PROFITABILITY OF BORO RICE CULTIVATION IN THE SELECTED AREAS OF JASHORE DISTRICT IN BANGLADESH

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PROFITABILITY OF BORO RICE CULTIVATION IN THE SELECTED AREAS OF JASHORE DISTRICT IN BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled '**PROFITABILITY OF BORO RICE CULTIVATION IN THE SELECTED AREAS OF JASHORE DISTRICT IN BANGLADESH**' submitted to the Faculty of Agribusiness Management, Sher-E- Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science in Agricultural Economics,** embodies the result of a piece of bonafide research work carried out by **SHARMIN AKTAR RUSHI**, Registration Number: **13-05458** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

…………………………………..

Dr. Rokeya Begum
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DEDICATED TO

MY BELOVED PARENTS

PROFITABILITY OF BORO RICE CULTIVATION IN THE SELECTED AREAS OF JASHORE DISTRICT IN BANGLADESH

ABSTRACT

The purpose of the study was to describe the socio-economic characteristics of Boro rice farmers; to estimate the cost and return of Boro rice cultivation; to find out the factors that affecting profitability of Boro rice cultivation and to identify problem faced by the farmers in Boro rice production. The study was undertaken purposively in Chaugachha upazila under Jashore district. Validated and well- structured interview schedule (questionnaire) was used to collect data from 90 boro rice cultivars during 1st June, 2019 to 30th June, 2019. Per hectare gross return of boro rice cultivation under small, medium and large farms were Tk. 144520, Tk. 146654 and Tk. 146893. Per hectare gross margin were Tk. 80457, Tk. 77711 and Tk. 72129 per hectare for small, medium and large boro rice farm. Total net return was estimated Tk. 44475, Tk. 47109 and Tk. 41065 for small, medium and large boro rice farm per hectare. Benefit Cost Ratio (BCR) were 1.44, 1.47 and 1.40 for small, medium and large boro rice farm. Cobb-Douglas production function analysis was carried out for examining the factors affecting the profitability of input use. In most of the cases the coefficients of seeds, irrigation, TSP, manure, pesticides and zinc sulphate had significant positive effect on production of boro rice farms, but human labor showed negative significant effect on boro rice cultivation. The values of the coefficient of multiple determination of rice production was 0.87 which implied that about 87 percent of the total variation in the gross return could be explained by the included explanatory variables of the model. Resource use efficiency indicated that all of the resources were under-utilization for rice production except over- utilization of human labor and TSP. Low yield and unstable price was the 1st problems in the study and natural calamities was the last problem.

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June, 2020 ***The Author***

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ABBREVIATIONS

BBS	Bangladesh Bureau of Statistics
TPS	True Potato Seed
BARI	Bangladesh Agricultural Research Institute
GDP	Gross Domestic Product
BCR	Benefit Cost Ratio
NGOs	Non-Governmental Organization
BB	Bangladesh Bank
MP	Murate of Potash
HYV	High Yielding Variety
TSP	Triple Super Phosphate
STW	Shallow Tube Well
DTW	Deep Tube-Well
SPSS	Statistical Package for Social Science
LUC	Land Used Cost
TVC	Total Variable Cost
NR	Net Return

CHAPTER-I
INTRODUCTION

1.1 Background of the Study

Bangladesh is first and foremost an agricultural based country restrained by crop production. Bangladesh is the 8th most populous country in the world with a total population of 161 million, population growth rate is 1.37 (BBS, 2020) and its density of population is 1109 persons per km^2 (BBS, 2020). More than 70 percent of the country's population as well as 45.1 percent of its labour force are directly and indirectly being dependent on agriculture and contributing 13.35 percent to the GDP (BBS, 2020). Bangladesh escalates by and large a sub-tropical monsoon climate. Bangladesh has been reputed for growing large variety of tropical crops particularly rice, wheat, maize, jute, pulses, oilseeds, sugarcane etc. Rice is one of the utmost indispensable cereals crops and it is one of the foremost crops in the world. The fertile soils and subtropical monsoonal climate make Bangladesh much suitable for rice cultivation, although rice is not a new crop. Before independence in 1971, rice was cultivated across Bangladesh except in a few tribal areas of the Southeastern Chittagong Hill Tracts (BBS, 2020).

Rice is the staple food of over half the world's population. It is the predominant dietary energy source for 17 countries in Asia and the Pacific, 9 countries in North and South America and 8 countries in Africa. Rice provides 20% of the world's dietary energy supply, while wheat supplies 19% and maize (corn) 5%.

Cooked, unenriched, white, long-grained rice is composed of 68% water, 28% carbohydrates, 3% protein, and negligible fat. In a 100 gram serving, it provides 130 calories and contains no micronutrients in significant amounts, with all less than 10% of the Daily Value (DV). Cooked, white, short-grained rice also provides 130 calories and contains moderate amounts of B vitamins, iron, and manganese (10–17% DV) per 100 gram amount.

A detailed analysis of nutrient content of rice suggests that the nutrition value of rice varies based on a number of factors. It depends on the strain of rice, such as white, brown, red, and black (or purple) varieties having different prevalence across world regions.[16] It also depends on nutrient quality of the soil rice is grown in, whether and how the rice is polished or processed, the manner it is enriched, and how it is prepared before consumption.

Rice is cultivating in two seasons, rabi and kharif in Bangladesh. Non-water logging soil such as sandy loam or loamy soil is the best for rice cultivation. Optimum temperature for rice cultivation is between 24c to 29c. Timely sowing is the preconditions for higher yield. Time of sowing and harvesting of rice production are given below:

Table 1.1 Time of sowing and harvesting time of rice production in Bangladesh

Season	Sowing time	Harvesting time
Rabi	1st November-1st December	4th March-3rd April
Kharif	Mid-March-4th April	Mid June-4th July

Source: BBS, 2020

1.2 Production of boro rice

Rice (*oryza sativa*) is the utmost extensively grown cereal crop in the world. Rice is an industrially significant money-making crop. In the middle of the world's cereal crops, rice ranks first to wheat in production. Nonetheless, amongst the developing countries rice rank first in Latin America and Africa but third after maize and wheat in Asia (Dowswell et al., 1996). As the demand for rice crop has been shifting increasingly in the world, particularly in the developing countries, its requirement will also increase from 282 million tons in 1995 to 504 million tons in 2020.

According to a recent US Department of Agriculture's (USDA) report, farmers in Bangladesh earn over $2,275 by investing $1,421 for every hectare of maize. Boro fetches them $1,081 against an investment of $1,319, a loss-making project, it claimed. And comparing to maize, growing wheat is less profitable too. Farmers can earn a little over $823 from per hectare of wheat farming with an investment of $663, stated the USDA report "Bangladesh: Grain and Feed Annual 2016". "The gross margin from maize sales, per hectare, is 2.4 times greater than that of wheat or rice. Maize also has fewer pest and disease problems," said a report of the UN Food and Agriculture Organization (FAO).

Rice is the first grain crop in Bangladesh. It can be grown in all the three seasons of the year. Boro rice is, however, found to be predominant with a share of 84% of the country's total rice area. Among different districts, Dinajpur, Chuadanga, Takurgaon, Lalmonirhat, Rajshahi, Kushtia, Rangpur and Bogra are noted to be more progressive in rice production with higher rates of growth. Highest production of rice occurred in Rajshahi division and Dhaka division is in 2nd position.

Table 1.2 Division wise area and production of rice in Bangladesh

Division	2016-17		2017-18	
	Area (acre)	Production (M. ton)	Area (acre)	Production (M. ton)
Barishal	321708	485567	323883	493378
Chittagong	1522105	2342992	1496836	2343174
Dhaka	1763479	3044422	1901208	3311552
Khulna	1417355	2391068	1483049	2477058
Mymensingh	1530615	2495197	1671853	2769727
Rajshahi	2000911	3301628	2039126	3359883
Rangpur	1892801	3118570	2004696	3264849
Sylhet	611363	834305	1087332	1556199
Bangladesh	11060337	18013749	12007983	19575819

Source: BBS, 2020

Table 1.3 Rice growing upazila of Khulna district (2017-18)

District	Area (acres)	Production (M. Ton)
Jessore	395637	669316
Jhenaidah	213297	366404
Chuadanga	95706	146744
Khulna	120618	194455
Kustia	70446	115237
Magura	105507	178989
Satkhira	176605	282007
Bagerhat	125609	219577
Meherpur	33674	55837
Narail	145950	248491

Source: BBS, 2020

In 2017-18 total rice production was 669316 M. Ton in Jessore, while total rice production was 2477058 M. Ton in Khulna district (BBS, 2020). It indicates that rice production is increased over the years.

Since 2010 to 2019, rice production showed progressive growth compared to other cereals. Compared to 2010-2011, rice production almost doubled in 2017-2018. It indicated steady growth.

Table 1.4. Production of Major crops in Bangladesh

Production of Major Crops						
Major Crops	**2015-16**		**2016-17**		**2017-18**	
	Area ‘000, Acres	**Production ‘000, M. tons**	**Area ‘000, Acres**	**Production ‘000, M. tons**	**Area ‘000, Acres**	**Production ‘000, M. tons**
Aus	2516	2288	2327	2134	2657	2710
Aman	13814	13484	13797	13656	14035	13993
Boro	11794	18938	11060	18014	12008	19576
Wheat	1099	1348	1026	1311	868	1099
Major cereals	29223	36058	28210	35115	29566	37377
Maize	827	2445	963	3026	990	3288
Jute	1675	7559	1823	8247	1873	8895

(BBS, 2020)

1.3 Justification of the Study

Bangladesh is one of the high populous countries in the world. For this it is essential for Bangladesh to diversify crops for increasing population to ensure food security. Rice has a great prospect in Bangladesh. It is one of the most important and fastest expanding cereal in our country. Total rice production in Jashore district was 669316 M. Tons in 2017-18. The area under rice cultivation is increased also. So, there had great research opportunity on profitability analysis of rice cultivation in Jashore district. Again, the principal consumption of rice is in the form of feed for poultry although some dairy farms use rice as feed grains and its plants as green fodder for the cattle. Demand for rice in the country is growing and is expected to increase further with the establishment of new poultry, dairy and fish farms. Like other crop growers, rice farmers are also not very aware about the input use efficiency of rice cultivation. The rural farmers are often suffer from risk and uncertainty. It is expected from this study to provide valuable information and useful for formulating appropriate policy for widespread cultivation of rice.

1.4 Objectives of the study

The overall goal of the study is to examine the profitability of Boro rice production in some selected areas of Jashore district in Bangladesh. The specific objectives of the study are as follows:

i. To describe the socio-economic characteristics of boro rice farmers;
ii. To estimate the cost and return of Boro rice cultivation;
iii. To find out the factors that affecting profitability of Boro rice cultivation;
iv. To identify the problem faced by the farmers in Boro rice cultivation.

1.5 Assumption of the Study

Boro rice is the most important cereal crop in terms of area of production contribution to the national income and national economic development substantial area is devoted to boro rice production and millions of farmers have been growing boro rice in this country. Despite the fact that boro rice is cultivated extensively in Bangladesh, per hectare yield is much lower in comparison with that of other paddy growing countries of the world. In order to meet this deficit, yield per unit area of boro rice should be increased. The number of landless laborers, disguised and unemployed population is increasing gradually. Therefore, it is necessary to produce food grain to meet food requirements for the increased population.

Bangladesh is the ninth most populous country in the world. The Government of Bangladesh has given too much emphasis on paddy production. Then every year Bangladesh imports rice. In 2016 Bangladesh has imported 50 tons of rice. Bangladesh soil is suitable for producing rice. In the past a few studies have been made on the profitability of boro rice in Bangladesh. But there is no exclusive study on the profitability of boro rice particularly in the Jashore district. As such it was felt that a study on the rice in the area Jashore district would be of much importance. This is obviously due to the fact that development basically means larger size productive activities in the economy. But we cannot have more of production unless the goods produced are actually sold out and selling depends on the proper marketing conditions. Besides, the results also would serve as a reference for researchers to embark upon similar or related work in other parts of the country. Some arguments supporting the importance of this study are presented below:

- Firstly, the study helps to know about the socio-economic condition of the farmers.
- Secondly, it is very much important to know about production of boro rice in the study area and analysis of production cost and margins of the farmers. It helps to identify the different cost items, the share of different cost items to total marketing cost.

- Fourthly, it is important to know the marketing costs and marketing margins of intermediaries. It helps to identify the different cost items, the share of different cost items to total marketing cost. Also, it helps to identify who are the most bearer of marketing cost, the level of marketing margin and net margin of market functionaries. Since all of these costs and margins indeed influence the market participants in participating in the markets. So this study will give some shed in this line.

