PROFITABILITY AND RESOURCE USE EFFICIENCY OF BORO RICE BRRI DHAN-28 PRODUCTION IN SOME SELECTED AREAS OF CHUADANGA DISTRICT IN BANGLADESH

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CERTIFICATE

*This is to certify that thesis entitled, "**PROFITABILITY AND RESOURCE USE EFFICIENCY OF BORO RICE BRRI DHAN-28 PRODUCTION IN SOME SELECTED AREAS OF CHUADANGA DISTRICT IN BANGLADESH**" submitted to Agricultural Statistics department in 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 STATISTICS,** represents the result of a piece of bona fide research work carried out by **Md. Rafikul Islam**, Registration No. **13-05612** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information has been availed of knowledge and during the course of this investigation has been acknowledged duly.

Date, 10 November, 2020

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TO

MY BELOVED

PARENTS

Abstract

Bangladesh is predominantly an agrarian country where the contribution of agriculture in total GDP is 13.74% and 40.6% people are directly involved with agriculture. Due to its very fertile land and favorable weather, varieties of crop grow abundantly in this country. It has been persistently contributing to higher rice production in last successive years. Bangladesh has acquired third position of producing rice over the world in 2020. My present study was designed to measure the profitability and resource use efficiency of boro rice production in some selected areas of four villages named Morevanga, Keshobpur, Sheikhpara and Hatboalia under three unions of Alamdanga Upazilla in Chuadanga district. Primary data were collected randomly from selected total 60 farmers from the study areas. Both tabular and functional analyses were applied in this study. The major findings of the study reveal that boro production is profitable. Total cost of production of boro was Tk.141449.10 per hectare. Gross return of boro was Tk. 171857.00 per hectare and net returns of boro was Tk. 30407.90 per hectare. Benefit Cost Ratio (BCR) was found to be 1.21 which implies that one-taka investment in boro production will be generated Tk.1.21. The coefficients of parameters like Fertilizer, Insecticide and Human labor were found positive and significant at 5, 5 and 1 percent level of significant respectively where land preparation was negative at 5 percent level of significant. The other variables seed and irrigation coefficient were positive but insignificant. The resource use efficiency of the samples seed (r=2.091) was only underutilized. The other variables as insecticides (0.3110), fertilizer (0.136), irrigation (0.346) and human labor (0.0832) were over utilized and the land preparation cost was indiscriminately over utilized. On that farm area most of the variables were over utilized which implied that they need to utilize the variables properly with reducing cost behind it for achieving the highly gross return. The study revealed that a considerable improvement took place to increase household income of the farmers in the study area and to improve the socioeconomic conditions with the introduction of large-scale commercial boro production. The study also identified some problems and constraints faced by the boro farmers and suggested some recommendations to improve the present production situation so that yield of boro would possibly be increased.

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Author

Md.Rafikul Islam

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ABBREVIATIONS AND ACRONYMS

BRRI	: Bangladesh Rice Research Institute
BBS	: Bangladesh Bureau of Statistic
BCR	: Benefit Cost Ratio
BER	: Bangladesh Economic Review
DAE	: Department of Agricultural Extension
GR	: Gross Return
Ha	: Hectare
IOC	: Interest on Operating Capital
Kg	: Kilogram
MoP	: Muriate of Potash
NGO	: Non-Government Organization
TC	: Total Cost
TFC	: Total Fixed Cost
Tk.	: Taka
TSP	: Triple Super Phosphate
TVC	: Total Variable Cost
MPP	: Marginal Physical Product
MVP	: Marginal Value Product
MFC	: Marginal Factor Cost
(USDA)	: United States Department of Agriculture
GCA	: Gross Cropped Area

CHAPTER 1

Introduction

1.1 Study Background

Bangladesh is predominantly an agrarian country. Due to its very fertile land and favorable weather, varieties of crop grow abundantly in this country. Agriculture sector contributes about 14.23 percent to the country`s Gross Domestic Product (GDP) and employs around 40.60 percent of total labor force. (BBS, 2019)

Rice is Bangladesh’s largest crop and the main staple food for the 157 million people of the country. Total rice production in Bangladesh was about 10.59 million tons in the year 1971 when the country's population was only about 70.88 millions. However, the country is now producing about 25.0 million tons to feed her 135 million people. Agricultural sector plays an important role in the overall economic development and food security of this highly populated country. Historically, agricultural sector is prominent for a long time in Bangladesh (Molla et al., 2015).It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intake of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow rice. It is the country's largest dominant sector. About 80% of its population lives in rural areas, where agriculture is the main occupation and 41% of the workers work in agriculture (Bangladesh Economic Review 2018).About 75% of the total cropped area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh.

Table 1.1 Share of agriculture to GDP (%) of Bangladesh

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Agriculture	17.6	17.1	17	16.81	16.18	15.49	15.35	14.78	14.05	13.41	13.07	12.68

(Source: BBS, 2019)

Major agricultural crops include rice (73.94%), wheat (4.45%), jute (3.91%), rape and mustard (3.08%), lentil (1.54%), potato (1.13%), sugarcane (1.12%) and chili (1.05%) of total GCA dominate the cropping pattern (BBS, 2017). Rice and wheat are mainly grown for domestic consumption whereas jute and tea is grown for export purpose.

Bangladesh is going to clinch third place in global rice production with an increased output of 36 million metric tons. A recent World Agricultural Production report of US Department of Agriculture (USDA) estimated that Bangladesh will have 36 million metric tons or rice while Indonesia 34.9 million metric tons, India 118 million metric tons and China 149 million metric tons 2020/21 period. Rice production is one of the main sources of revenue for the country's economy l sector in Bangladesh (Rahman, 2017). The significant contribution of rice in Bangladesh economy makes the crop very important among all agricultural crops.

