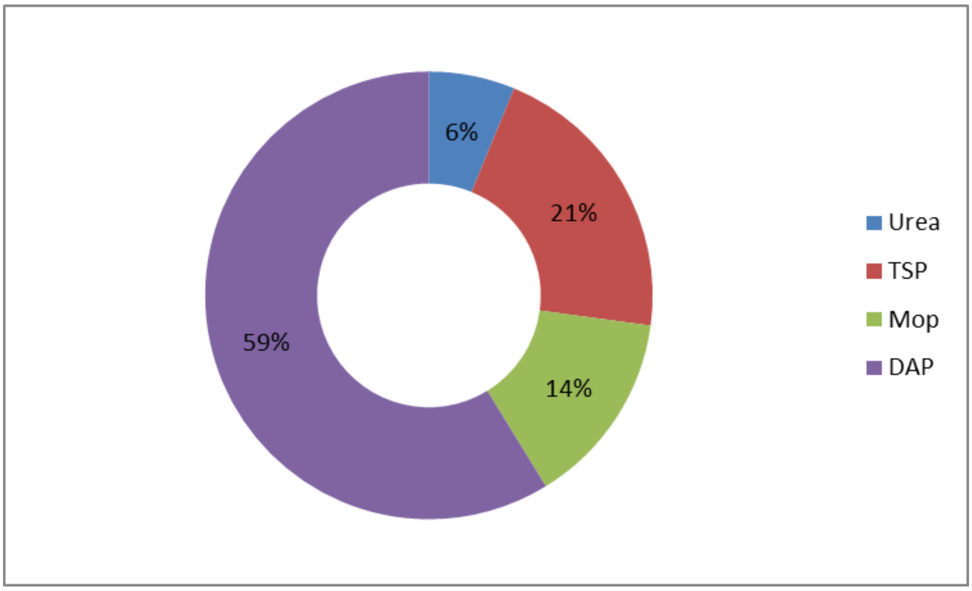
It was found that farmers used different kind of fertilizers in producing their enterprises. Commonly used fertilizers were Urea, TSP, MOP, DAP. There were some variations in the application of fertilizers between enterprises. It can be seen from Table 6.1 that per hectare use of Urea, DAP, MOP, DAP for Boro rice production were 253.84 kg, 87.20 kg, 112.53 kg and 163.36 kg and costs were estimated at Tk. 4177.94, Tk. 2306.17, Tk. 1784.63, and Tk. 4579.47, respectively. Per hectare use of Urea, TSP, MOP, DAP for lentil production were 19.32 kg, 46.33 kg, 46.21 kg and 110.23 kg for which costs were Tk. 311.82, Tk. 1049.15, Tk. 706.29 and Tk. 2944.79, respectively (Table 6.2). Per hectare use of Urea, TSP, MOP, DAP for wheat production were 164.67 kg, 29.94 kg, 225.79 kg and 83.58 kg for which costs were Tk. 2634.67, Tk. 703.58, Tk. 3461.41 and Tk. 2290.11, respectively (Table 6.3).

Figure 6.1Percentage of fertilizer cost in Boro rice production



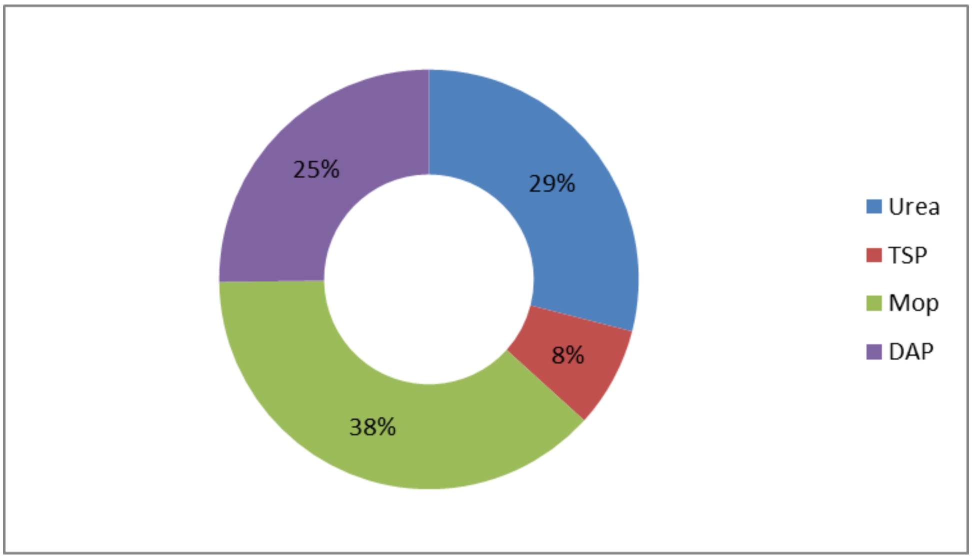
It was found that farmers paid the highest percentage (36 percent) of fertilizer cost for DAP and lowest percentage (14 percent) of fertilizer cost for MOP for Boro rice production (Figure 6.1).

Figure 6.2 Percentage of fertilizer cost in lentil production



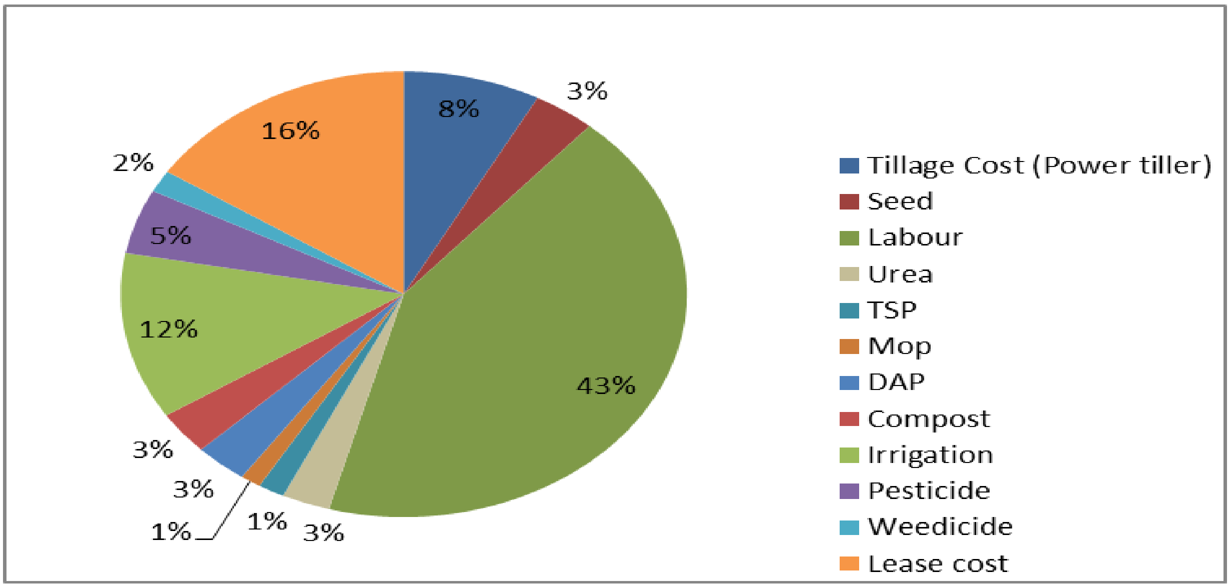
Farmers paid the highest percentage (59 percent) of fertilizer cost for DAP and lowest percentage (6 percent) of fertilizer cost for Urea for lentil production (Figure 6.2).