- Finally, problems of farmers and solutions and recommendations are important for government officials, non-government organizations and policy makers to formulate effective marketing policy for efficient rice production and marketing. This study will help in this regard.

The study would provide useful information to the producers, traders, consumers, future researcher and planners of this boro rice. This study has been conducted on profitability analysis which has important policy implications for farmer, and the policy makers in Bangladesh.

1.6 Limitation of the Study

During the period of data collection, the following problems were encountered by the author:

i. Most of the respondents were not well educated. They had no previous idea about such a study. They were suspicious about the researcher and therefore did not cooperate and it was therefore difficult to explain the purpose of this research to convince them. At last the respondents were convinced.

ii. Most of the farmers were fearful of imposition of taxes. Their anxiety was that the researcher might use the information against their interest.

iii. The respondents (farmers and intermediaries) did not keep records of their farming business and business activities; they had difficulty in recalling information. It was an added problem co the researcher to collect the reliable data because most of the fanners provided information from their memory.

iv. Sometimes the producer-respondents were not available at their home because they remained busy with their outside work. This is why some times more than two visits were required to get information from them. So, the author had to give extra effort and time to collect the information

v. The respondents always had a tendency not to provide correct data relating to the size of their holding, income and expenditure received from different activities. Because most of the respondents in the study area thought that the investigator was a government officer. They initially hesitated to answer the question relating to their income and expenditure. The respondents thought that new taxes would be imposed on them if correct information was provided. When they understood then they gave relevant data.

vi. Farmers provided data in local units of measures in response to questions which created complexity in analyzing the data. vii. There was a time limitation so all data and other necessary information was collected within the shortest possible time.

1.7 Outline of the Study

This thesis contains a total of eight chapters which have been organized in the following sequence. Chapter 1 includes introduction. The review of literature is presented in Chapter 2. Methodology of the relevant study is discussed in Chapter 3. Chapter 4 contains the socio- demographic profile of the boro rice producing farmers. Chapter 5 deals with the profitability of boro rice cultivation. Chapter 6 describes the factors affecting returns of boro rice cultivation. Chapter 7 presents problems of boro rice cultivation. Finally, Chapter 8 represents the summary, conclusion and policy recommendations to increase boro rice production.

CHAPTER II
REVIEW OF LITERATURE

2.1 Introduction

The main purpose of this chapter is to review some related studies in connection with the present study. Although a lot of studies have been done on costs and returns of rice production in Bangladesh, only a few studies have so far conducted related to profitability of rice production under different area. This study highlights only a few of the studies, which are considered and very relevant for this research. Again, some of these studies may not entirely relevant to the present study, but their findings, methodology of analysis and suggestions have a great influence on the present study and all of these studies have been conducted on Bangladesh, so it has great influence on the present study. Therefore, some of the literatures related to the present study are briefly discussed below:

Akter et al. (2019) conducted a study on Factors determining the profitability of rice farming in Bangladesh. The finding of cost-benefit analysis reveals that rice farming is a profitable activity in Bangladesh as the estimated cost of production was lower than the return in the selected study areas. However, the profitability differs among different farmers' group and large farmers are more profitable in rice cultivation than small and medium farmers. In addition, the functional analysis identifies three inputs such as the cost of power tiller, fertilizer and hired labor as the significant determinants of profitability for all farmers in the study regions. Moreover, these factors also differ across the farmer's groups except the cost of fertilizer.

Sujan et al. (2017) conducted a study on financial profitability and resource use efficiency of boro rice cultivation in some selected area of Bangladesh. Result based on Farm Budgeting model showed that per hectare variable cost and total cost of production was BDT (Bangladeshi Taka) 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

Islam et al. (2017) conducted a study on Profitability and productivity of rice production in selected coastal area of Satkhira district in Bangladesh. The study found that the small farmers (Tk. 10292.89) got higher net returns than the medium (Tk. 6894.39) and large (Tk. 4798.70) farmers per hectare, respectively. The undiscounted BCR was 1.38, 1.23 and 1.15 for small, medium and large farmers respectively. It is found that the coefficient of seed, fertilizer, power tiller, irrigation cost and human labor have significantly impact on gross return.

Toma et al. (2015) conducted a study on financial profitability of aromatic rice production in some selected areas of Bangladesh. Total costs for aromatic rice was estimated at Tk. 64446.51 per hectare and per hectare gross return of aromatic rice was Tk. 114243.71. Gross margin for aromatic rice was estimated at Tk. 59999.29 per hectare. Thus, the net return was estimated at Tk. 49797.20 for aromatic rice production. The undiscounted Benefit Cost Ratio on the basis of total cost was 1.77 implying that the aromatic rice production was highly profitable.

Long (2015) conducted a study on "Comparative analysis of resource use efficiency between organic rice and conventional rice production in Mekong Delta of Vietnam. 'The efficiency with which farmers use available resources is very important in agricultural production. The study was conducted to measure and compare resource use efficiency and relative productivity of farming under Organic rice and Conventional rice production in Mekong Delta of Vietnam. One hundred twenty randomly selected farms, 60 from each system, were surveyed. The study explored differences in efficiency and productivity between production systems. Cobb-Douglas production function analysis was used to calibrate resource use efficiency. The results showed that the regression coefficients of expenditure on seed, organic manure and bio-fertilizers in Organic rice cultivation, and expenditure on herbicide and machine labor in Conventional rice cultivation were significant. The efficiency was greater than one for seed, organic manure, machine labor and bio-fertilizer for Organic rice production. In conventional rice production, herbicide and machine labor were underutilized resources. The results suggested that the quantity of these resources was used less than optimum and there exists further scope for increased use of these resources. Other resources were over utilized, such as human labor and bio-pesticide in organic rice production, and seed, chemical fertilizer, pesticide and human labor in conventional rice production.

Devi and Singh (2014) analyze "Resource use and technical efficiency of rice production in Manipur." Rice is regarded as the first cultivated crop in Asia as well as important food crop of India. The cost and return structure and technical efficiency in rice production has been reported in different regions as well as in the state of Manipur to show different regions have adopted the latest technology. Primary data have been collected from the sample rice farms with the help of pre-tested scheduled through personal interview with respondent farmers. Technical efficiency of individual farms has been estimated through stochastic production function analysis. The total cost of cultivation on small farms was much higher than the large farms. Imputed rental value for owned land was the major cost items for all the farms. On an average majority (40%) of the rice growing farmers were operating at the technical efficiency level of (99-100) % in relation to frontier output level. Gross return as well as net return per hectare have been observed to be highest for category I followed by category II. Most of the farms have been observed to be potential to expand production and productivity, increasing technical efficiency as majority has been performing with increasing returns to scale.

Chowdhury et al. (2013) investigated the efficiency of rice farms during Boro period in Bangladesh. Empirical results of this study show that average technical, allocative and economic efficiency of the farmers during Boro period were 86 per cent, 75 per cent and 64 per cent respectively.

Chowdhury et al. (2013) investigated the Efficiency of Rice Farms during Boro Period in Bangladesh: An Econometric Approach. They was focusing to achieve the target by improving the efficiency of the farmers. Modern econometric tools, like Stochastic Frontier Approach (SFA) were used for measuring the efficiencies of the farmers. Empirical results of this study show that average technical, allocative and economic efficiency of the farmers during Boro period were 86 per cent, 75 per cent and 64 per cent respectively.

Nasrin et al. (2011) conducted a study on Land Tenure System and Agricultural Productivity in a Selected Area of Bangladesh. They examine relative efficiency of farming under tenancy systems in some selected areas of Mymensingh district. They were found that share tenant farmers earned significantly lower net return (Tk. 19,252.18) than the cash tenant farmers (Tk. 22,815.89) from Boro rice production and Boro rice production was profitable from the viewpoint of both tenant operators. They also showed that all the explanatory variables (key production inputs) included in the Cobb- Douglas revenue type production function model were important for explaining the variations in gross returns under both tenancy arrangements.

Sarker et al. (2010) conducted a study on comparative economic analysis of borrower & non borrower Boro rice farmers in some selected sites of Mymensingh district. They were found that borrower farmers used more inputs &attained more returns through higher yield than their counterparts. The yields of rice per hectare were 5260.80 kg &422177.34 kg for the borrower and non-borrower farmers respectively. They also found that borrower farmer's net return and gross return are higher than non-borrower farmers.

Majumder et al. (2009) investigated the productivity & Resource use efficiency of Boro rice production in Bhola district under different tenure conditions. They showed the difference in the efficiency & productivity among owner, cash tenant & crop share tenant. They found that total gross costs for producing Boro rice was highest in owner farms& lowest in crop share tenants farm because owner operator used more hired labor in compare to other groups. However, the cash tenant farmers were more efficient than crop share tenant farmers because crop share tenant used poor resource and they are unable to invest modern farm inputs. They also mentioned that in Bangladesh the predominant tenancy arrangement share cropping is an inefficient form of tenure arrangement in compare to cash tenancy.

Akanda et al. (2008) conducted a study on problem of share crop tenancy system in rice farming in Sherpur district of Bangladesh. The 1984 land reform act in Bangladesh fixed land rent for sharecropping tenants at 33% of harvest yield without input sharing and at 50% with 50% of input sharing. This positively influenced expansion of HYV rice farming. However, the returns for tenants fell over time because of a gradual increase in input prices and wages. This research analyzed the present distribution of returns in the dominant rice farming area in Bangladesh. There was semi feudalism in the tenancy market with landowners earning more from sharecropping than they could from cash renting. Land-rich farmers often cultivated only a small part of their cultivable land and rented out most of it. The existing economic structure did not fairly balance the returns between tenants and landowners. This study suggested the need to reset the land rent at 20%

of harvest yield without input sharing and at 40% with input sharing, to protect land-poor tenants.

Arif (2008) conducted a research proposal about comparative profitability and technical efficiency of aromatic BRRI34 and non-aromatic BR11 rice varieties which are transplanted at two contiguous upazilas of dinajpur district. The study reveals that the yield of BRRI dhan34 is found lower than that of BR11 rice. But gross return of BRRIdhan34 is much higher (Tk.82467/ha) than that of BR11 (Tk.66455/ha) rice. Gross margin was also found higher for BRRIdhan 34 (Tk.58869/ha) than by BR11 rice (Tk.39013/ha) return over per taka investment (BCR) were Tk. 1.87 and Tk. 1.37 for BRRI dhan 34 and BR11 rice.

Rahman et al. (2007) conducted a study on measuring the costs of production, based on sizes of farm operation on rice farmers in Jessore district of Bangladesh study. The objectives of the study were to measure the differences in the cost of production of Boro rice farmers on the basis of land. They included three types of rice farmers in this, small, medium &large. They found that although there were no significant differences in the quantity of inputs used for all categories of farmers, the unit cost of some inputs significantly varied between small-large medium-large, thus affecting the cost of production. The reason is that most of the small medium farmers purchased inputs on credit, spending comparatively more than cash &they paid higher interest on borrowed money. They showed that for that reason rice production increased regardless of the land operation size but small &medium farmers still have a serious problem especially the increasing cost involved in the production.

Iqbal (2005) conducted a study on cost requirements for cultivation of boro rice (Oriza Sativa) under different farming system at four villages in Mymensingh district of Bangladesh. The study found that input cost per hectare varied from

Tk.14877 to 18145 and output varied from Tk.25101 to 31647, respectively under different farmer's categories. The benefit cost ratio found in landless, marginal, small, medium & large categories of farmers were 1.87, 1.4, 1.83 and 1.64 respectively.

Khan et al. (2002) was estimated the growth rates and trend of production and yield of HYV Boro and Aman rice. The growth rates of yield and production of HYV Boro and HYV Aman rice were also computed for the nineties. During the period of ten years in nineties, yield and production growth rates of HYV Boro were positive and significant. The growth parameters of HYV Boro were significantly different in early nineties and late nineties but in case of HYV Aman growth parameters were not significantly different between the two sub periods of nineties.

Khan et al. (2002) was conducted a study to find out the level of input uses and input output relationship with respect to HYV Boro and HYV Aman rice cultivation. The result showed that the amount of human lobour, animal lobour, and fertilizer used per hectare of HYV Boro were 197.17 man-days, 43.38 pair-days and 321.22 kg and for HYV Aman were 153.68 man-days, 44.13 pair-days and 176.14 kg respectively, per hectare real cost of seed, irrigation, and pesticides of HYV Boro were Tk 1818.93, Tk 4591.33, and Tk 536.34 respectively. Human lobour and animal lobour are positively significant but irrigation cost is negatively significant in case of HYV Boro rice production. On the other hand, human lobour is negatively but animal lobour and seed are positively significant for HYV Aman rice production. For achieving maximum efficiency, the use of human labour, animal labour, seed and fertilizer of HYV Boro, animal labour, seed and pesticide of HYV Aman should be increased, pesticide of HYV Boro should be decreased and the additional use of the irrigation water of HYV Boro, human lobour and fertilizer of HYV Aman should be decreased.