1.2 Rice Production in Bangladesh

There are three seasons of rice production in Bangladesh- aus, aman and boro. BRRI has already developed 94 rice varieties. Among them 27 varieties are boro rice, 36 are aman rice and 10 are aus rice (Elahi, 2017). BINA has developed 20 rice varieties (Elahi, 2017).

"Boro" is the dry season irrigated rice crop planted from December to early February and harvested between April and June. In 2018/2019, the total production of rice in Bangladesh was 36,391,000 (36.4 million) metric tons (MT), of which boro rice accounted for 53.8 percent; aman rice, 38.6 percent; and aus rice, 7.6 percent. In 2019, paddy prices in Bangladesh were depressed due to a bumper harvest of the boro rice crop. Average paddy price was Tk 17.42 per kg in January 2019 after the aman harvest, but declined by 22 percent to Tk 13.56 per kg in May 2019 (DAM 2020).

Rice is the staple food of about 150 million people of Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh (BBS, 2018).

Almost all of the 15 million farm families of the country grow rice (Ghosh *et al.*, 2017). Rice is grown on about 15.4 million hectares which has remained almost stable over the past three decades (BBS, 2017). Rice is planted on about 75% of the total cropped area and over 80% of the total irrigated area (BBS, 2017). Thus, rice plays a major role in the livelihood of the people of Bangladesh.

1.3 Importance of Boro Rice in Bangladesh

1.3.1 Economic Importance:

Rice plays an important role in all spheres of life in Bangladesh and when it comes to food security of the rural farmers it is the most significant commodity in terms of livelihood and food. Bangladesh is trying to achieve self- sufficiency in food production from the time of independence (Rahman, 2017). According to government estimates, Bangladesh is self-sufficient in food production at present which is the result of increased rice production (Rab, 2017). The increased rice production has been possible due to the adoption of modern high yielding rice varieties. There are many high yielding rice varieties. Among them the most popular high yielding and modern boro varieties are BR 17 (Hashi), BR 18 (Shahjalal), BR-19 (Mongal), BRRI dhan 28, BRRI dhan 29 (Khan *et al.*, 2011).

In 2018/2019, the total production of rice in Bangladesh was 36,391,000 (36.4 million) metric tons (MT), of which boro rice accounted for 53.8 percent; aman rice, 38.6 percent; and aus rice, 7.6 percent. In 2019, paddy prices in Bangladesh were depressed due to a bumper harvest of the boro rice crop. Average paddy price was Tk 17.42 per kg in January 2019 after the aman harvest, but declined by 22 percent to Tk 13.56 per kg in May 2019 (DAM 2020).

Boro rice is considered as the most important and single largest crop in Bangladesh in respect of volume of production (Hoque and Haque, 2014). Around 4,472,000 MT land is cultivated under boro season and boro rice varieties contribute to 54.56% of total rice production in Bangladesh (BBS, 2017). Thus, boro rice plays a big part not only in the economy and livelihood of agriculture based farmers but also in the total production, GDP and food security in Bangladesh.

Table 1.2 Share of boro rice in the total rice production

Year	Area (‘000,hactors)			Production (‘000.MT)			% of total production		
	Aus	Aman	Boro	Aus	Aman	Boro	Aus	Aman	Boro
2011-12	1120	5850	4750	2300	12800	18600	6.91	37.98	55.19
2012-13	1150	5750	4750	2400	12800	18800	7.06	37.64	55.29
2013-14	1200	5850	4700	2500	13200	18500	7.30	38.60	54.09
2014-15	1045	5530	4841	2328	13190	19192	6.71	38	55.29
2015-16	1018	5590	4773	2288	13484	18938	6.59	38.85	54.56
2016-17	1098	5900	4750	2338	13350	18890	6.76	38.61	54.63
2017-18	1100	5700	4472	2350	12500	17800	7.20	38.28	54.52

(Source: Bangladesh Economic Review, 2017)

1.3.2 Nutrient Importance

Table 1.3 Nutrients from per 100 gm. rice

Composition	**Rice**
Calories (k. calorie)	325
Moisture content (percent)	13.3
Carbohydrate (percent)	79
Protein (gm)	6.4
Fat (gm)	0.4
B-carotine (µg)	0
Vitamin B (mg)	0
Thiamin	0.21
Riboflovine	0.09
Vitamin C (mg)	0
Calcium (Ca) (mg)	9
Iron (Fe) (mg)	1

(Source: Bose and Som, 1986; Wahed and Anjan, 2008)

1.4 Justification of the Study

Rice is the major cereal crop in Bangladesh and highly related with food security. The study will be helpful for the individual farmers for effective operation and management of their farms through pointing the drawbacks and for the planners for proper planning and policy making. The average per hectare yield of boro rice is higher than of Aus Aman. But it is argued that the cost of production of HYV boro or local boro rice is increasing day by day due to increase in input price but the output price is not increasing accordingly. It is observed that farmers are used different types of inputs based on their economic condition but there are in many cases resources are not used efficiently. Moreover farmers are faced many problems producing boro Rice, like high price of inputs, lack of cooperation of extension department, lack of capital and shortage of hired labor at the critical stage of cultivation.

Keeping this idea in mind, this study has been undertaken to take an insight into profitability and resource use efficiency of boro rice cultivation. Finally an attempt is made to find out the problems faced by farmers to produce boro rice on their farms.

1.5 Objectives of the Study

The specific objectives of this study are-

i. To identify the socio-economic characteristics of farmers growing boro rice;
ii. To compare the costs, returns and profitability of boro rice;
iii. To estimate the major factors affecting profitability and resource use efficiency of boro rice;
iv. To identify the major problems and constraints faced by the farmers;
v. To suggest some policy recommendations.