Figure 6.3 Percentage of fertilizer cost in wheat production



Farmers paid the highest percentage (38.08 percent) of fertilizer cost for MOP and lowest percentage (7.74 percent) of fertilizer cost for TSP for wheat production (Figure 6.3).

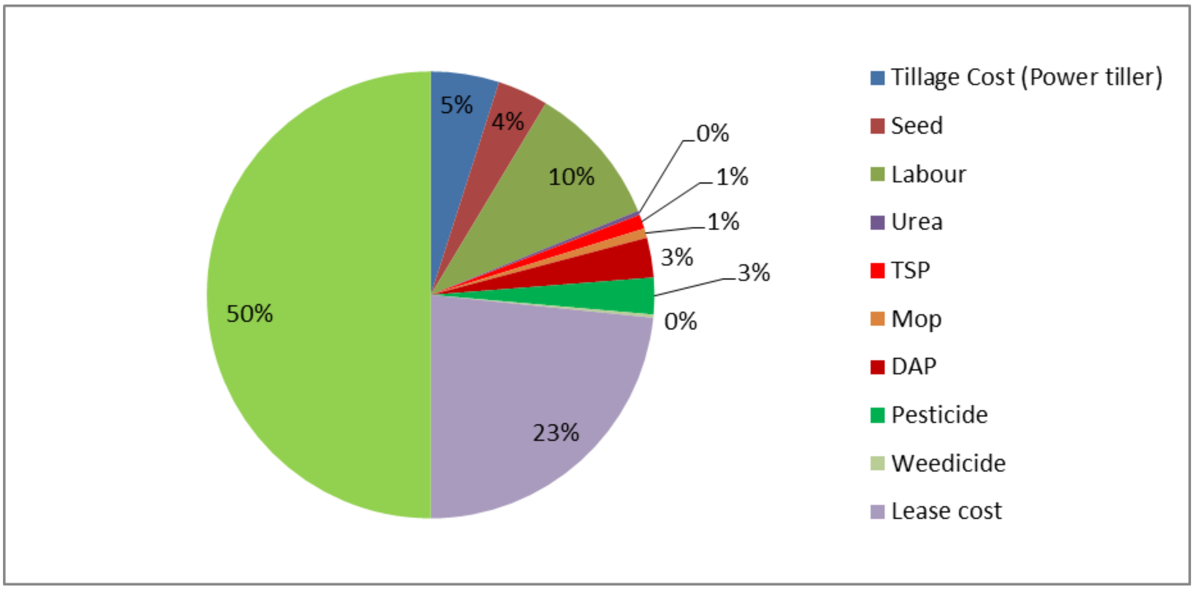
Figure 6.4 Cost percentage in Boro rice production



6.2.5 Cost of manure

It was observed in the present study area that farmers used cowdung for producing their enterprises. Most of the farmers have own several no. of cattle from which they supply the manure. It was found that cost of cowdung for Boro rice and wheat production was Tk. 4781.22 and Tk.2045.86 (Table 6.1 and Table 6.3), respectively which cover 3.14 percentage and 3.12 percentage of total cost, respectively (Figure 6.4 6.5 and 6.6). It was also found that farmers do not use any compost (cowdung) for lentil production.

Figure 6.5 Cost percentage in Lentil production



6.2.6 Cost of irrigation

Irrigation is considered as the leading input of production. Right doses application of irrigation water help to increase bulb diameter, number of cloves, number of leaves, and plant height. As a result, yield per hectare is being increased. It appears from Tables 6.1, 6.2 and 6.3 that per hectare cost of irrigation water of Boro rice and wheat production was Tk. 18455.39 and Tk. 2609.72 covering 12.12 and 3.98 percent of total cost, respectively (Figure 6.4, 6.5 and 6.6). It should be noted that irrigation cost is fully absence in lentil production.

BMDA develops low cost channel for the improvement of water distribution system since 1980. The channels are better than traditional earthen channel especially in respect of efficiency and cost. Different types of channel with various materials have been tried in the farmer's field for improvement in water distribution system including better management of irrigation. The operational cost of traditional earthen channel has become a burden to the farmers unless the command area is large. The conveyance efficiency of traditional earthen channel is 50-55% and water loss rate 40-45% (BARI, 2007). In consideration with high water loss BMDA has developed six major distribution systems to reduce water loss:

(a) Lined open channel: Cast in-situ rectangular,

(b) Lined open channel; Cast in-situ Ferro-semicircular,

(c) Buried pipe irrigation (using PVC pipe),

(d) Lined open channel; Cast in-situ Ferro-trapezoidal, and

(f) Buried pipe irrigation in STW (using PVC/hose pipe).