Rahman et al. (2002) studied the technical efficiencies obtained by owner-operated farming and share cropping using Cobb-Douglass Stochastic production function. Mean technical efficiencies obtained by owner operators for Boro, Aus and Aman rice crops were 86 per cent, 93 per cent and 80 per cent respectively whereas mean technical efficiencies obtained by share croppers for Boro, and Aman rice respectively 73 percent and 72 percent. The study reveals that owner-operators were technically more efficient than share croppers in the production of all rice crops. To reduce the difference of technical efficiencies between owner operator and share cropper a perfect share leasing system is inevitable.

Rahman et al. (2000) found that the average level of technical efficiency among sample farmers for Boro, Aus and Aman rice crops was 88%, 91% and 81%, respectively. This meant that on an average there appeared to be 12% technical inefficiency for Boro rice. 9% for Aus rice, and 19% for Aman rice. This implied that the output per farm could be increased significantly without incurring any additional costs. The coefficient of age and experience were negative and significant for Boro rice, and the coefficient of experience was negative and significant for Aus rice. Farmers with larger farms were technically more efficient than farmers with smaller operations.

2.2 Concluding Remarks

The above-mentioned discussion and review indicate that most of the studies dealt with cost, return, profitability and productivity of boro rice cultivation. Some studies also determine the factors affecting the profitability. Maximum studies examined parameters, which influence production, more than a decade ago. Side by side the influence of other factors identified by the researchers of other countries is needed to study studied in the context of Bangladesh. Very limited integrated studies were conducted on productivity of boro rice cultivation in Bangladesh. Therefore, this study is expected to be conducted taking into account those aspects. The review of literature was helpful to re-design methodological aspects with a view to overcome the limitations of previous studies. From the above studies the researcher felt the need of conducting and analyzing the profitability of boro rice cultivation in Bangladesh within the current development context, which will help the policy makers to understand the current situation and take programmes to increase boro rice production and improving the livelihood of people in Bangladesh. On the other hand, researcher believed that the findings of this study would provide useful updated information, which would help the policy makers and researcher for further investigations.

CHAPTER III
METHODOLOGY

There are various methods of data collection in farm management research. Selection of particular method depends on many considerations, such as nature of research, sufficient literature and primary information, availability of funds and time etc. A farm management research involves collection of information from individual farmers. Survey method was used in the present study because it is thought to have some advantages over other methods. The following steps were followed in conducting the present study:

3.1 Selection of the Study Area

Chowgacha is located at 23.2667°N 89.0250°E . The main city is on the bank of the river Kopothakho River. It has a total area of 269.31 km². Chaugachha Upazila is bounded by Maheshpur, Kotchandpur and Kaliganj upazilas on the north, Jessore Sadar and Kaliganj upazilas on the east, Sarsha and Jhikargachha upazilas and Bagdah community development block in North 24 Parganas district in West Bengal, India on the south and Maheshpur Upazila on the west.

According to the 2011 Bangladesh census, Chaugachha had a population of 231,370. Males constituted 50.10% of the population and females 49.90%. Muslims formed 92.48% of the population, Hindus 7.49%, Christians 0.01% and others 0.02%. Chaugachha had a literacy rate of 53.7% for the population 7 years and above.

As of the 1991 Bangladesh census, Chaugachha Upazila had a population of 189,829. Males constituted 51.6% of the population, and females 48.4%; 91,297 of the population were aged 18 or over. Chaugachha had an average literacy rate of 25.5% (7+ years), against the national average of 32.4% literate.

The area in which a farm business survey is to be made depends on the particular purpose of the survey and the possible cooperation from the farmers. It also depends on the following two factors:

(i) What kind and quality of data is required and

(ii) Overall environments of the area in which the expected respondents belonged to.

Generally, owners of the farms hesitate to give information to strangers and outsiders on their own private business and financial transaction. In consideration of the above-mentioned factors, Chaugacha upazila under Jashore district was purposively selected where a large number of boro rice cultivars. Apart from these, the area is chosen for the following reasons:

i) No published information is available in the study areas.

ii) Very easy communication facilities from the researcher's residence and hence was less expensive as well as less time consuming to conduct the study in these locations.

iii) The researcher expected better co-operation from the owners of the boro rice farmer.

iv) The boro rice fields are located in the same physiographic area and the area is, therefore, more representative to conduct field survey.

3.2 Sampling technique

All the rice growers in Jashore district were not possible to include in this study because of the paucity of resources and time constraint. A reasonable sample survey, which would represent the population, was required in order to meet up the purpose of the study. Simple random sampling technique was adopted in this study. After purposively selecting Jashore district Chaugachha upazilas was selected randomly from 8 upazilas. Subsequently, six villages from two unions namely, Pashapole and

Fulsara were also selected randomly. From each of the two union's six villages namely, Daspakhia, Raghunathpur and Raniali from Pashapole union and Fulsara, Baruhati and Sayedpur from Fulsara union selected randomly as a locale of the study. Therefore, a list of rice producers was constructed with the help of village leaders and field level extension personnel. After preparing the sampling frame ninety farmers were selected randomly for primary data collection.

Table 3.1 Distribution of selected sample households in the study areas

Upazila	**Unions**	**Villages**	**Sample size**
Chauagachha	Pashapole	Daspakhia	15
		Raghunathpur	15
		Raniali	15
	Fulsara	Fulsara	15
		Baruhati	15
		Sayedpur	15
Total			**90**

Figure 3.1 Map of Jashore district showing Chaugachha upazila

Figure 3.2 Map of Chaugachha upazila showing the study area

3.3 Period of the Study

The present study covered period from 1st June 2019 to 30 June 2019. Data were collected by the researcher himself.

3.4 Preparation of the Survey Schedule

Preparation of survey schedules is of crucial importance in this study. A comprehensive survey schedule was prepared to collect necessary information from the concerned respondent in such a way that all relevant information needed for boro rice cultivation could be easily obtained within the shortest possible time. The interview schedule was pretested for judging their suitability. After pre testing, the schedule was finalized.

3.5 Collection of Data

To satisfy the objectives of the study, necessary data were collected by visiting each farm personally and by interviewing them with the help of a pretested interview schedule. Usually most of the respondent does not keep records of their activities. Hence it is very difficult to collect actual data and the researcher has to rely on the memory of the respondent. Before going to an actual interview, a brief introduction of the aims and objectives of the study was given to each respondent. The question was asked systematically in a very simple manner and the information was recorded on the interview schedule. When each interview was over the interview schedule was checked and verified to be sure that information to each of the items had been properly recorded. In order to minimize errors, data were collected in local units. These were subsequently converted into appropriate standard unit.

3.6 Editing and Tabulation of Data

After collection of primary data, the filled schedules were edited for analysis. These data were verified to eliminate possible errors and inconsistencies. All the collected data were summarized and scrutinized carefully. For data entry and data analysis, the Microsoft Excel programs and SPSS programs were used. It might be observed here that information was collected initially in local units and after checking the collected data, it was converted into standard units. Finally, a few relevant tables were prepared according to necessity of analysis to meet the objectives of the study.

3.7 Procedure for computation of costs

The farmers producing boro rice had to incur cost for different inputs used in the production process. The input items were valued at the prevailing market price and sometime at government price in the area during survey period, or at the priced at which farmers bought. Sometimes, the farmers purchased hired labor, seed, fertilizer, manure and insecticide from the market and it was easy to pricing these items. But farmers did not pay cash for some input such as family labor, home supplied seed, manure etc. So, it was very difficult to calculate the cost of production of these inputs. In this case opportunity cost principle was used. In calculating the production cost, the following components of cost were considered in this study area:

- Human labor
- Land preparation/Mechanical power cost
- Seed
- Manure
- Fertilizer
- Insecticides
- Weeding
- Irrigation
- Pesticides cost
- Interest on operating capital and
- Land use.

3.7.1 Cost of human labor

Human labor cost was one of the most important and largest cost items of boro rice production in the study area. It is required for different farm operations like land preparation, weeding, application of fertilizer and insecticide, harvesting and carrying etc. Mainly two types of human labor used in the study area; such as family labor and hired labor. Family labor includes the operator himself, the adult male and female as well as children of a farmer's family and the permanently hired labor. To determine the costs of unpaid family labor, the opportunity cost concept was used. In this study the opportunity cost of family labor was assumed to be market wage rate, i.e., the wage rate that the farmers actually paid to the hired labor. The labor that was appointed permanently was considered as a family labor in this study. In computing the cost of hired labor, actual wages were paid and charged in case where the hired labors were provided with meals; the money value of such payment was added to the cash paid. The labor has been measured in a man-day unit, which usually consisted of 8 hours a day.

In producing boro rice human labor were used for the following operations:

- Land preparation/ploughing/laddering
- Fertilizing, weeding and irrigation
- Pest control
- Harvesting, storing and marketing

3.7.2 Cost of power tiller and laddering

Human labor and mechanical power were jointly used for power tiller and laddering. Power tiller and laddering cost was the summation of hired and home supplied draft power and human labor. Hired power tiller and laddering cost were calculated by the prevailing market prices that were actually paid by the farmers. Home supplied mechanical power and human labor cost was estimated on the basis of opportunity cost principle.

3.7.3 Cost of seeds

Cost of seed was also estimated on the basis of home supplied and purchased seed. Home supplied seed were calculated at the prevailing market rate and the costs of purchased seed were calculated at the actual price.

3.7.4 Cost of cow dung

Cow dung may be used from home supplied or through purchased. The value of home supplied and purchased cow dung was calculated at the prevailing market price.

3.7.5 Cost of fertilizer

It is very important for boro rice cultivation to use the fertilizer in recommended dose. In the study area, farmers used different types of chemical fertilizer i.e., Urea, TSP (Triple Super Phosphate), MP (Muriate of Potash), Gypsum, Zinc sulphate and boron for growing boro rice cultivation. Fertilizer cost was calculated according to the actual price paid by the farmers.

3.7.6 Cost of insecticide

Most of the sample farmers used Dithane M-45, Thiovit 80wp and Rovral 50wp for boro rice cultivation. The cost of these insecticides was calculated by the prices paid by farmers.

3.7.7 Cost of irrigation

The cost of irrigation included the rental charge of machine plus and the costs of fuel. Someone rent/borrow only water from the shallow tube well (STW) owners by paying some charge.

3.7.8 Interest on operating capital

Interest cost was computed at the rate of 9% per annum. It was assumed that if farmers would take loans from a bank, they would have to pay interest at the above-mentioned rate. Since all expenses were not incurred it the beginning of the production process, rather they were spent throughout the whole production period the cost of operating was, therefore, computed by using the following formula:

$$\textbf{Interest on operating capital} = \frac{\text{Operating Capital * Rate of interest x Time}}{2}$$

The cost was charged for a period of 6 months at the rate of Tk. 9 per annum.

3.7.9 Land use cost

The price of land was different for different plots depending upon location and topography of the soil. The cost of land used was estimated by the cash rental value of land. In calculating land use cost, average rental value of land per hectare for a particular year. In computing rental value of land of the land used cost (LUC), it was calculated according to farmer's statement.

3.8 Analytical Techniques

Both descriptive and statistical tools was used for analyzing the data. Descriptive statistics was used for calculating profitability, average, percentage, total etc. Cobb-Douglas production function was also used to estimate the effects of key variables. Because in Cobb-Douglas production function, the regression co-efficient directly shows production elasticity and as all the sum of the production elasticities indicate whether the production process as an increasing, constant, or decreasing returns to scale.

Cobb-Douglas production frontier model was used for estimating profitability of boro rice production in the study areas and the model is given below:

$$Y = aX_1^{b1}\, aX_2^{b2}\, aX_3^{b3}\, aX_4^{b4}\, aX_5^{b5}\, aX_6^{b6}\, aX_7 b^7 aX_8 b^8\, X_9^{b9} aX_{10}^{b10}\, aX_{11}^{b11} aX_{12}^{b12} e^{ui}$$

To identify the factors affecting the gross return on boro rice production, the Cobb-Douglas production function has used:

$$\ln Y = \ln bo + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + b_9 \ln X_9 + b_{10} \ln X_{10} + b_{11} \ln X_{11} + b_{12} \ln X_{12}$$

Where,

X_1 = Cost of human labor (Tk. /ha),

X_2= Cost of power tiller (Tk/ha),

X_3= Cost of seed (Tk/ha),

X_4 = Cost of urea (Tk/ha),

X_5 = Cost of TSP (Tk/ha),

X_6 = Cost of MP (Tk/ha),

X_7 = Cost of gypsum (Tk/ha),

X_8 = Cost of Zn sulphate (Tk/ha),

X_9 = Cost of boron (Tk/ha),

X_{10} = Cost of irrigation (Tk/ha),

X_{11} = Cost pesticide (Tk/ha),

X_{12} = Cost manure (Tk/ha).

b_0= Intercept and $b_1 \ldots\ldots b_{12}$= parameters

3.9 Profitability Analysis

Cost and return analysis are the most common method of determining and comparing the profitability of different farm household. In the present study, the profitability of boro rice cultivation is calculated by the following way-

3.9.1 Calculation of Gross Return

Per hectare gross return was calculated by multiplying the total amount of product and by-product by their respective per unit prices.