1.6 Outline of the Study

The study consists of 7 chapters. Chapter 1 describes the introduction of the study, Chapter 2 relevant to literature. Chapter 3 deals with the methodology of the study. In Chapter 4, the socioeconomic characteristics of the sample farmers, production cost and profit, etc. are presented. In Chapter 5 depicts the total cost, gross return, net return, and Benefit cost ratio and resource use pattern. Chapter 6 reveals Resource Use efficiency. Finally, the conclusion, and recommendations of the study are presented in Chapter 7.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Introduction

This chapter presents the review of relevant literature with a view to understand the method and cause-effect relationship of past and present research work on boro rice production. An attempt has been made to review of relevant literature keeping in view the problem entitled, "**Profitability and resource use efficiency of boro rice production in some selected areas of Chuadanga district in Bangladesh"** This would help in narrowing down the problem correctly and in selecting the most appropriate technique of analysis. Unfortunately, a few number of economic studies are available in our country. This chapter reviews studies concerning the socio-economic aspects, problems and profitability of rice, which have so far been made by different researcher and organizations. The review of existing literature reveals that so far the attention has been given by the researchers in investigating the efficiency of boro rice production in the study area are not adequate.

Islam *et al*., (2017) conducted to assess the profitability, constraints and factors affecting rice production in coastal area of ShamnagarUpazila, Satkhaira district, Bangladesh by using stratified random sampling method. Simple statistical technique as well as the Cobb-Douglas production function was used to achieve the objectives of the study. 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. Lack of saline tolerable good quality seeds, high price of inputs, low price of outputs and natural calamity were the major problems for rice farming in the study area though rice farming was a profitable enterprise.

Saha*et al.*, (2017) looked for the economic profitability of Alternate Wet Drying (AWD) irrigation methods over conventional irrigation practices to address concerns of groundwater depletion associated with Boro rice production. In total 80 farmers of which 40 practice AWD and 40 farmers involved in conventional irrigation were selected randomly from Fulbaria and TrishalUpazilas of Mymensingh district and Nakla and NalitabariUpazilas of

Sherpur district. Descriptive as well as statistical analyses were done to achieve the objectives of the study. The key finding of the study is that AWD farmers gained more profit than conventional farmers on Boro rice production. The per hectare gross return and gross cost was higher and lower respectively in AWD farmers than conventional farmers from Boro rice production which ultimately leads higher net return of AWD farmers (Tk. 8621.456/hectare) than conventional farmers (Tk. 4551.204/hectare). The undiscounted Benefit Cost Ratio (BCR) was 1.111 and 1.057 respectively for AWD farmers and conventional farmers. The results indicated that application of AWD method was more profitable than conventional practices in Boro rice production.

Bapari (2016) analyzed the determinants, costs and benefits and resources allocation of both conventional and high yielding rice cultivation over the Rajbari district of Bangladesh. Data were accumulated from 300 regular rice growers of conventional and high yielding varieties and random sampling technique was applied for selecting the respondents from the study area from which information was collected through pretested questionnaire. Cobb – Douglas production function and gross margin were mainly used to determine the productivities and profits of both rice and the marginal value of the product was highly recommended to derive the optimal use of the resources. Results obtained by applying ordinary least square method showed that the most important factors of production in the study area were irrigation, labor, fertilizer and insecticide costs whose elasticities were 0.904, 0.048, 0.045 and 0.044 respectively and insignificant factors were seed and ploughing costs whose elasticities were – 0.009 and 0.030 respectively for high yielding rice. On the other hand, irrigation, insecticide, seed and ploughing costs of elasticities 0.880, 0.589, 0.116 and – 0.127 respectively were the important factors and minor role-playing factors were labor and fertilizer costs whose elasticities were 0.098 and 0.077 respectively for conventional yielding rice. The core message from productivity analysis was that the irrigation was key variable which played a positive and vital role in producing rice of both varieties.

Tama *et al*. (2015) undertaken to assess the financial profitability of aromatic rice production. A total of 45 farmers of some selected villages of Chirirbandar Upazila of Dinajpur district were considered as sample for achieving these objectives. Collected data were analyzed with descriptive statistics. 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.

Hasnain*et al.* (2015) observed that owing to the application of high yielding variety seeds, chemical fertilizer, pesticide, and irrigation, productivity of rice in Bangladesh has increased in the recent years though it is still lower compared to other Asian countries. A review of existing literature reveals that so far little attention has been given by the researchers in investigating the efficiency of rice production in Bangladesh. They studied to analyze the technical efficiency of rice production in Bangladesh using data from boro rice farmers. Required data are collected from 115 boro rice producing farmers of Meherpur district selected using multistage random sampling procedure. The study found that the technical efficiency of boro rice farms in the Meherpur district is 89.5%. It is also found that 'labor', 'fertilizer and pesticide', 'seed' and 'irrigation' are the significant factors that affect the level of technical efficiency while 'farm size' and 'ploughing cost' are found insignificant in affecting technical efficiency of boro rice production in the study area.

Pervin*et al.* (2014) attempted to examine the profitability of Boro rice-producing farms according to these three tenure groups such as owner, cash tenant and crop share tenant farmers. About 90 sample farmers, 30 owner farmers, 30 cash tenant farmers and 30 crop share tenant farmers were selected for the present study. The average gross returns per hectare were Tk. 108933.00, Tk. 119079.50 and Tk. 117368.48 in owner, cash tenant and crop share tenant farmers respectively. Gross return was higher of cash tenant farmer than other farmer but the total cost of production was higher in owner farmer and cash tenant farmer so their net return is lower than crop share tenant farmer. It was observed that per hectare net return was Tk. 14296.78. 27285.54 and 38615.72 for the owner. Cash tenant and crop share tenant farmers respectively. Which indicates that crop share tenant farmer earned more profit than the other farmers.