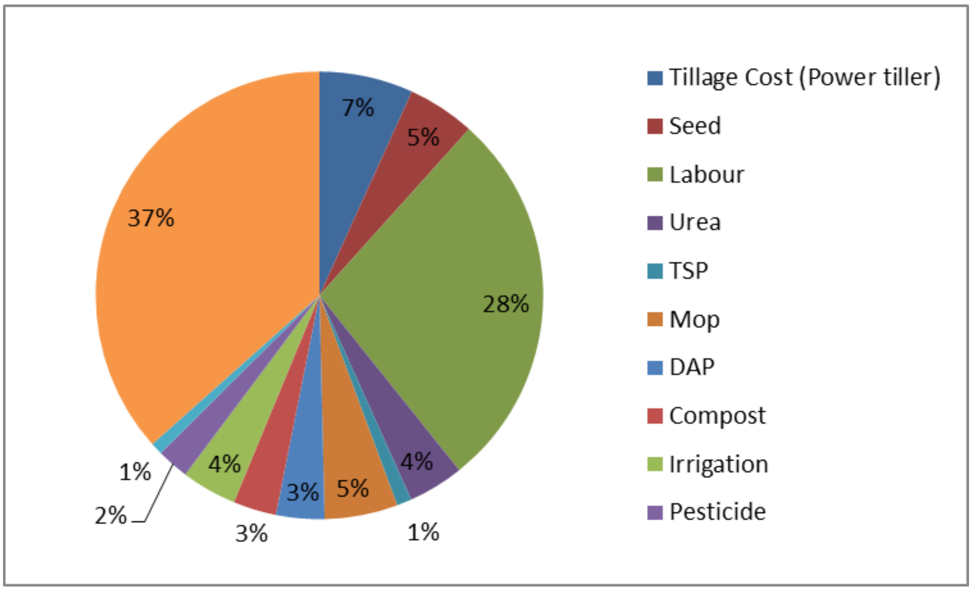
Table 6.2: Per hectare costs of lentil

Item	Unit	Quantity	Price per Unit	Total Cost
Tillage Cost (Power tiller)				5066.00
Seed	Kg	44.17	85.00	3754.45
Labour	Man-days			
a. Family labour (male)	Man-days	25.61	300.00	7683.24
b. Family labour (female)	Man-days	0.71	250.00	178.21
c. Hired labour (male)	Man-days	6.77	300.00	2031.60
d. Hired labour (female)	Man-days	2.49	250.00	623.74
Total labour cost	Man-days	35.59		
Urea	Kg	19.32	16.14	311.82
TSP	Kg	46.33	22.64	1049.15
MoP	Kg	46.21	15.29	706.29
DAP	Kg	110.23	26.71	2944.79
Pesticide	Tk.			2714.81
Weedicide	Tk.			231.67
Lease cost	Tk.			23951.52
Total				51247.30

6.2.7 Cost of insecticide and pesticides

Boro rice, lentil and wheat growers used different kinds of insecticides and pesticides to keep their crop free from diseases and pesticide attacks. It was found that per hectare cost of insecticides and pesticides for Boro rice, lentil and wheat production were Tk. 7164.22, Tk. 2714.81 and Tk.1521.92 (Table 6.1, 6.2 and 6.3) covering 4.71, 5.30 and 2.32 percent of total cost, respectively (Figure 6.4, 6.5 and 6.6).

Figure 6.6: Cost percentage in wheat production



6.2.8 Cost of weedicide

Boro rice, lentil and wheat growers used different kinds of insecticides and pesticides to keep their crop free from unwanted vegetation. It was found that per hectare cost of weedicide for Boro rice, lentil and wheat production were Tk. 2422.18, Tk. 231.67 and Tk.573.84, respectively (Table 6.1, 6.2 and 6.3) covering1.59, 0.45 and 0.88 percent of total cost, respectively (Figure 6.4, 6.5 and 6.6).

Table 6.3: Per hectare cost of wheat

Item	Unit	Quantity	Price per Unit	Total Cost
Tillage Cost (Power tiller)				4441.01
Seed	Kg	116.26	27.50	3197.28
Labour	Man-days			
a. Family labour (male)	Man-days	31.69	310.00	9822.62
b. Family labour (female)	Man-days	11.98	250.00	2993.94
c. Hired labour (male)	Man-days	16.97	310.00	5259.35
d. Hired labour (female)	Man-days	0.00	250.00	0.00
Total labour cost	Man-days	60.63		
Urea	Kg	164.67	16.00	2634.67
TSP	Kg	29.94	23.50	703.58
MoP	Kg	225.79	15.33	3461.41
DAP	Kg	83.58	27.40	2290.11
Compost	Tk.			2045.86
Irrigation	Tk.			2609.72
Pesticide	Tk.			1521.92
Weedicide	Tk.			573.84
Lease cost	Tk.			23951.52
Total				65506.81

6.2.9 Land use cost

Land use cost was calculated on the basis of the average rental value. Average rental value of land per hectare for the study year was considered as land use cost. Per hectare value was estimated at Tk.23951.52 (Table 6.1, 6.2 and 6.3) which cover15.73, 46.74 and 36.56 percentage of total cost for Boro rice, lentil and wheat production, respectively (Figure 6.4, 6.5 and 6.6).

6.3 Yield and gross return

Per hectare Boro rice, lentil and wheat production were estimated 7474.77 kg and 1025.38 Kg and 2844.24 Kg, respectively. Gross return per hectare was calculated by multiplying the total amount of products by average farmgate price and added value of by-products, if any (Table 6.4).

Per hectare gross return of Boro rice, lentil and wheat were estimated at Tk. 190692.40, Tk. 67014.36 and Tk. 91811.95, respectively (Table 6.4). Table 6.4 shows that per hectare gross return of wheat was higher than that of lentil and Boro rice.

It is necessary to note that though the calculation of by product for rice is easy but it is really difficult in case of lentil and wheat. Most of the farmers were unable to estimate the value of by products for wheat and lentil. The by-product of lentil is mainly used as fodder crops and also used as cooking fuel, sometimes it is also used as ashes in the land. By-products of wheat is mainly used as cooking fuel and sometimes also used as the house building materials. By asking again and again the value of by products were assumed.

Table 6.4 Per hectare gross return for Boro rice, lentil and wheat

Item	Product Yield (kg)	Price per kg	Value (Tk.)	By-product (Tk.)	Gross return
Boro Rice	7474.77	22.81	170518.12	20174.28	190692.40
Lentil	1025.38	61.67	63231.85	3782.50	67014.36
Wheat	2844.24	27.51	78239.42	13572.53	91811.95

6.4 Net Return

Net return is a very useful tool to analyze or compare economic performance of enterprises. It is calculated by subtracting total cost from total return. Per hectare net return of Boro rice, lentil and wheat were estimated at Tk. 38459.12, Tk. 15767.05 and Tk. 26305.14, respectively (Table 6.5). Table 6.5 shows that per hectare net return of wheat was higher than that of lentil and Boro rice.

6.5 Benefit Cost Ratio

Benefit cost ratio (BCR) is a relative measure, which is used to compare benefit per unit of cost. In the study, BCR of Boro rice, lentil and wheat was calculated as a ratio of gross return and gross cost. Benefit cost ratio of Boro rice, lentil and wheat production per hectare came out to be 1.25, 1.31 and 1.40, respectively, which implies that Tk. 1.25, 1.30 and Tk. 1.40, respectively for corresponding crop will be achieved by expending every Tk. 1.00 (Table 6.5).