Gross Return= Quantity of the product * Average price of the product + Value of by- product.

3.9.2 Calculation of Gross Margin

Gross margin is defined as the difference between gross return and variable costs. Generally, farmers want maximum return over variable cost of production. The argument for using the gross margin analysis is that the farmers are interested to get returns over variable cost. Gross margin was calculated on TVC basis. Per hectare gross margin was obtained by subtracting variable costs from gross return.

That is, Gross margin = Gross return – Variable cost.

3.9.3 Calculation of Net Return

Net return or profit was calculated by deducting the total production cost from the total return or gross return. That is,

Net return = Total return – Total production cost.

The following conventional profit equation was applied to examine farmer's profitability level of boro rice producing farms in the study areas.

Net profit, $\pi = \Sigma P_m Q_m + \Sigma P_f Q_f - \Sigma(P_{xi} X_i) - TFC$.

Where, π = Net profit/Net return from boro rice cultivation (Tk. /ha);

P_m = Per unit price of boro rice (Tk. /ha);

Q_m = Total quantity of the boro rice cultivation (Tk. /ha);

P_f = Per unit price of other relevant boro rice (Tk. /ha);

Q_f = Total quantity of other relevant boro rice (Tk. /ha);

P_{xi} = Per unit price of i-th inputs (Tk.);

X_i = Quantity of the i-th inputs (Tk. /ha);

TFC = Total fixed cost (Tk.) and

i = 1, 2, 3,............. , n (number of inputs).

3.9.4 Undiscounted Benefit Cost Ratio (BCR)

Average return to each taka spent on production is an important criterion for measuring profitability. Undiscounted BCR was estimated as the ratio of total return to total cost per hectare.

$$\textbf{BCR} = \frac{\text{Total Return}}{\text{Total Cost}}$$

3.10 Measurement of Input Use Efficiency

In order to test the efficiency, the ratio of Marginal Value Product (MVP) to the Marginal Factor Cost (MFC) for each input were computed and tested for its equality to 1. i.e., MVP/MFC = 1.

The marginal productivity of a particular resource represents the additional to gross returns in value term caused by an additional one unit of that resource, while other inputs are held constant. When the marginal physical product (MPP) is multiplied by the product price per unit, the MVP is obtained. The most reliable, perhaps the most useful estimate of MVP is obtained by taking resources (Xi) as well as gross return

(Y) at their geometric means.

That is, $$\frac{MVP}{MFC} = r$$

Where,

r = Efficiency ratio,

MVP = value of change in output resulting from a unit change in variable input (BDT) MFC = price paid for the unit of variable input (BDT)

Under this method, the decision rules are that, when: r >1, the level of resource use is below the optimum level, implying under-utilization of resources. Increasing the rate of use of that resource will help increase productivity. r <1, the level of resources use is above the optimum level, implying over utilization of resources. Reducing the rate of use of that resource will help improve productivity. r = 1, the level of resource use is at optimum implying efficient resource utilization.

The most reliable, perhaps the most useful estimate of MVP is obtained by taking all input resources (Xi) and gross return (Y) at their geometric means (Dhawan and Bansal, 1977). All the variables of the fitted model were calculated in monetary value. As a result, the slope co-efficient of those independent variables in the model represent the MVPs, which were estimated by multiplying the production co-efficient of given resources with the ratio of geometric mean (GM) of gross return to the geometric mean (GM) of the given resources, that is,

$$MVP\ (X_i) = \beta_i \frac{\bar{Y}\ (GM)}{\ddot{X}_i\ (GM)}$$

Where, $\bar{Y}$ (GM) = Geometric mean of gross return (BDT)

$\ddot{X}_i$ (GM) = Geometric mean of different independent variables (BDT)

β_i = Co-efficient of parameter i = 1, 2,… .... n

3.11 Problems Faced in Collecting Data

The researcher had to face following problems in the field during the collection of data.

- ✓ The farmers did not keep records of their farming activities. Therefore, the researcher had to depend upon their memory. It was difficult to get information from memory.

- ✓ Most of the farmers in the study area thought that the investigator was a government officer. So, they initially hesitated to answer the questions relating to their income and expenditure. Some were afraid of imposition of new taxes.

- ✓ Sometimes, the farmers were not available at their home because they remained busy with outside work. That is why sometimes more than two visits were required to get information from them.

CHAPTER IV

SOCIO-ECONOMIC CHARACTERISTICS OF THE FARMERS

4.1. Socioeconomic characteristics of rice farmers

This section deals with the socio-economic characteristics of the sample farmers. To get a complete and accurate scenario of rice producing farmers of a particular area, it is required to know these socio-economic characteristics. An effort has, therefore, been made in this chapter to describe briefly some of the basic socioeconomic characteristics of the sample farmers of the study area because people differ from one to another in many respects. Decision making behavior of an individual is determined by his socio-economic characteristics. There are numerous interrelated and constituent attributes that characterize a person and these profoundly influence development behavior. Socio economic characteristics of the producers affect their production process and technology use. It is, however, not easy task to collect all the relevant information regarding the socio - economic characteristics of the sample farmers due to limitation of time and resources.

4.1.1 Age distribution of farmers

Age of the farmers ranged from 17 to 72 years. All the variables were categorized on the basis of their possible scores except age was categorized based on the classification provided by the Ministry of Youth and Sports, Government of the People's Republic of Bangladesh. The distribution of the rice farmers according to their age is shown in Table 4.1.

Table 4.1 Distribution of the farmers according to their age

Age group (Years)	**Farmers**			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
17-35 years	10 (33.3)	11 (36.7)	3 (10)	24 (26.7)
36-50 years	17 (56.7)	13 (43.3)	15 (50)	45 (50)
Above 50 years	3 (10)	6 (20)	12 (40)	21 (23.3)
All age group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

Age structure of the farmers are presented in Table 4.1. The farmers were classified into three age groups: 17-35 years, 36-50 years and above 50 years. Out of 90 samples farmers of all categories, 50 percent belonged to the age group of 36-50 years, 26.7 percent 17-35 years and 23.3 per cent fell in above 50 years age group. On the other hand, out of 30 farmers of small farm categories, 56.7 percent belonged to the age group of 36-50 years, 33.3 percent 17-35 years and 10 percent were in the age group of above 50 years (Table 4.1). On the other hand, out of 30 farmers of medium farm categories, 43.3 percent belonged to the age group of 36-50 years, 36.7 percent 17-35 years and 20 percent were in the age group of above 50 years (Table 4.1). On the other hand, out of 30 farmers of large farm categories, 50 percent belonged to the age group of 36-50 years, 10 percent 17-35 years and 40 percent were in the age group of above 50 years (Table 4.1). These findings imply that the majority of the sample farmers were in the most active age group of 36-50 years indicating that they provided more physical efforts for farming and this age group are supposed to have enormous vigor and risk bearing ability.

4.1.2 Education distribution of farmers

The education scores of the farmers ranged from 0 to 18. On the basis of their educational scores, the rice cultivars were classified into four categories, namely "illiterate (0-0.5), primary (1-5), secondary (6-10) and above secondary (above 10). This distribution of the farmers according to their education are shown in the Table 4.2.

Table 4.2 Distribution of the farmers according to their education

Education group (Classes)	Farmers			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
Illiterate (0-0.5)	6 (20)	7 (23.3)	3 (10)	24 (26.7)
Primary level (1-5)	6 (20)	3 (10)	14 (46.7)	45 (50)
Secondary level (6-10)	10 (33.3)	7 (23.3)	12 (40)	21 (23.3)
Above secondary level (>10)	8 (26.7)	13 (43.3)	1 (3.3)	00
All education group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

Literacy plays an important role in accelerating agricultural development of a country in the sense that the literate farmers tend to apply modem technology. Table 4.2 shows the literacy levels of different categories of farmers. In the case of small farms, 33.3 per cent farmers had secondary level, 26.7 per cent had above secondary school level, 20 per cent primary level and 20 per cent had illiterate level of education. In the case of medium farms. 10 per cent farmers had primary level. 23 3 per cent illiterate, 43.3 per cent above secondary level and 23.3 per cent secondary level of education. On the other hand, in the case of large farms, 46.7 per cent farmers had primary level, 10 per cent illiterate, 40 per cent secondary level of education and 3.3 per cent above secondary level of education.

4.1.3 Family size

To describe the family size of the respondents, the category has been followed as represented by Poddar (2015). Family size scores of the farmers ranged from 2 to 9. According to family size, the respondents were classified into three categories as shown in Table 4.3.

Table 4.3 Distribution of the farmers according to their family size

Family size (Numbers)	**Farmers**			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
Small family (2-4)	15 (50)	17 (56.6)	5 (16.7)	24 (26.7)
Medium family (5-6)	11 (36.7)	11 (36.7)	13 (43.3)	45 (50)
Large family (above 6)	4 (13.3)	5 (16.7)	12 (40)	21 (23.3)
All family size group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

The family size and its composition are related to both occupation and income. In this study a family has been defined as a group of persons living together and taking their meals from the same kitchen under the administration of the head of the family. It included husband, wife, son, daughter, brother, sister, parents and permanent hired labour. The

Table 4.3 shows the average family size of the selected farmers under different farming systems. Out of 30 farmers small farmers, 50 percent belonged to the small family of 2-4 members, 36.7 percent 5-6 persons and 13.3 percent were in the large family size of above 6 persons (Table 4.3). On the other hand, out of 30 farmers medium farmers, 56.6 percent belonged to the small family size of 2-4 persons, 36.7 percent 4-6 persons and 16.7 percent were in the large family size of above 6 persons (Table 4.3). On the other hand, out of 30 farmers of large farmers, 16.7 percent belonged to the small family size of 2-4 persons, 43.3 percent 5-6 persons and 40 percent were in the large family size of above 6 persons (Table 4.1).

4.1.4 Farm size

The farm size of the respondents varied from 0.20 to 3.75 hectares. The respondents were classified into three categories based on their farm size as followed by DAE (DAE, 1999): "small farm" (0.21 – 1.0 ha) and "medium farm" (1.0 -3.0). The distribution of the farmers according to their farm size is shown in Table 4.4.

Table 4.4 Distribution of the farmers according to their farm size

Farm size (Hectares)	**Farmers**	
	Number	Percent
Small farm (0.21-1.0 ha)	30	33.3
Medium farm (1.01-3.0 ha)	30	33.3
Large farm (above 3 ha)	30	33.4
All age group	90	100

Source: Field Survey, 2019

Table 4.4 indicated that 33.3 percent of the farmers possessed small farms, 33.3 and 33.4 percent of them having medium farms and large farm size.

4.1.5 Annual family income

Annual income score of the respondents ranged from 20 to 562 (in thousands). On the basis of the observed scores, the respondents were classified into three categories as shown in Table 4.5.

Table 4.5 Distribution of the farmers according to their annual income

Income ('000' tk.)	**Farmers**			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
Low income (20-100)	13 (43.3)	14 (46.7)	3 (10)	24 (26.7)
Medium income (101-150)	5 (16.7)	6 (20)	15 (50)	45 (50)
High income (above 150)	12 (40)	10 (33.3)	12 (40)	21 (23.3)
All income group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

Table 4.5 indicated that majority 43.3 percent of the small farmers had 20-100 thousand annual family income followed by 40 percent of the small farmers had above 150 thousand annual family income and only 16.6 percent of the small farmers had 101-150 thousand annual family income. About 46.7 of the medium farmers had 20-100 thousand annual family income, while 33.3 percent of them having above 150 thousand annual family income and only 20 percent of the medium farmers had 101-150 thousand annual family income. Data presented in the Table 4.6 revealed that the highest 50 percent of the large farmer's had 101-150 thousand income compared to 40 percent of the large farmers having above 150 thousand annual family income and only 10 percent of the large farmers had 20-100 thousand annual family income.

4.1.6 Credit received

Credit received score of the respondents ranged from 20 to 350 (in thousands. On the basis of the observed scores, the respondents were classified into three categories as shown in Table 4.6.