Reza *et al.* (2013) investigated to find out the input productivity and resource use efficiency of boro rice farm in Sylhet District. In total 120 farmers were selected randomly from three thanas of Sylhet District named Gohainghat, Fenchugonj and Balagonj, where equal number of samples were collected from each thana. Data were collected through farm survey by using a suitable pretested questionnaire. Cobb-Douglas Production Function, Marginal Value Product (MVP) and Marginal Factor Cost (MFC) are used for analysis. The use of inputs like human labour, seed, irrigation, insecticides, power tiller/animal power are also statistically significant but not for all the crops. Findings of the study revealed that the farmers were inefficient of the use of resources, generally, inputs such as fertilizer, seed and insecticides were under-utilized in Boro Paddy under three categories of farms (animal, power and pooled farm). The ratios of the MVP to the MFC were less than unity for Boro and Aman Paddy of all categories of farms except Boro Paddy in animal operated farm.

Rahman *et al.* (2012) estimated the farm-size-specific productivity and technical efficiency of all rice crops. Farm-size- specific technical efficiency scores were estimated using stochastic production frontiers. Gross return was the highest for small farms and net return was the highest for marginal farms. The lowest net return or the highest cost of production was accrued from both the highest wage rate and highest amount of labour used in medium farms. The marginal farms experienced the highest benefit-cost ratio (BCR) followed by small and medium farms. Average technical efficiency for large, medium, small, marginal and all farms were respectively 0.88, 0.92, 0.94, 0.75 and 0.88. There were significant technical inefficiency effects in the production of rice for marginal farms only. In this case, production cannot be increased by increasing efficiency with the existing technology except in marginal farms. The application of efficient management system would be able to increase production in the marginal farms. In the technical inefficiency effect, age, education and family size had positive impact on efficiency effect, whereas land under household had negative impact on efficiency effect.

Banu (2011) studied on economic analysis of BR-28, BR-29 and Hybrid Hira rice production in Kurigram district with a sample of 90 farmers considering Cobb-Douglas production function and found that Hybrid Hira was more profitable than BR-28 and BR-29 rice as the net return was much higher than BR-28 and BR-29.

Kamruzzaman (2011) studied on economic potential of BRRI Dhan-51 and BR-11 rice production in Rangpur district with a sample of 60 farmers considering Cobb Douglas production function and found that BRRI Dhan-51 had higher gross return than BR-11.

Kana (2011) studied on economic analysis of salt tolerant Binadhan-8 and HYV BRRI Dhan28 rice production in Satkhira district with a sample of 60 respondents using CobbDouglas production function and found that total return of Binadhan-8 was greater than total return of BR-28.

Sarkar *et al.* (2010) conducted to examine the differences in input use, costs and returns of the borrower and non-borrower rice farmers. One hundred samples from four villages under Trishal Upazila of Mymensingh district were selected for the study. The study revealed that borrower farmers used more inputs and attained more returns through higher yield than their counterparts. The yields of rice per hectare were 5260.80 kg and 4177.34 kg for the borrower and non-borrower farmers, respectively. The gross returns and net returns were Tk. 41699.03 and Tk. 4475.64, respectively, for the non-borrower farmers and Tk. 51589.53. and Tk. 8821.68, respectively, for borrower farmers. The undiscounted BCRs were 1.73 and 1.12 in case of non-borrower farmers and 1.74.

Hanifa (2009) studied on economic analysis of BR-29 and Hybrid Hira rice production in Netrokona district with a sample of 80 farmers using Cobb-Douglas production function and found that total returns from Hybrid Hira rice per hectare was higher than BR-29.

Siddiqui (2008) studied on economic profitability of BRRI Dhan33 and BR-11 rice production in Kurigram district with 60 farmers using Cobb-Douglas production function and found that gross return for BRRI Dhan33 was higher than BR-11.

Anik*et al*. (2002) analyzed to evaluate the economic and financial profitability of aromatic and fine rice production, using both primary and secondary data. Forty farmers who cultivated both Kataribhog and Chinigura, and fifteen farmers each producing Pajam and Nizershail were selected from Dinajpur district. The net returns per hectare for the aromatic varieties were higher due to the higher market prices and less production cost of the varieties. Domestic Resource Cost (DRC) ratios showed that Bangladesh had comparative advantage in the production of aromatic and fine rice both from the point of view of export and import substitution, except the Nizershail variety which was marginally unprofitable under export proposition. The study also identified some problems faced by the farmers in producing aromatic and fine rice.

Mustafi and Azad (2000)conducted a study on adoption of modern rice varieties in Bangladesh. They examined the comparative profitability of BR-28 and BR-29 and found that the average yields 5,980 kg and 6,670 kg per hectare respectively. The gross margin was higher for BR-29 which was Tk. 27,717.02 per hectare. The farm level data also showed that the unit cost of BR-29 and BR-28 were Tk. 4.70 and Tk. 5.12 per kg. They also compared to BR-28 return from BR-29 is higher by Tk. 3,759 per hectare.

Miah (1999) conducted a study on Boro paddy marketing in selected areas of Tangail district. The study shows that Faria, Bepari, Miller, Arathdar and retailer who were involved in Boro paddy/rice marketing formed a complex marketing channel. The margin was the highest for miller followed by Bepari and Arathdar. The millers also received the highest profit. The Arathdar obtained the lowest profit. Major problems in the study area were low price of Boro paddy, poor communication and transportation facilities, inadequate credit facilities and lack of adequate storage facilities etc.