Table 6.5 Comparative profitability of Boro rice, Lentil and Wheat

Item	Boro rice	Lentil	Wheat
Gross Return	190692.40	67014.36	91811.95
Gross Cost	152233.28	51247.30	65506.81
Net profit	38459.12	15767.05	26305.14
BCR	1.25	1.31	1.40

6.6 Comparative Profitability of Boro Rice, Lentil and Wheat

In this section, a comparison has been made to assess per hectare relative profitability of growing Boro rice, lentil and wheat. The summary results having per hectare yield, gross return, net return and BCR of Boro rice, lentil and wheat were presented in Table 6.5. It is evident that Boro rice, lentil and wheat enterprises were profitable. Moreover, wheat cultivation was more profitable than lentil cultivation which is more profitable than Boro rice production based on BCR (Table 6.5).

Though per hectare return from Boro rice cultivation is impressive, the return over investment for Boro rice (1.25) is not satisfactory. On the other hand the return over wheat is very impressive (1.40) which most of the farmers can not realize. They can earn more by investing less by producing wheat.

In this study it is found that the benefit cost ratio (BCR) of Boro rice is 1.25 (Table 6.5) which is similar with another research conducted by Sujan *et al.* (2017) on 'Financial Profitability and Resource Use Efficiency of Boro Rice Cultivation in Some Selected Area of Bangladesh', where researchers showed that the BCR for Boro rice was 1.22, which is much similar with this study.

The BCR for lentil was found in this study was 1.31 (Table 6.5). The research conducted by Rahman *et al.* (2012) on 'Adoption and Profitability of Bari Lentil Varieties in Some Selected Areas of Bangladesh', where researchers found that the BCR of lentil in Kaliganjupazila of Jhenaidah district was 1.49 which is slightly higher with this study. The possible reasons for the variation are improved variety uses, lower land use cost and lower labour cost compared to this study.

Another crop in this study was wheat whose BCR was calculated as 1.40 (Table 6.5) which is highly similar with another research work conducted by Rahman and Hasan (2011) on 'Wheat in Bangladesh: Profitability, Production Practices and Environmental and Managerial Factors Affecting Yield', where the researchers showed that the BCR of wheat is 1.41.

6.7 Reasons behind producing rice

From the above scenario it is transparent that Boro rice cultivation is less profitable than lentil and wheat. But the most of the farmer is producing huge amount of Boro rice where the amount of lentil and wheat production is not so high. There are some reasons behind this such as:

- There is some risk in producing lentil and wheat. The land where lentil is produced need to be fully dry. Lentil cannot tolerate least amount of water. But recently it noted that fluctuation time periods in rainy season and heavy amount of rains in winter season. As a result farmer has the probability to face high loss in lentil production.
- In case of wheat production, the risk is involved in disease such as "wheat blast". The name becomes the grueling word for the wheat producers. Last year a large no. of farmers suffer from this hazard.
- Besides these wheat and lentil both are sensitive in case of insecticide attacks. Last year lentil producers suffer mostly from high insecticide attack.

From the discussion with farmers it also appears that Boro rice production has some social value. Some of the farmers produce Boro rice for traditional reason. It also seems that they even don't know about the comparative profitability of rice with other crops. Some of the farmers think rice as the alternative of money. For example a farmer Mr. Md. Abu Syeed says:

"I don't have any cash, whenever I need cash money I sell rice and meet my necessaries."

Some of them consider storing of rice as the alternative bank account. Such as Mr. Md. Abu Bashar says *"I don't have saving in bank but I have rice."*

6.8 Concluding remarks

On the basis of above discussions, it could thoughtfully be concluded here that cultivation of Boro rice, lentil and wheat were found profitable. However, cultivation of wheat was estimated more profitable than that of other two crops. Cultivation of wheat would help growers to increase their income. But to make this popular to the farmers, necessary steps should also be taken so that they can come forward to produce other profitable Rabi crops than rice.

Chapter 7

CHALLENGES FACED BY FARMERS

Agricultural work is never easy. As the work is always combined of different sub work so the whole procedure is highly complicated. In winter season as there is a scarcity of natural water resources so almost the whole irrigation system depends on underground water in the study areas. Farmers face a number of challenges during Rabi season in producing Rabi crops.

The information about challenges faced by farmers are obtained from the close discussion with the farmers, discussion with the sub assistant agricultural officers and general over view in the area with close observation. Some of them are discussed below from these above perspectives.

7.1 Climatic condition

Seasons have changed during last decades. Time period has shifted of winter season. Farmers face climatic adversity during Rabi season. Some of the crops of Rabi season are highly sensitive in water. Small amount of water can destroy the whole production such as lentil. But in recent years it is noticed that raining is a common phenomenon in Rabi season. Early coming of rainy season also makes the situation adverse for the farmers for harvesting Rabi crops. At the mid April to first May raining is a common phenomenon which made the harvesting work complicated for Rabi crops. Such as Mr. Md. Sabuj says:

"Fluctuation time period in rainy season made the post-harvest work worse."

7.2 Lease complexity

Leasing or rental arrangement is not so easy in the study area. As large portion of the crops are produced in rental or lease based they face the complexity. Some of the land owners demand cash money for leasing land and some of them demand portion of crops. So maintaining the system is really difficult for the farmers. Besides these they don't have the surety whether they get the land for next year. In case of crop sharing most of the land owners demand one third of the produced crop and cash demanding land owner demand Tk. 71854.53 (Field survey 2018) per year which is really high for farmers. A farmer Md. Naimul Islam says:

"The same field with two kinds of tax issues making the production system complicated."

7.3 Access to capital

Most of the farmers in the study area have a few amount of land for crop cultivation for their own. So they have to depend on land owners for crop cultivation. Besides this other capital access is also low for the farmers. It is said by the farmers often that the capital requirement for crop production is not so much available to them. Sometimes they have to wait for the prerequisites. Lack of information make the situation worse as it is often occur that they don't even know about the availability of capital.

7.4 Problems in water supply

Farmers face a variety of problems in case of water supply such as:

7.4.1 Water scarcity

Water scarcity is a gigantic problem during Rabi season. All of the farmers have to depend on underground water for crop production as they do not have any common water resources. Irrigation never an easy job and always require supervision. To meet the irrigation demand, BMDA deep tube wells run all day and night long. So for timely irrigation sometimes purchaser need to stay at night and the task is done by male.

Sometimes for water purchasing in due time, some sorts of conflict took place between water buyer and pump operator. It is not often and the effects of the quarrel never last long. Similarly, in case of community tube well especially in the case of electric motor based community tube well, some conflict of interest among male members happen who were responsible for operating and maintaining them, even during field survey researcher had observed quarrel. In the study area, the groundwater level is very low and tube well installation is very costly. For this, majority of the households had no own tube well in their premises.

7.4.2 Insufficient water supply

During Rabi season farmers has to collect water from deep tube well for crop production. They have no common water resources to irrigate their crops or surface water facility. As in winter season the water level decrease, they do face the scarcity or mitigated water flow as Mr. Md. Sabuj says:

"The flow of water is very low and we have to pay the same amount as the payment is hour basis."