Table 4.6 Distribution of the farmers according to their credit received

Credit received (Scores)	Farmers			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
Bank (1)	9 (30)	3 (10)	10 (33.3)	24 (26.7)
NGOs (2)	10 (33.3)	9 (30)	11 (36.7)	45 (50)
Relatives (3)	6 (20)	11 (36.7)	5 (16.7)	21 (23.3)
Others (4)	5 (16.7)	7 (23.3)	4 (13.3)	6 (20)
All credit received group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

Table 4.6 indicated that majority 33.3 percent of the small farmers received credit from NGOs, while 30 percent of the small farmers received credit from bank, 20% credit received from relatives and only 16.7 percent of the small farmer's credit received from others sources. The highest 36.7 percent of the medium farmer's credit received from relatives, 30% of the medium farmers received credit from NGOs, 23.3% and 10 percent of the medium famers credit received from others and bank, respectively. Data presented in the Table revealed that the highest 36.7% of the large farmers credit received from NGOs compared to 33.3 percent of the large farmers credit received from bank, 16.7% and 13.3 percent of the large farmers credit received from relatives and others, respectively.

4.1.7 Training received

Credit received score of the respondents ranged from 20 to 350 (in thousands. On the basis of the observed scores, the respondents were classified into three categories as shown in Table 4.7.

Table 4.7 Distribution of the farmers according to their training received

Credit received (Scores)	Farmers			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
No training (0)	12 (40)	9 (30)	12 (40)	24 (26.7)
Low training (1-3)	4 (13.3)	4 (13.3)	4 (13.3)	45 (50)
Medium training (4-6)	8 (26.7)	7 (23.3)	8 (26.7)	21 (23.3)
High training (above 6)	6 (20)	10 (33.4)	6 (20)	4 (13.3)
All age group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

Table 4.7 indicated that majority 40 percent of the small farmers had no training on rice cultivation, while 26.7 percent of the small farmers had medium training, 20% and 13.3 percent of the small farmer's had low and high training on rice cultivation. The highest 33.3 percent of the medium farmer's had high training on rice cultivation, 30% of the medium farmers had no training on rice cultivation, 23.3% and 13.3 percent of the medium famers had medium and low training on rice cultivation, respectively. Data presented in the Table revealed that the highest 40% of the large farmers had no training on rice cultivation compared to 26.7 percent of the large farmers had medium training on rice cultivation, 13.3% and 20 percent of the large farmers had low and high training on rice cultivation, respectively.

4.1.8 Market distance

The observed market distance score of the respondents ranged from .25 to 5 km. On the basis of market distance scores, the respondents were classified into three categories namely, short distance medium distance and long distance is shown in Table 4.8.

Table 4.8 Distribution of the farmers according to their market distance

Distance (km)	**Farmers**			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
Short distance (0.25-1)	10 (33.3)	6 (20)	21 (70)	24 (26.7)
Medium (1.01-2)	9 (30)	16 (53.3)	7 (23.3)	45 (50)
Long distance (>2)	11 (36.7)	8 (26.7)	2 (6.6)	21 (23.3)
All age group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

Table 4.8 showed that the highest proportion 36.7 percent of the small farmers had long market distance, while 33.3 percent of the small farmers had short market distance and 30 percent of the small farmers had medium market distance. In case of medium farmers, the highest 53.3 of the farmers had medium market distance, whereas 26.7 percent had long market distance and only 20 percent had short market distance. Again, the highest 70 percent of the large farmers had short market distance, while 23.3 percent of the large farmers had medium market distance and only 6.6 percent of the large farmers had long market distance.

4.1.9 Extension Media contact

Extension media contact scores of the farmers ranged from 10 to 30. On the basis of their media contact, the respondents were classified into three categories namely, low contact, medium contact and high contact. The scale used for computing the media contact score of a respondent is given Table 4.9.

Table 4.9 Distribution of the farmers according to their media contact

Contact (Scores)	Farmers			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
Low contact (10-15)	4 (13.3)	9 (30)	4 (13.3)	24 (26.7)
Medium contact (16-20)	20 (66.7)	16 (53.3)	20 (66.7)	45 (50)
High contact (above 20)	6 (20)	5 (16.7)	6 (20)	21 (23.3)
All contact group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

Table 4.9 showed that the highest proportion 66.7 percent of the small farmers had medium extension contact, while 20 percent of the small farmers had high contact and 13.3 percent of the small farmers had low contact. In case of medium farmers, the highest 53.3 of the farmers had medium contact, whereas 30 percent of the medium farmers had low contact in rice cultivation and 16.7 percent had high contact. Again, the highest 66.7 percent of the large farmers had medium contact, while 20 percent of the large farmers had high contact and 13.3 percent of the large farmers had low contact in rice cultivation.

4.1.10 Experience in rice cultivation

Experience rice ranged from 4 to 54. On the basis of their experience, the farmers were classified into the following three categories "low experience" (4-15), "medium experience" (16-30) and "high experience" (above 30). Table 4.10 contains the distribution of the farmers according to their experience.

Table 4.10 Distribution of farmers according to their experience rice cultivation

Contact (Years)	Farmers			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
Low (4-15)	10 (33.3)	11 (36.7)	6 (20)	24 (26.7)
Medium (16-30)	16 (53.4)	13 (43.3)	16 (53.3)	45 (50)
High (>30)	4 (13.3)	6 (20)	8 (26.7)	21 (23.3)
All age group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

Table 4.10 showed that the highest proportion 53.4 percent of the small farmers had 16-30 years of experience, while 33.3 percent of the small farmers had above 30 years' experience and 13.3 percent of the small farmers had 4-15 years' experience. In case of medium farmers, the highest 43.3 of the farmers had 16-30 years' experience, whereas 36.7 percent had 4-15 years' experience in rice cultivation and only 20 percent had above 30 years' experience. Again, the highest 53.3 percent of the large farmers had (16-30 years) experience, while 26.7 percent of the large farmers had above 30 years' experience and 20 percent of the large farmers had 4-15 years' experience in rice cultivation.

4.1.11 Distance from DAE office

Distance from DAE office score of the respondents ranged from 0.25 to 5 km. On the basis of distance from DAE office, the respondents were classified into three categories namely, short, medium and long distance is as shown in Table 4.11.

Table 4.11 Distribution of the farmers according to their distance from DAE office

Contact (km)	**Farmers**			
	Small	Medium	Large	All farmers
	Number (%)	Number (%)	Number (%)	Number (%)
Short distance (1-2)	23 (76.7)	20 (66.7)	23 (76.7)	24 (26.7)
Medium (3-4)	3 (10)	8 (26.7)	6 (20)	45 (50)
Long distance (>4)	4 (13.3)	2 (6.6)	1 (3.3)	21 (23.3)
All age group	30 (100)	30 (100)	30 (100)	90 (100)

Source: Field Survey, 2019

Table 4.11 showed that the highest proportion 76.7 percent of the small farmers had short distance from DAE office, while 13.3 percent of the small farmers had long distance from DAE office and 10 percent of the small farmers had medium distance from DAE office. In case of medium farmers, the highest 66.7 of the farmers had short distance from DAE office, whereas 26.7 percent had medium distance from DAE office in rice cultivation and only 6.6 percent had long distance from DAE office. Again, the highest 76.7 percent of the large farmers had short distance from DAE office, while 20 percent of the large farmers had medium distance from DAE office and only 3.3 percent of the large farmers had long distance from DAE office.

4.2 Concluding remarks

This chapter analyzed the socioeconomic characteristics of the rice farmers. The findings of analysis clearly indicate the socioeconomic characteristics from each other in respect of age, education, family size, experience, annual family income, farm size, credit received, contact, training received, market distance and distance from DAE office.

CHAPTER V

PROFITABILITY OF BORO RICE PRODUCTION

5.1 Introduction

This chapter is designed to analyze and compare the per hectare profitability of rice production of the farmers. The related cost items include fertilizer cost, seed cost, animal and power tiller cost, manure cost, pesticide cost, irrigation cost, labor cost, land rental value and land preparation cost. The average gross return and average net return are estimated in this chapter. The Benefit cost ratio (BCR) is also estimated for determining the profitability of the farmers.

5.2. Pattern of input use for boro rice cultivation

Farmers in the study areas used various inputs for rice cultivation. Farmers used on an average family labor was 34 man-days and hired labor was 82 man-days. On an average, they sowed 61 kg seed per hectare of farms. They applied at the rate of urea 188 kg/ha, TSP 119 kg/ha and MP 105 kg/ha. It was observed that among the chemical fertilizer, farmers used highest amount urea for the farms. In the study areas, farmers also applied gypsum (39 kg/ha), zinc (7 kg/ha), boron (7 kg/ha) and manure 1150 kg/ha for rice cultivation.

Table 5.1 Level of input use per hectare of boro rice cultivation

Particulars	Farms				
	Small	Medium	Large	All farms	Price Tk./unit
Human labor (man-day)					
Family	44	30	28	34	400
Hired	74	80	92	82	400
Seed (kg)	55	62	66	61	50
Urea (kg)	165	195	204	188	21
TSP (kg)	95	120	142	119	27
MP (kg)	90	110	115	105	18
Manure (kg)	1200	1300	950	1150	3
Gypsum (kg)	36	42	39	39	36
Zinc (kg)	9	7	5	7	200
Boron (kg)	8	6	7	7	200

Source: Field Survey, 2019

5.3 Profitability of boro rice production

To determine the profitability and compare it among the rice producers' farmers the following costs and returns items were calculated.

5.3.1 Estimation of costs

Costs are the expenses incurred in organizing and carrying out the production process. In the production process farmers used two categories of cost, variable cost and fixed cost. The variable costs of rice production include the cost of seed, animal and power tiller cost for land preparation, fertilizer, manure, irrigation and pesticide. In this study the fixed costs include family labour cost, interest on operating capital and land rental value. Farmers used both homes supplied and purchased inputs. The costs of purchased inputs were estimated on the basis of the actual payments made by the farmers and for home supplied inputs, opportunity cost principle was applied to determine their value.

5.3.1.1 Cost of human labor

For rice production human labor is the most important inputs. It was required for different operations like land preparation, weeding, fertilizing, using pesticide, harvesting, carrying, threshing, drying, storing, etc. In this study, human labor was measured in man-days. One man-day was equivalent to 8 hours work of an adult man. For women and children, man equivalent day was estimated. This was computed by converting all women and children day into man equivalent day according to the following ratio. 1 man –day = 1.5-woman day = 2 child day.

Per hectare hired labor cost of rice is shown in table 5.2. Per hectare hired labor costs were Tk. 29600, Tk. 32000 and Tk. 36800 for small, medium and large farmers respectively and their percentages of total cost of production were 29.59, 32.15 and 35.11 percent respectively.

5.3.1.2 Cost of land preparation

In the study area, power tiller was mainly used for land preparation. Power tiller was used on contact basis. Most of the farmer used animal labor for leveling their land. By adding power tiller cost and animal labor cost total cost of animal labor and power tiller was found. Table 5.2 indicates that per hectare animal labor and power tiller cost for rice production were Tk. 4250, Tk. 4326 and Tk. 4420 for small, medium and large farmers respectively and their percentages of total cost of production were 4.25, 4.35 and 4.21 percent respectively.

5.3.1.3 Cost of seeds

In the study area, farmers used mainly purchased seed. The costs of purchased seed were calculated on the basis of actual prices paid by the farmers in the study area. Per hectare costs of seeds of rice production were Tk. 2750, Tk. 3100 and Tk. 3300 for small, medium and large farmers respectively and their percentages of total cost of production were 2.75, 3.11 and 3.15 percent (Table 5.2).

5.3.1.4 Cost of fertilizers

In the study area farmers used six types of chemical fertilizer namely, Urea, Triple Supper Phosphate (TSP), Muriate of Potash (MP), Gypsum, Zinc Sulphate ($Znso_4$) and boron. These chemical fertilizers were charged at the rate of price paid by the farmers.

Per hectare costs of urea were Tk. 3465, 4095 and 4284 for the small, medium and large farmers respectively and their percentages of total cost of production were 3.46, 4.11 and 4.09 percent respectively.

Per hectare costs of TSP were Tk. 2565, 3240 and 3834 for the small, medium and large farmers respectively and their percentages of total cost of production were 2.26, 3.25 and 3.66 percent respectively.

Per hectare costs of MP were Tk. 1620, 1980 and 2070 for the small, medium and large farmers respectively and their percentages of total cost of production were 1.62, 1.99 and 1.97 percent respectively.

Per hectare costs of Zinc Sulphate were Tk. 1800, 1400 and 1000 for the small, medium and large farmers respectively and their percentages of total cost of production were 1.80, 1.41 and 0.95 percent respectively.