Uddin (1997) conducted a study of Boro paddy marketing in some selected areas of Jamalpur district and found that profit and marketing cost was highest for the millers. The study reveals that lack of communication, lack of adequate market functionaries, and lack of adequate market information, price fluctuation, lack of marketing facilities and lack of adequate storage facilities along with higher market toll and uncertainty in electricity supply were the major marketing problems.

2.2 Research Gaps

The above-mentioned opinions evidently show that only a few studies were conducted on boro rice production. As far from the knowledge of the researcher, no profitability and resource use efficiency study on boro rice production was conducted in my study area Chuadanga. The present study was, therefore, undertaken to determine the profitability and resource use efficiency of boro rice production and thereby to facilitate farmers and policy maker's decision making by providing information on boro rice production.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The design of any survey is predominantly determined by the nature, aims, and objectives of the study. It also depends on the availability of necessary resources, materials and time. Methodology is the theory of producing knowledge through research that we use. It provides a rationale for the way we proceed a researcher. Methodology is more than particular activities, such as doing a survey or interviewing people. It answers the question of how we should go about finding out knowledge (Williamson et al. 2018).

In this study, “survey method" was employed mainly due to two reasons:

- Survey enables quick investigations of large number of cases; and
- Its results have wider applicability.

The major disadvantage of the survey method is that the investigator has to rely upon the memory of the farmers. To overcome this problem, repeated visits were made to collect data in the study area and in the case of any omission or contradiction the farmers were revisited to obtain the `missing and/or correct information. This chapter presents a detailed sequential steps of research work for instance, selection of the study area, preparation of survey schedule, selection of sample, period of data collection and analysis of data. The study was conducted to measure profitability and resource use efficiency of boro rice in some selected areas of Chuadanga in Bangladesh and also to determine socio-economic characteristics of farmers. Necessary data were collected from the farmers of the selected areas and analyzed in terms of the objectives set for the study.

3.2 Topography of Bangladesh

Bangladesh is located in South Asia in a northern latitude range of $20^{o}34'$ to $26^{o}\ 38'$ and in east longitude $88^{o}01'$ and $92^{o}41'$ (BBS 2017). The subtropical mountain land is Bangladesh. The average winter weather is between 17 and 20.6ºC and the average summer temperature is between 26.9 and 21.1ºC and the mean precipitation between regions varies (Shahid, 2010; Shahid and Behrawan, 2008). The average size of farmland in 1960 (Rashid, 1978) was 3.1 acres and in 2014 it was reduced to 1.23 acres per person (WB, 2015). Land holdings are highly dispersed and small and marginal farmers are mainly. There has been also significant land use change by bringing crop diversification from double to triple crops (Islam, 2003). In the year 2014-2015, aman rice was cultivated in 48.44% and boro was42.40% of land (BBS, 2014). T. amanis a rainfed crop and in other two seasons, irrigation is the source of water. Approximately, 60% of the cultivated area is under irrigation coverage (FAO, 2013) and rice accounts for 75.01% area of total cultivated area (BBS, 2014). However, Bangladesh confronted loss in Boro rice production in changing climate (GAIN, 2015) and Aman season rice faces the most production losses due to natural hazards like floods, heavy downpour and water rush (BBS, 2014).