Farmers often accuse that they are not getting the amount of water against their payment. In this case the sub assistant agricultural officer Mr. Atanu Sarkar says:

"*During Rabi season the flow of water may fall due to over pressure in lift up the water."*

But in this situation as the farmers have to take the water in prepaid basis there is no consideration about money.

7.4.3 Risk in water collection

There are some risk involve in water collection such as the place of water collection is slippery and thus water collection is risky. Accident often occurs during irrigation time and they have to suffer for the accident. Sometimes it makes the situation worse than general imagination and those farmers have own tube-well facility they have to stay night long which is a toilsome work.

7.4.4 Load-shedding

As the whole irrigation work done in study area through underground water there is a pressure on electricity as a result there is an inconsistency for supplying electricity which we may call load-shedding.

7.4.5 Maintain serial

As the large portion of study area are covered by a single deep tube-well and the number of farmers are high so they don't get the water whenever they want. It often occurs that they have to maintain serial and wait which is really time consuming and tedious. In this context Mr. Md. Saiful Islam says:

"There is some loss of efficiency in agricultural work due to serial maintain for irrigation."

7.4.6 Repair and maintenance cost

Farmers have to bear the cost of repair of deep tube-well and that system is also complicated and it should be noted that the cost is burden for the farmers. The deep tube well drivers do not follow rules properly.

7.4.7 Irrigation cost is high

Farmers have to pay a notable amount which is pre-paid basis. The paid system is hours based and it varies area to area. On an average they have to pay 180-220 Tk. per hour which is also high. As the system is hour based they have to pay the amount if the tub-well runs without considering the amount of water they have.

7.5 Fluctuations of yield price

The prices of the crops are not constant on year basis. In some years, the crop prices are high enough and in some years the prices become so low that farmers can't cover the production cost. The variation is not only year basis but also within the year. At the beginning of the year, prices may be high but with the passing of time prices becoming low. The price variation of within the year for rice may 1300 Tk. to 650 Tk.

Mr. Md. Abu Bashar says: *"At the beginning of the season I sold the crops (Rice) 1200 Tk. per mound but at the end it was 800 Tk. per mound (One mound = 40kg)."*

7.6 Lower access to agricultural extension service

Farmers are not so much familiar with agricultural extension services. Only a few percentages are conscious about the facility. Whenever they face problem about crop production such as fertilizer, insect attack, etc., they go to the dealers or local old aged persons and do as they suggest.

7.7 Government credit facility

In case of credit facility, farmers are not so much interested to taking loan from formal credit institutions. There are some reasons behind this such as NGOs required meeting in every week, complexity in gaining loan from government institution, maintaining pass book etc. instead they prefer loan from local lender and they also think that the procedure is much easier than formal credit institution.

7.8 Lack of quality seed

Most of the Boro rice producers produce the seed by their own but whenever they buy others crop seeds they think that the seed quality is not so high compared the high amount of money they pay for the seed. They are willing to pay but they expect a good quality of seed as they know better yield comes from good quality of seed.

Mr. Md. Sabuj says: *"Sometimes we are having less quality of seed by paying high amount and there is no one to monitor this."*

7.9 Biasness in input distribution

One of my sample farmers who is not interested in mentioning his name says with agitation that,

"Fertilizer and seed are distributed to those farmers who are relatives and close to the chairman. Poor farmers don't get the seed and fertilizer."

From his quote it is clear that farmers are not satisfied with the agricultural input distribution system. They think that biasness is so high and there is no one to monitor this biasness. It often occurs that poor and helpless farmers are totally deprived from these facilities even they don't know about the benefit.

The above mentioned discussions indicate that Rabi crops growers in the study area have currently been facing some major problems in producing Rabi crops during winter season. These are the major constraints for the producers of Rabi crops in the study area. Public and private initiative should be taken to reduce or eliminate these problems for the sake of better production.

Chapter 8
SUMMARY AND CONCLUSION

8.1 Summary of the study

Agriculture is the mainstay of Bangladesh economy. Achievement of rapid agricultural growth, particularly self-sufficiency in food, has been core objective of the development planning since independence.

Agriculture plays a dominant role in the growth and stability of the economy of Bangladesh and more than three quarters of the total population in rural areas derive their livelihood from the agricultural sector. The key findings of the study are summarized in this chapter. In this chapter, the justification and objective of the study are recapitulated and the findings of the study are briefly discussed.
The focus of the study was to examine the socioeconomic status of the major Rabi crops (Boro rice, lentil and wheat) producers. The study also focuses on the estimation of growth rates and trend in area, production and yield of Boro rice, lentil and wheat in the study areas. The study covered the time period of 1979-80 to 2015-16 for the secondary data (area, production and yield of Boro rice, lentil and wheatfor the study areas). The study was based on both primary and secondary data.

8.2 Summary of the findings for objective 1

In case of socioeconomic characteristics, it was found that the average family sizes for Boro rice, lentil and Wheat growers were 4.98 persons, 5.09 persons and 4.56 persons respectively. For Boro rice growers 2.64 members were male and 2.35 members were female. On other hand in the case of lentil growers 3.17 persons were male and 2.13 persons were female and in case of wheat growers 2.25 persons were male and 2.31 persons were female. Average working members for Boro rice, lentil and Wheat growers were 2.36persons, 2.43 persons and 3 persons respectively. For Boro rice growers 1.58 members were male and .78 members were female. On other hand in the case of lentil growers 1.61 persons were male and 0.86 persons were female and in case of wheat growers 1.56 persons were male and 1.44 persons were female.

Average school going children for Boro rice, lentil and Wheat growers were 1.80 persons, 2 persons and 1.75 persons respectively. For Boro rice growers 1.08 members were male and .74 members were female. On other hand in the case of lentil growers 1.56 persons were male and 0.44 persons were female and in case of wheat growers 0.83 persons were male and .92 persons were female.

The highest numbers of family members were in the age group between 31 to 50 years. Lowest number of family members belonged to the age group of 15-30 for both Boro and wheat grower but in case of lentil it belongs to the aged group 50 years. The literacy rate of Boro rice, lentil and wheat farmers was 79.09 percent, 86.96 percent and 87.50 percent, respectively.

Boro rice, lentil and wheat growers were engaged in agriculture as their main occupation by 93.46, 91.30 and 81.25 percent respectively and Boro rice, lentil and wheat growers were engaged in labour selling as their main occupation by 6.36, 8.70 and 18.75 percent respectively.

The cultivated farm size of Boro rice, lentil and wheat growers was 203.01 decimal, 210.74 decimal and 154.70 decimal respectively. Owned farm size of Boro rice, lentil and wheat growers was 89.03 decimal, 96.83 decimal and 9.39 decimal respectively.