Per hectare costs of gypsum were Tk. 1296, 1512 and 1404 for the small, medium and large farmers respectively and their percentages of total cost of production were 1.29, 1.52 and 1.34 percent respectively.

Per hectare costs of boron were Tk. 1600, 1200 and 1400 for the small, medium and large farmers respectively and their percentages of total cost of production were 1.60, 1.21 and 1.34 percent respectively.

5.3.1.5 Manure cost

Per hectare cost of manure for small, medium and large farmers were Tk. 3600, 3900 and 2850, respectively and their percentages of total cost of production were 3.60, 3.92 and 2.72 percent respectively (Table 5.2).

5.3.1.6 Cost of irrigation

Rice production needs a huge amount of water. In the study area, farmers had to depend on shallow tube well (STW) and deep tube-well (DTW). These tube-wells were diesel operated and/or electricity operated. The cost of irrigation water was charged at fixed rate for per unit area of irrigated land. All irrigation water charges were paid in cash. Per hectare costs of irrigation cost were Tk. 8712 Tk. 8940 and Tk. 9845 for small, medium and large farmers and their percentages of total cost of production were 8.71, 8.98 and 9.39 percent (Table 5.2).

5.3.1.7 Cost of pesticides

The pesticides used by the farmers in the study area were Vittaku, Sunforan, Rijent, Dithane M-45, Thiovit 80wp and Rovral 50wp, etc. Table 5.2 reveals that per hector cost of pesticides were Tk. 2805, Tk. 3250 and Tk. 3557 for small, medium and large farmers respectively and their percentages of total cost of production were 2.80, 3.26 and 3.39 percent (Table 5.2).

Table 5.2 Per hectare costs of rice cultivation

Particulars	Small		Medium		Large		All farms
	(Tk/ha)	%	(Tk/ha)	%	(Tk/ha)	%	**(Tk/ha)**
Hired labor	29600	29.59	32000	32.15	36800	35.11	32800
Land preparation	4250	4.25	4326	4.35	4420	4.21	4332
Seed	2750	2.75	3100	3.11	**3300**	3.15	3050
Urea	3465	3.46	4095	4.11	4284	4.09	3948
TSP	2565	2.56	3240	3.25	3834	3.66	3213
MP	1620	1.62	1980	1.99	2070	1.97	1890
Zinc sulphate	1800	1.80	1400	1.41	1000	0.95	1400
Gypsum	1296	1.29	1512	1.52	1404	1.34	1404
Boron	1600	1.60	1200	1.21	1400	1.34	1400
Manure	3600	3.60	3900	3.92	2850	2.72	3450
Irrigation	8712	8.71	8940	8.98	9845	9.39	9165
Pesticide	2805	2.80	3250	3.26	3557	3.39	3204
A. Total variable cost	**64063**	64.03	**68943**	69.26	**74764**	71.32	**69256**
Lease value	15500	15.49	15500	15.57	15500	14.79	15500
Family labor	17600	17.60	12000	12.05	11200	10.68	13600
Interest on operating capital	2882	2.88	3102	3.12	3364	3.21	3116
B. Fixed Costs	35982	35.97	**30602**	30.74	**30064**	28.68	**32216**
Total cost (A+B)	**100045**	**100**	**99545**	**100**	**104828**	**100**	**101472**

Source: Field Survey, 2019

5.3.2 Total variable cost

In the study area, the total variable costs varied from year to year. It was observed that the total variable cost per hectare for rice cultivation were Tk. 64063, Tk.

968943 and Tk. 74764 for small, medium and large farmers and their percentages of total cost of production were 64.03, 69.26 and 71.32 percent (Table 5.2).

5.3.3 Fixed Costs

5.3.4 Lease value

The farmers used the land as per conditions of leasing arrangement. The term leasing cost means the cost which was required for rice farmers to take land lease which would be used for rice production to a particular period of time. Leasing cost varies from one place to another depending on the location, soil fertility, topography of the soil and distance from the sources of water etc. Leasing cost was the single highest cost item in the study areas. The value of own land was calculated as opportunity cost concept. Land use cost for rice production was estimated at the prevailing lease value per hectare in the study area. The lease value of per hectare land were estimated at Tk. 15500, Tk. 15500 and Tk. 15500 for small, medium and large farmers and their percentages of total cost of production were 15.49, 15.57 and 14.79 percent (Table 5.2).

5.3.5 Family labor

In the study area, it was estimated that per hectare family labor cost for rice cultivation were Tk. 17600, Tk. 12000 and Tk. 11200 for small, medium and large farmers and their percentages of total cost of production were 17.60, 12.05 and 10.68 percent (Table 5.2).

5.3.6 Interest on operating capital

It is evident from table 5.2 that interest on operating capital per hectare was Tk. 2882, 2102 and 3364 for small, medium and large farmers which covered 2.88, 3.12 and 3.21 percent of the total cost.

5.3.7 Total fixed cost

In the study area, it was estimated that per hectare total fixed cost for rice cultivation were Tk. 35982, 30602 and 30064 for small, medium and large farmers which comprised of 35.97, 30.74 and 28.68 percent of total cost.

5.4 Total cost of boro rice cultivation

The total costs were calculated by adding up total variable cost and total fixed cost. In the study per hectare total cost of rice cultivation were calculated at Tk. 100045, Tk. 99545 and Tk. 104828 for small, medium and large farmers (Table 5.2).

5.5 Return of boro rice production

5.5.1 Gross return

Per hectare gross return of rice production under small, medium and large farms are shown in Table 5.3. Gross return per hectare consisted of the value of main product and by-product also. Per hectare return was calculated by multiplying the total amount of products by their respective average market price. The average market price of rice was Tk. 21 per kg. Per hectare gross return of rice cultivation under small, medium and large farms were Tk. 144520, Tk. 146654 and Tk. 146893 respectively which indicates that per hectare gross return of large farms were higher than medium and small farms (Table 5.3).

5.5.2 Gross margin

Gross margin is the gross return over variable cost. Gross margin was calculated by deducting the total variable cost from the gross return. On the basis of the data, gross margin was found to be Tk. 80457, Tk. 77711 and Tk. 72129 per hectare for small, medium and large rice farm respectively (Table 5.3).

5.5.3 Net return

Net return or profit was calculated by deducting the total production cost from the gross return. On the basis of the data the net return were estimated as Tk. 44475, Tk. 47109 and Tk. 41065 for small, medium and large rice farm per hectare (Table 5.3).

Table 5.3: Per hectare cost and return of boro rice production

Sl. No.	Particulars	**Small farm**	**Medium farm**	**Large farm**	**All farm**
a.	Total Production (kg/ha)	6620	6674	6733	6676
b.	Price of rice (Tk./kg)	21	21	21	21
c.	By-product (straw tk./ha)	5500	6500	5500	5833
d.	Gross Return (axb+c)	144520	146654	146893	146029
e.	Total variable cost	64063	68943	74764	69256
f.	Gross Margin (d-e)	80457	77711	72129	76773
g.	Total cost	100045	99545	104828	101472
h.	Net Return (d-g)	44475	47109	41065	44557
i.	BCR (d/g)	1.44	1.47	1.40	1.43

Source: Field Survey, 2019

5.5.4 Benefit cost ratio (Undiscounted)

Benefit cost ratio (BCR) is a relative measure, which is used to compare benefit per unit of cost. Benefit cost ratio (BCR) was found to be 1.44, 1.47 and 1.40 for small, medium and large rice farm respectively which implies that one-taka investment in rice production generated Tk. 1.44, 1.47 and 1.40 (Table 5.3). From the above calculation it was found that rice production is profitable in Bangladesh but there is a difference in profitability among individual farm groups. It can be seen from table

5.3 that medium farmers are making the highest amount of profit while the large farmers are earning the lowest amount of profit from their rice production.

5.6 Concluding Remarks

From the above discussion and the results presented in Table 5.3 it is clear that rice production is a profitable business for farmers.

CHAPTER VI

FACTORS AFFECTING PROFITABILITY OF BORO RICE CULTIVATION

6.1 Introduction

This chapter is designed to estimate and compare the relative economic potential of rice production in tabular form. The main focus of the present chapter is to estimate the contribution of the individual key variables to the production process of rice.

6.2 Factors affecting profitability of boro rice cultivation

For producing rice production different kinds of inputs, such as human labor, power tiller, seed, fertilizer, manure, irrigation and insecticides were employed which were considered as a priori explanatory variables responsible for variation in rice production. Multiple regression analysis was employed to understand the possible relationships between the production of rice and the inputs used.

6.3 Method of estimation

For determining the effect of variable inputs to the rice production, Cobb-Douglas production function was chosen on the basis of best fit and significance result on output. (Dillion Hardaker, 1993). Moreover, use of Cobb-Douglas production function enables one to obtain the returns to scale directly. This model is also popular in applied work. The functional form of the multiple regression equation is as follows.

$$Y= aX_1^{b1}aX_2^{b2}aX_3^{b3}aX_4^{b4}aX_5^{b5}aX_6^{b6}aX_7^{b7}aX_8^{b8}aX_9^{b9}aX_{10}^{b10}aX_{11}^{b11}aX_{12}^{b12}e^{ui}$$

This equation may be alternatively expressed as:

$$lnY= lna + b_1ln X_1 +b_2lnX_2 + b_3lnX_3 +b_4lnX_4 + b_5lnX_5 + b_6lnX_6 + b_7lnX_7 + b_8lnX_8+ b_9lnX_9+ b_{10}lnX_{10}+ b_{11}lnX_{11}+ b_{12}lnX_{12}+ u_i$$

Where,

Y = Gross return (Tk. /ha)

a = Intercept

X_1 = Land preparation (Tk. /ha)

X_2= Quantity of seed (Tk. /ha)

X_3 = Irrigation (Tk. /ha)

X_4= Quantity of human labor (Tk./ha)

X_5= Quantity of urea (Tk. /ha)

X_6= Quantity of TSP (Tk. /ha)

X_7= Quantity of MP (Tk. /ha)

X_8= Quantity of manure (Tk. /ha)

X_9= Quantity of pesticides (Tk. /ha)

X_{10}= Quantity of Zn (Tk. /ha)

X_{11}= Boron (Tk. /ha)

X_{12}= Gypsum (Tk. /ha)

$b_1, b_2 \ldots\ldots\ldots b_{12}$=Coefficient of relevant variables.

u_i=Disturbance term

ln=Natural logarithm.

This equation is individually applicable for rice production farmers because the same set of inputs as indicated in the model were used.

6.4 Interpretation of results

Interpretation of the estimated co-efficient and related statistics of Cobb-Douglas production function of the farms which rice production have been shown in Table 7.1. The following features were noted.

- ✓ Cobb-Douglas production function fitted well for rice production farms as indicated by F-values and R^2.

- ✓ The relative contribution of individual key variables affecting productivity of rice production farmers can be seen from the estimates of regression equation. The results showed that most of the co-efficient had expected sign. However, the explanatory variables like seed (X_2), irrigation (X_3) TSP (X_6), manure (X_8), pesticides (X_9) and zinc sulphate (X_{10}) were found to have significant positive effect on production in rice farms, but human labor (X_4) showed negative significant effect on rice cultivation and rest of variables such as land preparation (X_1), urea (X_5), MP (X_7), boron (X_{11}) and gypsum (X_{12}) were found to have insignificant effect on production of rice.

6.4.1 Factors affecting yield of boro rice

Land preparation (X_1):

It is evident from Table 6.1 that the coefficient of land preparation was 0.034 which was insignificant for rice production. That means, 1 percent in cost of this input keeping other factors constant would result in an increase of yield by 0.034 per cent.

Seed (X_2):

The estimated co-efficient of seed was 0.180 which was positively significant at 1 percent level for rice production. This indicates that an increase of 1 per cent in cost of this input keeping other factors constant would result in an increase of yield by 0.180 per cent.

Irrigation (X_3):

The co-efficient of irrigation was 0.018 and significant at 5 percent level. This suggests that holding other factors constant an additional spending of 1 percent on irrigation water would enable the farmers to earn 0.018 percent of yield from rice cultivation.

Human labor (X_4):

The co-efficient for human labor was 0.403 and was significant but negative for rice cultivation. This indicates that 1 percent increase in human labor keeping other factors constant, would decrease the yield by 0.403 percent. For farmers, it also can be stated that use of additional labor would harm the output.

Urea (X_5):

The estimated value of the co-efficient of urea fertilizer was 0.088 for rice production farmer and was insignificant. It can be said that 1 percent increase in urea cost keeping other factors constant, would increase the yield by 0.088 percent.