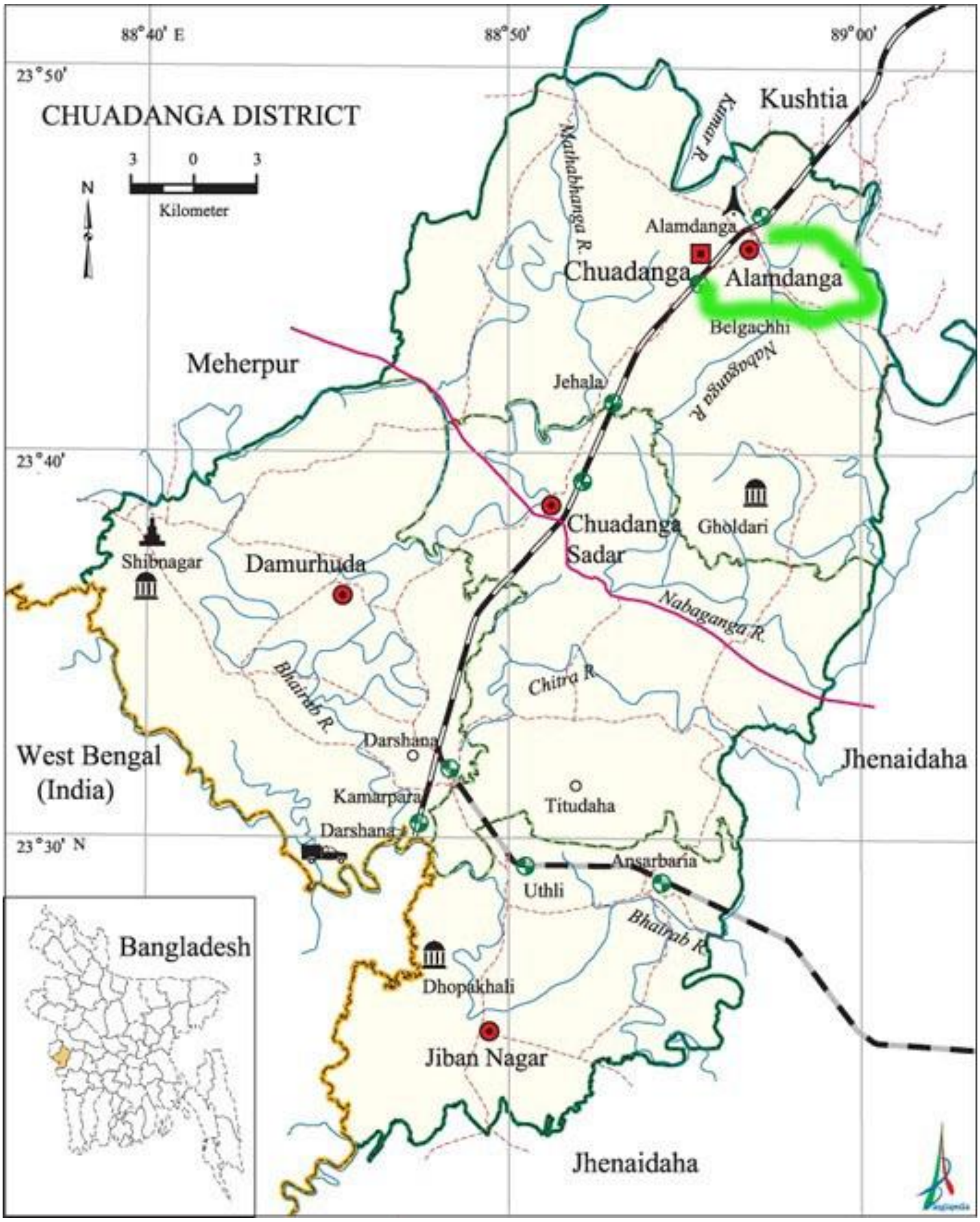
Figure 3.1Map of Bangladesh

Source: www.gogle.com/mapofbangladesh

3.3 Selection of the Study Area

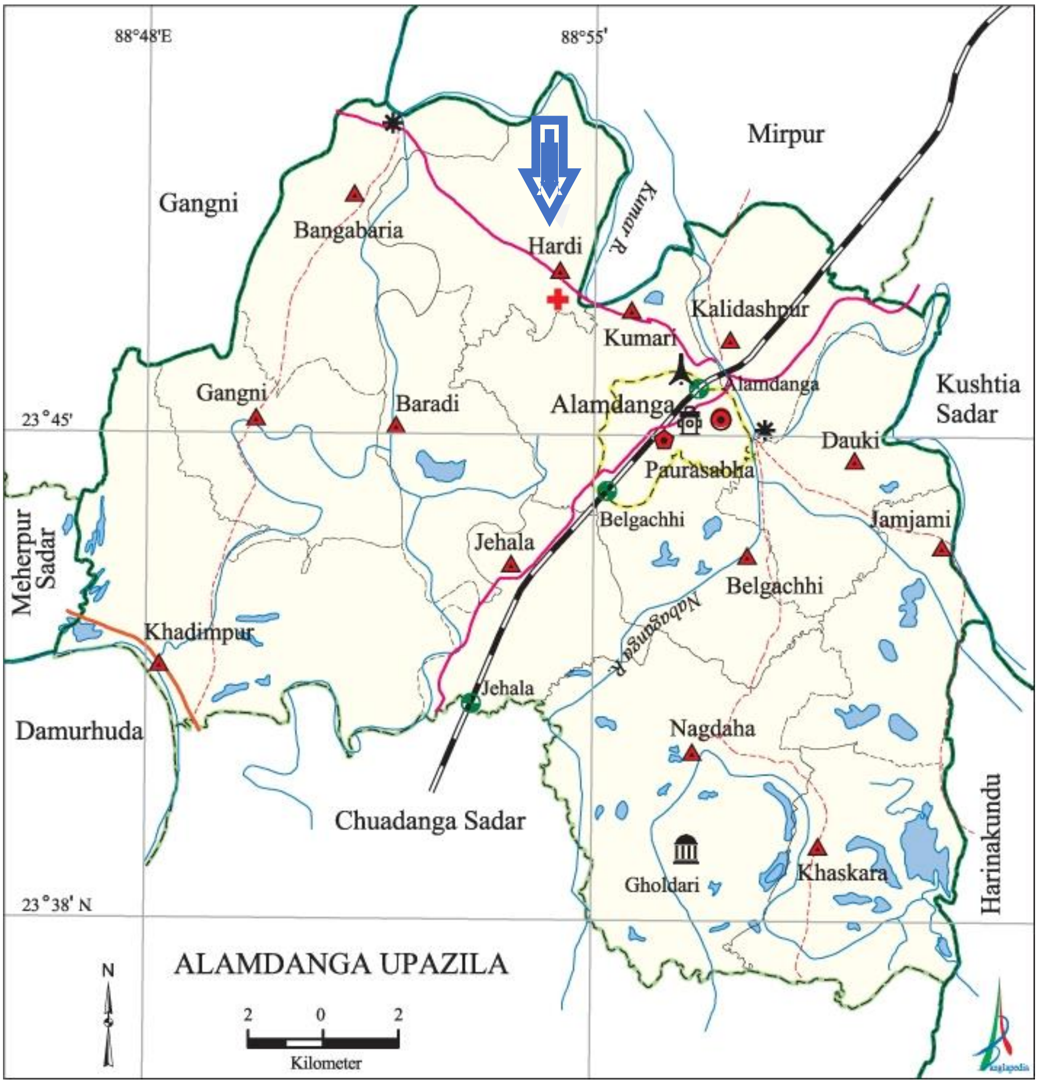
Selection of the study area is an important step for farm management study. The selection of an area fulfilled the particular purpose which was set for the study and also the possible cooperation from the farmer. Although boro is grown all over Bangladesh, the district Chuadanga and the Southwest area of Bangladesh is the important district where it is grown quite extensively. The area in which a farm business study is to be made depends on the particular purposes of the survey and possible cooperation from the farmers. So, on the basis of higher concentration of boro production, some selected areas in Alamdanga upazila under Chuadanga district was purposively selected for the study.