In case of Boro rice and wheat grower's highest experience farmers belonged to the group between 26-35 years and lentil grower's highest experience farmers belonged to the group between 5-15 years.

In case of agricultural investment decision, male took 42.73 percent, 34.78 percent and 62.50 percent decision for Boro rice, lentil and wheat grower respectively. Female took the 0.91 percent agricultural investment decision for Boro rice only.

56.36 percent, 65.22 percent and 37.50 percent decision about agricultural investment are taken by male and female both for Boro rice, lentil and wheat growers respectively. In case of crop choice decision, male took 43.64 percent, 34.78 percent and 50 percent decision for Boro rice, lentil and wheat grower respectively. Female took the 4.31 percent crop choice decision for lentil only.56.36 percent, 60.87 percent and 50 percent decision about crop choice are taken by male and female both for Boro rice, lentil and wheat growers respectively.

8.3 Summary of the findings for objective 2

The study shows that all the growth rates have positive sign except lentil production area for all periods and wheat production area in Rajshahi for the periods 2000-01 to 2015-16. It indicates that the growth rate has increased except those three periods. The estimated growth rates for Boro production area 10.5 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of Boro rice production area was 1.4 and 0.3 percent in Chapai-Nawabgonj and Rajshahi respectively which is lower than previous time periods and lastly the growth rate of Boro rice production area for all time periods (1979-80 to 2015-16) was 6.6 and 6.2 percent in Chapai-Nawabgonj and Rajshahi respectively. The overall trend line shows the slight uprising trend of Boro rice production area over the year for both Chapai-Nawabgonj and Rajshahi districts.

Study shows that in the periods 1979-80 to 1999-00 the growth rate of Boro rice production was 11.9 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of Boro rice production was 2.3 and 1.8 percent in Chapai-Nawabgonj and Rajshahi respectively and the growth rate of Boro rice production for all time periods (1979-80 to 2015-16) was 8 and 7.9 percent in Chapai-Nawabgonj and Rajshahi respectively and there is a uprising trend for Boro rice production over the year for both districts.

The periods 1979-80 to 1999-00 the growth rate of lentil production area was 1.6 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of lentil production area was 7.7 and 7.6 percent in Chapai-Nawabgonj and Rajshahi respectively. For the all periods it showed from the study that the co-efficient for production area in Chapai-Nawabgonj and Rajshahi showed a negative sign which implies that production had decreased in this time periods in both district. Now the growth rate of lentil production area was -0.6 and -0.7 percent in Chapai-Nawabgonj and Rajshahi respectively for the time period 1979 to 2016. The overall trend of lentil production area had a decreasing trend over the time periods.

In the periods 1979-80 to 1999-00 the growth rate of lentil production was 1.7 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of lentil production was 9.8 and 11.3 percent in Chapai-Nawabgonj and Rajshahi respectively which is lower than previous time periods.

Now the growth rate of lentil production for all time periods (1979-80 to 2015-16) was .3 and .6 percent in Chapai-Nawabgonj and Rajshahi respectively which is dramatically low then previous two subsector. The overall trend of lentil production had a decreasing trend for Rajshahi districts over the time periods but in Chapai-Nawabgonj district production trend of lentil production continually and slowly uprising.

The study implies in the period 2000-01 to 2015-16 growth of wheat production area was decreased and that was 0.5 percent. In the periods 1979-80 to 1999-00 the growth rate of wheat production area was 2.8 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of lentil production area was 9.8 percent in Chapai-Nawabgonj. Now the growth rate of wheat production area was 4.3 and 1.6 percent in Chapai-Nawabgonj and Rajshahi respectively for the time period 1979 to 2016.

In the periods 1979-80 to 1999-00 and 2000-01 to 2015-16 it showed from study that in the periods 1979-80 to 1999-00 the growth rate of wheat production was 3.5 percent for both Chapai-Nawabgonj and Rajshahi and in the periods 2000-01 to 2015-16 the growth rate of wheat production was 12.6 and 2.7 percent in Chapai-Nawabgonj and Rajshahi respectively. Now the growth rate of wheat production for all time periods (1979-80 to 2015-16) was 5.8 and 3 percent in Chapai-Nawabgonj and Rajshahi respectively. Study showed there had a rapid uprising and slight uprising trend in both wheat production area and whear production Chapai-Nawabgonj and Rajshahi district respectively.

From the study it founds that the growth rate of Boro rice, lentil and wheat yield was 1.4, 0.1 and 0.8 percent respectively in Chapai-Nawabgonj district for the time period 1979-80 to 1999-00 and the growth rate of Boro rice, lentil and wheat yield was 1, 2.1 and 2.8 percent respectively in Chapai-Nawabgonj district for the time period 200-01 to 2015-16. Now the growth rate of Boro rice, lentil and wheat yield was 1.4, 0.9 and 1.5 percent respectively in Chapai-Nawabgonj district for the all periods. It can be say that from the study that the yield of Boro rice and wheat in Chapai-Nawabgonj districts was sharply fluctuated over time. In case of lentil production the trend was more steady then the other two crops.

It is also founds that from the study the growth rate of Boro rice, lentil and wheat yield was 1.2, 0.1 and 0.8 percent respectively in Rajshahi district for the time period 1979-80 to 1999-00 and the growth rate of Boro rice, lentil and wheat yield was 1.6, 3.7 and 3.1 percent respectively in Rajshahi district for the time period 200-01 to 2015-16. Now the growth rate of Boro rice, lentil and wheat yield was 1.6, 1.3 and 1.4 percent respectively in Rajshahi district for the all periods.). Study found that in case of lentil production the trend was more steady where the trend of yield of Boro rice and wheat in Rajshahi district was sharply fluctuated over time.

8.4 Summary of the findings for objective 3

Relative profitability analysis was done to compare costs and returns of Boro rice, lentil and wheat production.It was observed that per hectare power tiller cost of Boro rice, lentil and wheat production was Tk. 11937.45, Tk. 5066.00 and Tk. 4441.01 respectively. Per hectare average seed cost of Boro rice, lentil and wheat was estimated Tk. 5405.02, 3754.45 and 3197.28 respectively. The amount of human labour used for Boro rice cultivation was 205.42 (both family and hired labour) man-days per hectare while this was 35.59 and 60.63 man-days per hectare for lentil and wheat production respectively.