TSP (X_6):

The estimated value of the co-efficient of TSP fertilizer was 0.398 for rice cultivation. The co-efficient of TSP was positive and significant at 1 percent level. It can be said that 1 percent increase in TSP cost keeping other factors constant, would increase the yield by 0.398 percent.

MoP (X_7):

The estimated value of the co-efficient of MoP fertilizer was 0.010 for rice farmer and was insignificant. It can be said that 1 percent increase in MoP fertilizer cost keeping other factors constant, would increase the yield by 0.010 percent.

Manure (X_8):

The co-efficient of the variable was 0.274 and positively significant at 1 percent level. This suggests that an additional spending of 1 percent on manure would enable the farmers to earn 0.274 percent of yield from rice cultivation.

Pesticide (X_9):

The co-efficient of the variable was 0.284 and positively significant at 1 percent level. This suggests that an additional spending of 1 percent on pesticide would enable the farmers to earn 0.284 percent of yield from rice cultivation.

Zinc sulphate (X_{10}):

The co-efficient of the variable was 0.119 and positively significant at 1 percent level. This suggests that an additional spending of 1 percent on zinc sulphate would enable the farmers to earn 0.119 percent of yield from rice cultivation.

Boron (X_{11}):

The estimated value of the co-efficient of boron fertilizer was -0.001 for rice production farmer and was negatively insignificant. It can be said that 1 percent increase in boron cost keeping other factors constant, would decrease the yield by 0.001 percent.

Gypsum (X_{12}):

The estimated value of the co-efficient of gypsum fertilizer was 0.006 for rice production farmer and was insignificant. It can be said that 1 percent increase in gypsum cost keeping other factors constant, would increase the yield by 0.006 percent.

Table 6.1 Estimated Values of Coefficients and Related Statistics of Cobb- Douglas Production Function

Explanatory variables	Coefficient	Standard error	p- value
Intercept	4.181	.142	.000
Land preparation (X_1)	.034 NS	.033	.295
Seed (X_2)	.180**	.067	.009
Irrigation (X_3)	.018*	.008	.027
Human labor (X_4)	-.403**	.071	.000
Urea (X_5)	.088 NS	.093	.349
TSP (X_6)	.398**	.087	.000
MP (X_7)	.010 NS	.013	.425
Manure (X_8)	.274**	.057	.000
Pesticides (X_9)	.284**	.096	.004
Zinc (X_{10})	.119**	.042	.006
Boron (X_{11})	-.001 NS	.008	.901
Gypsum (X_{12})	.006 NS	.008	.470
R^2	0.913		
Adjusted R^2	0. 872		
Return to scale	1.007		
F-value	126.008***		

Source: Field Survey, 2019

Note: ** Significant at 1 percent level; * Significant at 5 percent level and NS: Not Significant

Value of R^2:

The co-efficient of multiple determinations, R^2 was 0.872 for farmers which indicates that about 87 percent of the total variation in yield of boro rice production is explained by the variables included in the model. In other words, the excluded variables accounted for 87 percent of the total variation in yield of rice.

F-Value:

The F-value of the equation was highly significant and it implies that the included variables are important for explaining the variation in yield of rice production.

Returns to Scale

The summation of all the production coefficients indicates returns to scale. For rice production in farmers the summation of the coefficients was 1.007. This indicated that the production function showed increasing returns to scale.

6.5 Input Use Efficiency in Boro Rice Production

In order to identify the status of resource use efficiency, it was considered that a ratio equal to unity indicated the optimum use of that factor, a ratio more than unity indicated that the yield could be increased by using more of the resources. A value of less than unity indicated the unprofitable level of resource use, which should be decreased to minimize the losses because farmers over used this variable. The negative value of MVP indicates the indiscriminate and inefficient use of resource (Dhawan and Bansal, 1977).

The ratio of MVP and MFC of land preparation cost (9.44) for rice production was positive and more than one, which indicated that in the study area land preparation was under used (Table 6.2). So, farmers should increase the optimum use of land preparation to attain efficiency considerably.

Table 6.2 showed that the ratio of MVP and MFC of human labor (0.32) for rice cultivation was positive and less than one, which indicated that in the study area human labor for rice cultivation was over-utilization. So, farmers should decrease the use of human labor to attain efficiency level.

The ratio of MVP and MFC of seed was found to be 2.11 for rice cultivation was positive and more than one, which indicated that in the study area use of seed for rice production was under-utilization (Table 6.2). So, farmers should increase the use of seed for rice production to attain efficiency considerably.

Table 6.2 revealed that the ratios of MVP and MFC of irrigation used for rice cultivation was positive and more than one (4.41), which indicated that irrigation application was underutilized. So, farmers should increase the use of irrigation to attain efficiency in rice cultivation.

It was evident from the table 6.2 that the ratio of MVP and MFC of urea (4.97) for rice cultivation was positive and more than one, which indicated that in the study area use of urea for rice cultivation was under used. So, farmers should increase the use of urea to attain efficiency in rice cultivation.

Table 6.2 Estimated Input Use Efficiency in Boro Rice Production

Variable	Geometric mean (GM)	$\bar{Y}$ (GM)/$\ddot{x}_i$ (GM)	Co-efficient	MVP (Xi)	r=MVP/MFC	Decision rule
Yield (Y)	40710.07					
Land preparation (X_1)	1831.93	22.22	.425	9.44	9.44	Under-utilization
Human labor (X_2)	7686.39	5.29	.061	0.32	0.32	Over-utilization
Seed (X_3)	2239.44	18.17	.116	2.11	2.11	Under-utilization
Irrigation (X_4)	2818.74	14.15	.305	4.41	4.41	Under-utilization
Urea (X_5)	1434.60	28.38	.175	4.97	4.97	Under-utilization
TSP (X_6)	1043.37	39.02	-.076	-2.96	-2.96	Over-utilization
MoP (X_7)	660.07	61.68	.131	8.08	8.08	Under-utilization
Pesticide (X_8)	471.59	86.33	.027	2.33	2.33	Under-utilization

Source: Field survey, 2019

The ratio of MVP and MFC of TSP (-2.96) for rice cultivation was negative and less than one, which indicated that in the study areas use of TSP for rice cultivation was over used (Table 6.2). So, farmers should decrease the use of TSP to attain efficiency considerably.

It was evident from the table 6.2 that the ratio of MVP and MFC of MoP (8.08) for rice cultivation was positive and more than one, which indicated that in the study area use of MoP for rice cultivation was under used. So, farmers should increase the use of MoP to attain efficiency in rice cultivation.

It was evident from the table 6.2 that the ratio of MVP and MFC of pesticide (2.33) for rice cultivation was positive and more than one, which indicated that in the study area use of pesticide for rice cultivation was under used. So, farmers should increase the use of pesticide to attain efficiency in rice cultivation.

6.6 Concluding Remarks

It is evident from the Cobb-Douglas production function model, which the included key variables had significant and positive effect on rice production except the positive and insignificant effect of human labor cost, seed cost and pesticide cost. Resource use efficiency indicated that all of the resources were under-utilization for rice production except over- utilization of human labor cost and TSP cost. So there is a positive effect of key factors in the production process of rice production.

CHAPTER VII
PROBLEM OF BORO RICE CULTIVATION

7.1 Introduction

The rice growers were found to face different problems were non-available of good quality seed, low yield and unstable price, land unsuitability, attack by insects and diseases, high price of pesticide and fertilizer, lack of capital. Shortage of hired labor at the harvesting period, irregular extension contacts and drought. The nature and extent of these problems are discussed below**:**

- **Low yield and unstable price:**

The problem of low price and unstable price was noticed by 24.44 percent of rice growers in the study areas (Table 7.1). It was a severe problem for rice production and ranked 1st among the problems.

- **Lack of storage facilities**

There was a lack of storage facility for rice farmers was the major problem in the study areas. Most of the products were sold just after harvest at a low price due to lack of proper storage facilities. About 15.56% of the farmers in this study area reported that lack of storage facilities and high charge for storage discouraged them to produce more rice. In the rank order, problem of lack of storage facility was the 2nd in the study area.

- **Lack of sufficient fund**

Farmers in our country especially the small farmers cannot save much from their crops for investing in the succeeding crops. On the other hand, agricultural credit from formal sources is very much limited and farmers often cannot afford it for various reasons. About 12.22 percent of the rice growing farmers mentioned that they had dearth of cash for rice cultivation (Table 7.1) and ranked 3rd problem.

• **Shortage of human labor at the critical stage:**

Shortage of human labor at the critical stage is a seasonal problem and generally occurs in peak period of rice production. Shortage of human labor hampered different intercultural management and delayed harvesting which ultimately reduced yield. About 11.11 percent of rice growers faced the problem of shortage of human labor. This problem ranked 4^{th} for rice cultivation.

• **Lack of good quality seed:**

Though all the farmers were found to produce high yielding varieties of rice, 10 percent of them mentioned that they had lacking of good quality seed and this constraint ranked 5^{th} among the constraints (Table 7.1). Most of the own preserved seeds and the seeds collected from local markets or neighbors were not good quality seeds as their germination was poor.

• **High price of inputs:**

Based on farmers' opinion, another top-ranking constraint was high price and spot scarcity of fertilizers. Majority (7.78%) of the farmers mentioned that they faced the problem of high price and spot scarcity of one or more of the chemical fertilizers in rice growing season. Such problem led some of the farmers to apply less amount of some of the fertilizers which further aggravated the imbalanced use of chemical fertilizers. This problem was ranked 6^{th} for rice growers (Table 7.1).

- **Lack of irrigation facility**

Irrigation water is one of the most important inputs for rice production. Yield of rice varied in the application of irrigation water. They took irrigation facility from other farmer by some rate of amount but it is a problem for timely supply of water. About 6.67% of the farmers in the study area reported that they were not received water timely and water charge was much higher for them.

- **Lack of suitable land:**

It was observed that 5.56 percent of rice growers in the study areas had lacking of suitable land for the cultivation of the rice (Table 7.1). This problem ranked 8th for rice farmers.

Table 7.1 Problems of boro rice production

Problems	Farmers	Responded (%)	Rank
Low yield and unstable price	22	24.44	1st
Lack of storage facilities	14	15.56	2nd
Lack of sufficient fund	11	12.22	3rd
Shortage of human labor at the critical stage	10	11.11	4th
Lack of good quality seed	9	10	5th
High price of inputs	7	7.78	6th
Lack of irrigation facility	6	6.67	7th
Lack of suitable land	5	5.56	8th
Disease infestation	4	4.44	9th
Natural Calamities	2	2.22	10th
Total	90	100	

Source: Field Survey, 2019

• Disease infestation:

Diseases was one of the most severe constrains to produce rice. About 4.44 percent of rice producers, reported that they were facing this problem (Table 7.1). This problem ranked 9th for the rice cultivar.

- **Natural Calamities**

Farmers reported that natural hazards, such as. Haze weather in sowing or planting period, rainfall and flood during harvesting period hampered proper production and quality. On an average, 2.22% of the farmers in the study area reported that large amount of crops were damaged due to flood.

CHAPTER VIII

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Rice is the staple food of over half the world's population. It is the predominant dietary energy source for 17 countries in Asia and the Pacific, 9 countries in North and South America and 8 countries in Africa. Rice provides 20% of the world's dietary energy supply, while wheat supplies 19% and maize (corn) 5%.

Cooked, unenriched, white, long-grained rice is composed of 68% water, 28% carbohydrates, 3% protein, and negligible fat. In a 100 gram serving, it provides 130 calories and contains no micronutrients in significant amounts, with all less than 10% of the Daily Value (DV). Cooked, white, short-grained rice also provides 130 calories and contains moderate amounts of B vitamins, iron, and manganese (10–17% DV) per 100 gram amount.

A detailed analysis of nutrient content of rice suggests that the nutrition value of rice varies based on a number of factors. It depends on the strain of rice, such as white, brown, red, and black (or purple) varieties having different prevalence across world regions. It also depends on nutrient quality of the soil rice is grown in, whether and how the rice is polished or processed, the manner it is enriched, and how it is prepared before consumption.

The overall goal of the study is to examine the profitability of Boro rice production in some selected areas of Jessore district in Bangladesh. The specific objectives of the study are as follows:

v. To describe the socio-economic characteristics of boro rice farmers;
vi. To estimate the cost and return of Boro rice cultivation;
vii. To find out the factors that affecting profitability of Boro rice cultivation; and
viii. To identify the problem faced by the farmers in Boro rice cultivation.