Figure 3.2 Map of Chuadanga



Source: www.banglapedia.com/chuadanga

Figure 3.3 Map of Alamdanga



Source: www.banglapedia.com/alamdanga

3.3.1 The Main Reasons for Selecting the Villages

i. Availability of a large number of farmers

ii. The large number of respondents and reliable sources of data were expected to obtain under these study areas.

iii. Easy accessibility and good communication facilities in these villages and

iv. Researcher himself was fairly well known to the local customs and practices and was able to speak the farmers' language. A good cooperation was expected from the respondents.

v. Co-operation from the respondents was expected to be high so that the reliable data would be obtained.

3.4 Selection of Sampling Technique

The primary purpose of the sampling is to pick a small group that is fairly true to the population. Two considerations must be taken into account when choosing specimens for a study. In statistical analysis, the sample size should be so large as to provide enough independence. On the other hand this should be within the limits imposed by physical, human and finance capital for handling field research, data processing and evaluation (Mannan 2001). Because of diversity in the technical and human environment, it is necessary to several numbers of the population before any conclusion can be drawn. Therefore, the purpose of sampling is to select a sub-set of the population that is representative of the population (Rahman, 1993). The term 'population' refers to the households, the farms etc. where a sample is representative under a study.

A deliberate random sample approach was used in this analysis. The district of Chuadanga was first intentionally chosen. Alamdanga upazilla has then been selected through deliberate random sampling among 4 Upazillas in the Chuadanga district. Upazilla Alamdanga is broken down into 13 unions. The districts of Bangladesh are divided into sub-districts called upazila (Sarker, 2010). For each union's selection, union wise information on the boro rice was taken from the upazilla DAE office.

The unions were also chosen on the basis of the purposively selected highest boro concentration. Eventually, four villages are randomly selected out of the most concentrated selected boro rice producing villages. **The villages were Morevanga, Keshobpur, Sheikhpara, Hatboalia.**

Name of the Upazilla	Villages	No. of Sample
Alamdanga	Morevanga	15
	Keshobpur	15
	Sheikhpara	15
	Hatboalia	15

3.5 Sample Size

All farmers could not be included in the study because space, money and staff were limited. To order to achieve the goals of the analysis, the appropriate sample size was taken into account. A total of 60 farmers have been selected for the final study goal. The required sample was first obtained from the selected Agricultural Office in the listing of boro rice producers. 200 farmers from the selected area have been found to have boro rice grown. Of the 200 farmers, 100 small-house farmers cultivating boro rice for at least 3 years have been identified. Total 60 farmers were then selected from villages randomly.

3.6 Period of the Study

Data were collected during the period of March to April in 2020 through direct interview with the farmers. Data relating to inputs and outputs were obtained by making time to time visit in the study area.

3.7 Data Collection Method

Required data were collected through field survey by interviewing the boro rice growers. The relevant information was collected from the boro rice farmers who were selected. The selected farmers were contacted first so that they could be interviewed according to their convenient time. Most of interview were taken from the farmer’s field. During interview, the researcher systematically asked questions and explained the purpose of the study for better understanding. The interviewer told the farmers the study was properly academic. When interview was over, the interview schedule was rechecked to ensure that each of the required information was collected properly.

3.8 Preparation of Survey Schedule and Pre-testing

A draft survey schedule was prepared in accordance with the aims of the study, which enabled reliable data from farmers to be collected. The draft survey schedule was pre-tested by researcher himself. The draft survey was conducted among 5 boro rice producers of small farmers in selected area. Thus the draft schedule was improved, rearrangedand modified in the light of the actual and practical experience gained during the pre-test.After making necessary adjustment a final survey schedule was developed in logical sequence.

The final schedule included the following information parts:

i. General information of respondents
ii. Respondent's socio-demographic information
iii. Farm holding status of the respondents
iv. Information about boro rice production
v. Respondent's opinion

The first part of the questionnaire contained respondent's identification, village and Upazila name. Second part contained information about respondent's socio-economic conditions, their age, sex, education, occupation, income etc. Different code was used for this purpose. The third part provided the farm holding status of the farmers such as the information on homestead land, owned land, land given to others, land taken from others etc. The fourth part contained the boro rice production related information such as the unit cost of inputs and the price and quantity of output. The last part of the questionnaire contained respondent's perception regarding impact of boro rice production in socio economic status of the farmers and constraints faced by them to boro rice production.

3.9 Processing of Data

The collected data were coded and edited manually. After that all the collected data were scrutinized and summarized very carefully. The information was first collected in local units and then it was converted into international standard units.

3.10 Entry and Analysis of Data

For the sake of consistency and completeness each survey schedule was verified after data collection. Data entry was done in computer and analysis was done accordingly in computer. The data were then transferred from the interview schedule to MS Excel sheet and analysis was done by using MS Excel.

3.11 Analytical Techniques

Data were analyzed with the purpose of fulfilling the objectives of the study. Both descriptive and statistical analysis was used for analyzing the data.

3.12 Descriptive Analysis

Tabular technique of analysis was generally used to find out the socio-demographic profile of the respondent, to determine the cost, returns and profitability of boro rice farm enterprises. It is simple in calculation, widely used and easy to understand. It was used to get the simple measures like average, percentage etc.