Per hectare use of Urea, TSP, MOP, DAP for Boro rice production were 253.84 kg, 87.20 kg, 112.53 kg and 163.36 kg whose costs were estimated at Tk. 4177.94, Tk. 2306.17, Tk. 1784.63, and Tk. 4579.47 respectively. Per hectare use of Urea, TSP, MOP, DAP for lentil production were 19.32 kg, 46.33 kg, 46.21 kg and 110.23 kg whose costs were Tk. 311.82, Tk. 1049.15, Tk. 706.29 and Tk. 2944.79 respectively. Per hectare use of Urea, TSP, MOP, DAP for wheat production were 164.67 kg, 29.94 kg, 225.79 kg and 83.58 kg whose costs were Tk. 2634.67, Tk. 703.58, Tk. 3461.41 and Tk. 2290.11 respectively. It was found that cost of cowdung for Boro rice and wheat production was Tk. 4781.22 and Tk.2045.86 and absence of manure cost in lentil production. Per hectare cost of irrigation water of Boro rice and wheat production was Tk. 18455.39 and Tk. 2609.72 covering 12.12 and 3.98 percent of total cost, respectively absence of irrigation cost in lentil production.

It was found that per hectare cost of insecticides and pesticides for Boro rice, lentil and wheat production were Tk. 7164.22, Tk. 2714.81 and Tk. 1521.92 and per hectare cost of weedicide for Boro rice, lentil and wheat production were Tk. 2422.18, Tk. 231.67 and Tk. 573.84 respectively and per hectare land use cost was estimated at Tk. 23951.52.

8.5 Summary of the findings for objective 4

The objective 4 was to find out the challenges faced by the farmers during Rabi seasons. The study identified some major challenges which were reported by farmers in Rabi season. Among them, most of the farmers mentioned that water scarcity, insufficient water supply and high irrigation cost were major challenges during Rabi season. Some farmers reported that they did not get help from the government in time. They also reported the indifference of the sub assistant agricultural officer and agricultural officer in field level work. Besides theses, they reported the problems capital access, fluctuating climatic condition, yield price deviation in the study areas. Lease complexity, low quality of seeds and biasness of distribution in agricultural input among farmers also depict major challenges faced by farmers.

8.6 Conclusion

There is an important role of agricultural sector in the developing countries which can accelerate the growth of the economy. Most of the national policies and planning of the developing countries are reflected by the agriculture sector. Both developed and developing countries pursued different policy to protect agriculture, to obtain self-sufficiency in food for domestic consumer, price support and protect the producer from the global competition etc.

From the study it can be conclude that the overall trend of production area and trend of production for Boro rice and wheat was uprising for both districts but in case of lentil production area there was a downward trend over the time period and in case of lentil production the trend is slightly high for Rajshahi districts and almost constant for Chapai-Nawabgonj. There is a uprising yield trend for Boro rice and wheat for both production and production area for both districts but in case of lentil the trend is almost constant.

From the results of the present study, it can be concluded that considerable scope apparently exists in the study area to increase the productivity of Boro rice, lentil and wheat to increase income of growers. The study revealed that wheat growing was relatively more profitable than Boro rice and lentil production. The economic profitability analysis demonstrates that Bangladesh enjoys profitability of many non-rice crops, implying that Bangladesh has more profitable options other than production of Boro rice. Several other cereal crops such as wheat, pulse specially lentil, have economic returns that are as high as or higher than rice.

8.7 Policy Recommendation

The study revealed that Boro rice, lentil and wheat were profitable crops. There was a great opportunity to increase the productivity of Boro rice, lentil and wheat to their highly nutritious value and demand in the country. Several policy recommendations emerged from the results of this research which are highlighted bellow:

i. Improved of irrigation facility with lower cost and continue water flow should be ensured to make the irrigation facility improvised.
ii. Capital shortage was one of the severe problems faced by the farmers. Without institutional credit support. It is therefore, necessary that credit on easy terms be provided to the farmers for the entire area under Boro rice, lentil and wheat production.
iii. Scarcity of quality seeds was a serious problem for Boro rice , lentil and wheat production. So variety development programme may be undertaken by the relevant Research Institutes.
iv. Regular supply of fertilizer should be ensured and biasness should be controlled strictly.
v. Modern technology should be disseminated by the extension workers for improving the efficiency in producing these crops.
vi. To control price fluctuation and ensure fair price to the growers, it is necessary to have government intervention particularly in the procurement and marketing of Rabi crops.

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Appendices

Production area, Production and yield for Boro rice, Lentil and wheat in Rajshahi district over time (1979-80 to 2015-16)

Year	Boro Rice			Lentil			Wheat		
	Production Area	Production	Yield	Production Area	Production	Yield	Production Area	Production	Yield
1979-80	7809.49	16996.60	2.18	16613.68	12034.21	0.72	15371.25	29581.73	1.92
1980-81	6956.70	19385.47	2.79	15099.90	10729.68	0.71	20302.71	41698.32	2.05
1981-82	9221.00	22881.47	2.48	11586.15	7713.15	0.67	14408.61	25348.13	1.76
1982-83	10479.36	26256.37	2.51	11724.02	8306.70	0.71	20490.19	38319.64	1.87
1983-84	12409.16	33734.83	2.72	10988.99	8073.33	0.73	17858.25	39375.81	2.20
1984-85	11723.42	32124.08	2.74	10572.96	7416.75	0.70	26543.65	54146.19	2.04
1985-86	18525.32	48020.61	2.59	9881.36	6260.42	0.63	20850.73	30326.21	1.45
1986-87	22149.68	58381.46	2.64	23618.24	15158.79	0.64	18779.79	39097.96	2.08
1987-88	23961.54	64542.46	2.69	23848.57	15524.98	0.65	18469.01	33202.63	1.80
1988-89	30986.77	69854.49	2.25	23887.90	13392.40	0.56	16622.32	31047.54	1.87
1989-90	34870.48	84529.84	2.42	23163.80	14767.47	0.64	17272.74	27976.99	1.62
1990-91	34318.29	103489.40	3.02	22392.48	13109.13	0.59	18100.53	32874.92	1.82
1991-92	34935.01	105507.88	3.02	22277.09	14639.90	0.66	20550.76	37284.84	1.81
1992-93	36653.66	108436.69	2.96	21849.68	15020.72	0.69	21563.16	44312.92	2.06
1993-94	38316.76	117907.39	3.08	21665.96	15043.23	0.69	21677.09	42467.74	1.96
1994-95	41433.04	115743.58	2.79	21612.06	14726.20	0.68	21806.88	43628.99	2.00
1995-96	43734.11	129065.54	2.95	19511.43	14101.51	0.72	26043.95	54892.46	2.11
1996-97	44122.93	130960.89	2.97	19251.80	13998.33	0.73	25735.32	54336.76	2.11
1997-98	45012.48	140076.34	3.11	19143.24	13874.52	0.72	28958.55	65415.00	2.26
1998-99	56227.81	184660.49	3.28	12871.73	9126.49	0.71	31382.82	66636.81	2.12
1999-00	59517.27	192851.48	3.24	11540.15	7918.38	0.69	34793.52	81063.44	2.33
2000-01	65024.46	214281.66	3.30	10859.93	7471.90	0.69	32667.78	75449.52	2.31
2001-02	65753.09	212947.45	3.24	9852.52	6895.99	0.70	31557.32	73205.38	2.32
2002-03	68687.22	226459.14	3.30	9206.46	6460.77	0.70	30647.32	70922.05	2.31
2003-04	71993.82	242419.25	3.37	8445.77	5804.19	0.69	28625.41	69279.91	2.42
2004-05	72449.70	257324.30	3.55	7850.59	5702.88	0.73	27433.18	58089.83	2.12
2005-06	70776.31	257266.77	3.63	7169.61	5549.06	0.77	26489.57	45515.50	1.72
2006-07	72095.00	288752.00	4.01	7484.66	6036.80	0.81	25481.00	48464.00	1.90
2007-08	78451.00	341679.00	4.36	6836.64	6391.36	0.93	26525.00	59013.00	2.22
2008-09	79161.00	326367.00	4.12	6776.21	6249.16	0.92	27878.00	63053.00	2.26
2009-10	71246.00	272891.00	3.83	10712.81	9900.88	0.92	27071.00	67894.00	2.51
2010-11	72966.00	292510.00	4.01	12391.18	10644.88	0.86	27487.00	72385.00	2.63
2011-12	76502.00	311571.00	4.07	14567.41	12463.05	0.86	27541.00	87008.00	3.16
2012-13	74714.00	302834.00	4.05	16241.99	16132.03	0.99	29929.00	97422.00	3.26
2013-14	73136.00	286350.00	3.92	24203.86	31662.00	1.31	29469.00	92475.00	3.14
2014-15	72458.00	298819.00	4.12	26516.24	32084.00	1.21	28691.00	93684.00	3.27
2015-16	70072.00	284455.00	4.06	27737.18	28402.00	1.02	27623.00	89994.00	3.26