8.1 Summary of the Study

Out of 90 samples farmers of all categories, 50 percent belonged to the age group of 36-50 years, 26.7 percent 17-35 years and 23.3 per cent fell in above 50 years age group. On the other hand, out of 30 farmers of small farm categories, 56.7 percent belonged to the age group of 36-50 years, 33.3 percent 17-35 years and 10 percent were in the age group of above 50 years. On the other hand, out of 30 farmers of medium farm categories, 43.3 percent belonged to the age group of 36-50 years, 36.7 percent 17-35 years and 20 percent were in the age group of above 50 years. On the other hand, out of 30 farmers of large farm categories, 50 percent belonged to the age group of 36-50 years, 10 percent 17-35 years and 40 percent were in the age group of above 50 years. The majority of the sample farmers were in the most active age group of 36-50 years indicating that they provided more physical efforts for farming and this age group are supposed to have enormous vigor and risk bearing ability.

In the case of small farms, 33.3 per cent farmers had secondary level, 26.7 per cent had above secondary school level, 20 per cent primary level and 20 per cent had illiterate level of education. In the case of medium farms. 10 per cent farmers had primary level. 23 3 per cent illiterate, 43.3 per cent above secondary level and 23.3 per cent secondary level of education. On the other hand, in the case of large farms, 46.7 per cent farmers had primary level, 10 per cent illiterate, 40 per cent secondary level of education and 3.3 per cent above secondary level of education.

Out of 30 farmers small farmers, 50 percent belonged to the small family of 2-4 members, 36.7 percent 5-6 persons and 13.3 percent were in the large family size of above 6 persons. On the other hand, out of 30 farmers medium farmers, 56.6 percent belonged to the small family size of 2-4 persons, 36.7 percent 4-6 persons and 16.7 percent were in the large family size of above 6 persons. On the other hand, out of 30 farmers of large farmers, 16.7 percent belonged to the small family size of 2-4 persons, 43.3 percent 5-6 persons and 40 percent were in the large family size of above 6 persons. The highest 33.3 percent of the farmers possessed small farms, 33.3 and 33.4 percent of them having medium farms and large farm size. Majority 43.3 percent of the small farmers had 20-100 thousand annual family income followed by 40 percent of the small farmers had above 150 thousand annual family income and only 16.6 percent of the small farmers had 101-150 thousand annual family income. About 46.7 of the medium farmers had 20-100 thousand annual family income, while 33.3 percent of them having above 150 thousand annual family income and only 20 percent of the medium farmers had 101-150 thousand annual family income. The highest 50 percent of the large farmer's had 101-150 thousand income compared to 40 percent of the large farmers having above 150 thousand annual family income and only 10 percent of the large farmers had 20-100 thousand annual family income.

Majority 33.3 percent of the small farmers received credit from NGOs, while 30 percent of the small farmers received credit from bank, 20% credit received from relatives and only 16.7 percent of the small farmer's credit received from others sources. The highest 36.7 percent of the medium farmer's credit received from relatives, 30% of the medium farmers received credit from NGOs, 23.3% and 10 percent of the medium famers credit received from others and bank, respectively. Data presented in the Table revealed that the highest 36.7% of the large farmer's credit received from NGOs compared to 33.3 percent of the large farmer's credit received from bank, 16.7% and 13.3 percent of the large farmers credit received from relatives and others, respectively. Majority 40 percent of the small farmers had no training on rice cultivation, while 26.7 percent of the small farmers had medium training, 20% and 13.3 percent of the small farmer's had low and high training on rice cultivation. The highest 33.3 percent of the medium farmer's had high training on rice cultivation, 30% of the medium farmers had no training on rice cultivation 23.3% and 13.3 percent of the medium famers had medium and low training on rice cultivation, respectively. The highest 40% of the large farmers had no training on rice cultivation compared to 26.7 percent of the large farmers had medium training on rice cultivation, 13.3% and 20 percent of the large farmers had low and high training on rice cultivation, respectively.

The highest proportion 36.7 percent of the small farmers had long market distance, while 33.3 percent of the small farmers had short market distance and 30 percent of the small farmers had medium market distance. In case of medium farmers, the highest 53.3 of the farmers had medium market distance, whereas 26.7 percent had long market distance and only 20 percent had short market distance. Again, the highest 70 percent of the large farmers had short market distance, while 23.3 percent of the large farmers had medium market distance and only 6.6 percent of the large farmers had long market distance. The highest proportion 66.7 percent of the small farmers had medium extension contact, while 20 percent of the small farmers had high contact and 13.3 percent of the small farmers had low contact. In case of medium farmers, the highest 53.3 of the farmers had medium contact, whereas 30 percent of the medium farmers had low contact in rice cultivation and 16.7 percent had high contact. Again, the highest 66.7 percent of the large farmers had medium contact, while 20 percent of the large farmers had high contact and 13.3 percent of the large farmers had low contact in rice cultivation. The highest proportion 53.4 percent of the small farmers had 16-30 years of experience, while 33.3 percent of the small farmers had above 30 years' experience and 13.3 percent of the small farmers had 4-15 years' experience. In case of medium farmers, the highest 43.3 of the farmers had 16-30 years' experience, whereas 36.7 percent had 4-15 years' experience in rice cultivation and only 20 percent had above 30 years' experience. Again, the highest 53.3 percent of the large farmers had (16-30 years) experience, while 26.7 percent of the large farmers had above 30 years' experience and 20 percent of the large farmers had 4-15 years' experience in rice cultivation. The highest proportion 76.7 percent of the small farmers had short distance from DAE office, while 13.3 percent of the small farmers had long distance from DAE office and 10 percent of the small farmers had medium distance from DAE office. In case of medium farmers, the highest 66.7 of the farmers had short distance from DAE office, whereas 26.7 percent had medium distance from DAE office in rice cultivation and only 6.6 percent had long distance from DAE office. Again, the highest 76.7 percent of the large farmers had short distance from DAE office, while 20 percent of the large farmers had medium distance from DAE office and only 3.3 percent of the large farmers had long distance from DAE office.

Per hectare hired labor costs were Tk. 29600, Tk. 32000 and Tk. 36800 for small, medium and large farmers respectively and their percentages of total cost of production was 29.59, 32.15 and 35.11 percent respectively. Per hectare animal labor and power tiller cost for rice production were Tk. 4250, Tk. 4326 and Tk. 4420 for small, medium and large farmers respectively and their percentages of total cost of production was 4.25, 4.35 and 4.21 percent respectively. Per hectare costs of seeds of rice production were Tk. 2750, Tk. 3100 and Tk. 3300 for small, medium and large farmers respectively and their percentages of total cost of production were 2.75, 3.11 and 3.15 percent. Per hectare costs of urea were Tk. 3465, 4095 and 4284 for the small, medium and large farmers respectively and their percentages of total cost of production were 3.46, 4.11 and 4.09 percent respectively.

Per hectare costs of TSP were Tk. 2565, 3240 and 3834 for the small, medium and large farmers respectively and their percentages of total cost of production were 2.26, 3.25 and 3.66 percent respectively.

Per hectare costs of MP were Tk. 1620, 1980 and 2070 for the small, medium and large farmers respectively and their percentages of total cost of production were 1.62, 1.99 and 1.97 percent respectively.

Per hectare costs of Zinc Sulphate were Tk. 1800, 1400 and 1000 for the small, medium and large farmers respectively and their percentages of total cost of production were 1.80, 1.41 and 0.95 percent respectively.

Per hectare costs of gypsum were Tk. 1296, 1512 and 1404 for the small, medium and large farmers respectively and their percentages of total cost of production were 1.29, 1.52 and 1.34 percent respectively.

Per hectare costs of boron were Tk. 1600, 1200 and 1400 for the small, medium and large farmers respectively and their percentages of total cost of production were 1.60, 1.21 and 1.34 percent respectively. Per hectare cost of manure for small, medium and large farmers were Tk. 3600, 3900 and 2850, respectively and their percentages of total cost of production were 3.60, 3.92 and 2.72 percent respectively. Per hectare costs of irrigation cost were Tk. 8712 Tk. 8940 and Tk. 9845 for small, medium and large farmers respectively and their percentages of total cost of production were 8.71, 8.98 and 9.39 percent. Per hectare cost of pesticides were Tk. 2805, Tk. 3250 and Tk. 3557 for small, medium and large farmers respectively and their percentages of total cost of production were 2.80, 3.26 and 3.39 percent.

Total variable cost per hectare for rice cultivation were Tk. 64063, Tk. 68943 and Tk. 74764 for small, medium and large farmers and their percentages of total cost of production were 64.03, 69.26 and 71.32 percent. The lease value of per hectare land were estimated at Tk. 15500, Tk. 15500 and Tk. 15500 for small, medium and large farmers and their percentages of total cost of production were 15.49, 15.57 and 14.79 percent. Per hectare family labor cost for rice cultivation were Tk. 17600, Tk. 12000 and Tk. 11200 for small, medium and large farmers and their percentages of total cost of production were 17.60, 12.05 and 10.68 percent. Interest on operating capital per hectare were Tk. 2882, 2102 and 3364 for small, medium and large farmers which covered 2.88, 3.12 and 3.21 percent of the total cost. Per hectare total fixed cost for rice cultivation were Tk. 35982, 30602 and 30064 for small, medium and large farmers which comprised of 35.97, 30.74 and 28.68 percent of total cost. Per hectare total cost of rice cultivation were calculated at Tk. 100045, Tk. 99545 and Tk. 104828 for small, medium and large farmers.

The average market price of rice was Tk. 21 per kg. Per hectare gross return of rice cultivation under small, medium and large farms were Tk. 144520, Tk. 146654 and Tk. 146893 respectively which indicates that per hectare gross return of large farms were higher than medium and small farm**s.** Gross margin was found to be Tk. 80457, Tk. 77711 and Tk. 72129 per hectare for small, medium and large rice farm respectively. Net return was estimated Tk. 44475, Tk. 47109 and Tk. 41065 for small, medium and large rice farm per hectare. Benefit cost ratio (BCR) was found to be 1.44, 1.47 and 1.40 for small, medium and large rice farm respectively which implies that one-taka investment in rice production generated Tk. 1.44, 1.47 and 1.40.

In this study, Cobb-Douglas production function model was used to determine the effects of key variable inputs. The most important 12 explanatory variables were included in the model to explain the gross income or return of rice cultivation. Most of the variables in the production function were significant in explaining the gross return except the negative and insignificant effect of land preparation, urea, MP, boron and gypsum. The coefficient with expected sign indicates the selected inputs contributed positively to the gross return. The values of the coefficient of multiple determination of rice cultivation was 0.872 which implied that about 87 percent of the total variation in the gross return could be explained by the included explanatory variables of the model. Production function for rice cultivation exhibits increasing returns to scale (1.007). This means that, if all the variables specified in the model were increased by 1 percent, gross return would also increase by 1.007 percent. The F-value for the mustard cultivation was 126.008 which were highly significant at 1 percent level. Resource use efficiency indicated that all of the resources were under-utilization for rice production except over- utilization of human labor and TSP. So, there is a positive effect of key factors in the production process of rice production.

The present study also identified problems and constraints of rice production. The major problems of the farmers low yield and unstable price was the 1st followed by lack of storage facilities, lack of sufficient fund, shortage of human labor at the critical stage, lack of good quality seed, high price of inputs, lack of irrigation facilities, lack of suitable land, disease infestation and natural calamities.

8.2 Conclusion and Policy Recommendations

It may be concluded that rice production is moderately profitable. If modern inputs and production technology can be made available to farmers in time, yield and production will be increased which can help farmers to increase income and improve livelihood standards. It can help in improving the nutritional status of rural people. The results however, clearly showed that per hectare yield of rice production are still low among other rice production Asian countries. There is an ample opportunity to improve per hectare yield of rice production. To enhance the productivity, efficiency and effectiveness of rice production, the following recommendations are made as a part of present study which acts as a formulating strategy for enhancing rice production in the study area.

- ✓ Institutional credit should be made available to the farmers and all intermediaries to meet their production and marketing requirements. The rate of interest of credit should be reduced.
- ✓ To ensure supply of quality seeds, fertilizers, and pesticides to the farmers at subsidized price.
- ✓ For farmers and traders village link roads should be developed by the local

government.

- ✓ Storage facilities should be improved at primary and secondary market by establishing public as well as private go down and warehouses.
- ✓ The input price should be fixed at certain reasonable level and the government should ensure the supply.
- ✓ Standard system of weight should be introduced in the trading of rice.
- ✓ Marketing facilities should be increased at market place.
- ✓ Sufficient number of procurement centers should be established and temporary purchasing centers may be opened by government and non-government organizations to purchase rice directly from the farmers. Seasonal price variation of rice should be controlled by the government through controlling the supply to make the rice market efficient.
- ✓ Market information should be made available to the farmers and intermediaries regularly. If they get the market information about their produce, they would be able to know the real situation of rice markets and could decide what to do at that time.

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