Production area, Production and yield for Boro rice, Lentil and wheat in Chapai Nawabganj district over time (1979-80 to 2015-16)

Year	Boro Rice			Lentil			Wheat		
	Production Area	Production	Yield	Production Area	Production	Yield	Production Area	Production	Yield
1979-80	4742.99	10322.67	2.18	9218.93	6677.78	0.72	4241.41	8162.52	1.92
1980-81	4225.06	11773.52	2.79	8378.93	5953.90	0.71	5602.15	11505.86	2.05
1981-82	5600.26	13896.78	2.48	6429.15	4280.03	0.67	3975.78	6994.34	1.76
1982-83	6364.51	15946.48	2.51	6505.65	4609.39	0.71	5653.88	10573.58	1.87
1983-84	7536.55	20488.43	2.72	6097.79	4479.89	0.73	4927.65	10865.01	2.20
1984-85	7120.07	19510.16	2.74	5866.94	4115.55	0.70	7324.22	14940.62	2.04
1985-86	11251.12	29164.72	2.59	5483.16	3473.90	0.63	5753.36	8367.94	1.45
1986-87	13452.33	35457.25	2.64	13105.76	8411.61	0.64	5181.93	10788.34	2.08
1987-88	14552.74	39199.06	2.69	13233.57	8614.81	0.65	5096.17	9161.64	1.80
1988-89	18819.43	42425.25	2.25	13255.39	7431.44	0.56	4586.62	8566.98	1.87
1989-90	21178.15	51338.14	2.42	12853.59	8194.47	0.64	4766.08	7719.72	1.62
1990-91	20842.78	62853.00	3.02	12425.58	7274.25	0.59	4994.50	9071.21	1.82
1991-92	21217.34	64078.90	3.02	12361.55	8123.68	0.66	5670.59	10288.05	1.81
1992-93	22261.14	65857.67	2.96	12124.38	8335.00	0.69	5949.95	12227.31	2.06
1993-94	23271.21	71609.59	3.08	12022.44	8347.49	0.69	5981.38	11718.17	1.96
1994-95	25163.84	70295.42	2.79	11992.53	8171.56	0.68	6017.20	12038.60	2.00
1995-96	26561.36	78386.35	2.95	10826.89	7824.92	0.72	7186.33	15146.54	2.11
1996-97	26797.51	79537.47	2.97	10682.82	7767.67	0.73	7101.18	14993.20	2.11
1997-98	27337.77	85073.62	3.11	10622.58	7698.97	0.72	7990.56	18050.03	2.26
1998-99	34149.26	112151.25	3.28	7142.52	5064.29	0.71	8659.49	18387.17	2.12
1999-00	36147.07	117125.94	3.24	6403.62	4393.91	0.69	9600.61	22367.92	2.33
2000-01	39491.80	130141.30	3.30	6026.17	4146.16	0.69	9014.06	20818.87	2.31
2001-02	39934.32	129330.98	3.24	5467.16	3826.58	0.70	8707.65	20199.64	2.32
2002-03	41716.32	137537.14	3.30	5108.66	3585.08	0.70	8456.55	19569.60	2.31
2003-04	43724.55	147230.31	3.37	4686.56	3220.74	0.69	7898.64	19116.48	2.42
2004-05	44001.43	156282.71	3.55	4356.29	3164.53	0.73	7569.67	16028.79	2.12
2005-06	42985.11	156247.77	3.63	3978.41	3079.17	0.77	7309.30	12559.14	1.72
2006-07	43786.00	171529.00	3.92	4153.24	3349.82	0.81	7031.00	15228.00	2.17
2007-08	51499.00	206666.00	4.01	3793.65	3546.56	0.93	14032.00	37354.00	2.66
2008-09	50880.00	197015.00	3.87	3760.12	3467.66	0.92	8891.00	23741.00	2.67
2009-10	48915.00	168530.00	3.45	5944.54	5494.00	0.92	12197.00	35010.00	2.87
2010-11	50502.00	190666.00	3.78	6875.86	5906.84	0.86	15077.00	44712.00	2.97
2011-12	53178.00	202009.00	3.80	8083.45	6915.75	0.86	15228.00	36619.00	2.40
2012-13	50517.00	198404.00	3.93	9012.68	8951.66	0.99	21655.00	68573.00	3.17
2013-14	50718.00	196834.00	3.88	13430.72	11016.00	0.82	29395.00	93108.00	3.17
2014-15	48744.00	182010.00	3.73	15658.11	13156.00	0.84	28117.00	90176.00	3.21
2015-16	48045.00	177641.00	3.70	15390.61	14294.00	0.93	30813.00	98197.00	3.19