3.13 Production Function Analysis

The production role is the technical connection between the output and the input variable. In order to estimate the output function, its properties must be defined, leading to an explicit functional form stated. Cobb Douglas output is one of the most common manufacturing functions of statistical estimation. This form of the function was subsequently used in many production function studies for technical units (crops, livestock) and farm-firms in agricultures. The popularity of this function is because of the following characteristics of the function:

(i) It directly provides the elasticity's of production with respect to inputs;

(ii) It allows more degrees of freedom than other algebraic forms (like quadratic function) which allow increasing or decreasing marginal productivities, and

(iii) It simplifies the calculations by reducing the number of regression to be handled in regression analysis. The original form used by Cobb and Douglas was

$$\mathbf{Q = aL^{\beta}K^{1-\beta}U}$$

This forces sum of elasticity's to one. Their later modification was

$$\mathbf{Q = aL^{\alpha}K^{\beta}U}$$

Where, $\boldsymbol{\alpha} + \boldsymbol{\beta}$ need not equal one. In agriculture, this form of function has not been used in its original form. Neither the sum of elasticity's is kept equal to one nor is the number of variables limited to two. Even then as the basic idea of functional form was provided by Cobb and Douglas, various forms of this function have continued to be called as Cobb-Douglas production function. The Cobb–Douglas production function, in its stochastic form, may be expressed as $Yi = β_1X_{0i}β_2X_{1i}β_3X_{2i}\, e_{ui}$ ……………….. (3.1)

Where,

Y = output

X_1 = labor input

X_2 = Capital input

u = stochastic disturbance term,

e = base of natural logarithm.

From Eq. (3.1) it is clear that the relationship between output and the two inputs are nonlinear. However, if we log-transform this model, we obtain:

$\ln Y_i = \ln β_1 + β_2 \ln X_{1i} + β_3 \ln X_{2i} + u_i$

$= β_0 + β_2 \ln X_{1i} + β_3 \ln X_{2i} + u_i$………….. (3.2)

Where $β_0 = \ln β_1$.

Thus written, the model is linear in the parameters $β_0$, $β_2$, and $β_3$

The properties of the Cobb–Douglas production function are quite well known and is therefore a linear regression model. Notice, though, it is nonlinear in the variables Y and X but linear in the logs of these variables. In short, (3.2) is a log-log, double-log, or log linear model, the multiple regression counter part of the two-variable log-linear model.

The properties of the Cobb–Douglas production function are quite well known:

1. $β_2$ is the (partial) elasticity of output with respect to the labor input, that is, it measures the percentage change in output for, say, a 1 percent change in the labor input, holding the capital input constant.

2. $β_3$ is the (partial) elasticity of output with respect to the capital input, holding the labor input constant.

3. The sum (β_2+ β_3) gives information about the returns to scale, that is, the response of output to a proportionate change in the inputs. If this sum is 1, then there are constant returns to scale, that is, doubling the inputs will double the output, tripling the inputs will triple the output, and so on. If the sum is less than 1, there are decreasing returns to scale—doubling the inputs will less than double the output. Finally, if the sum is greater than 1, there are increasing returns to scale— doubling the inputs will more than double the output.

Before proceeding further, note that whenever you have a log–linear regression model involving any number of variables the coefficient of each of the X variables measures the (partial) elasticity of the dependent variable Y with respect to that variable. Thus, if you have a k-variable log-linear model:

$\ln Y_i = \beta_0 + \beta_2 \ln X_{1i} + \beta_3 \ln X_{2i} + \dots \dots + \beta_k \ln X_{ki} + u_i$ ………….. (3.3)

Each of the (partial) regression coefficients, β_2 through β_k, is the (partial) elasticity of Y with respect to variables X_1 through X_k. Assuming that the model (3.2) satisfies the assumptions of the classical linear regression model; we obtained the regression by the OLS. (Acharaya, 1988).

3.14 Specification of the Cobb-Douglas Production Function

The input-output relationships in boro rice farming was analyzed with the help of Cobb-Douglas production function approach. To determine the contribution of the most important variables in the production process of boro rice farming, the following specification of the model was used.

$Y= aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} e^{ui}$………….. (3.4).

The Cobb-Douglas production function was transformed into following logarithmic form so that it could be solved by ordinary least squares (OLS) method.

$\ln Y = \ln a + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + U_i$ ………….(3.5)

Where, Y= Gross income from year round boro rice (Tk./ha);

Y= Return per hectare (Tk./ha)

a= Intercept of the function

X_1= Cost of Seed (Tk. /ha)

X_2= Cost insecticide (Tk. /ha)

X_3= Cost of fertilizer (Tk. /ha)

X_4= Cost of Irrigation (Tk. /ha)

X_5 = Cost for land preparation(Tk. /ha)

X_6 = Cost for Labor (Tk. /ha)

β_1, β_2. . ….. β_6 = Coefficients of the respective input to be estimated.

3.15 Measurement of Resource 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.

In this study the MPP and the corresponding values of MVP were obtained as follows:

$MPPx_i * Py_i = MVP$

But, $MPP = b_i*(Y/X_i)$,

So, $MVP = b_i* (Y/X_i)*P_{yi}$

Y = Mean output

b_i = Regression coefficient per resource

X_i = Mean value of inputs

P_{yi}= Price per unit of output

MFC = Price per unit of input.

3.16 Decision Criteria

The decision criteria for choosing efficiency will be-

*When the ratio of MVP and MFC is equal to unity indicates that the resource is efficiently used.

*When the ratio of MVP and MFC is more than unity implying the resource is underutilized.
*When the ratio of MVP and MFC is less than unity implying the resource is over utilized.

3.17 Profitability Analysis

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

3.18 Calculation of Gross Return (GR)

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.

3.19 Calculation of Gross Margin (GM)

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.

3.20 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 the 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 farming (Tk. /ha);

P_m = Per unit price of boro rice (Tk/kg); Qm= Total quantity of the boro rice production (kg/ha);

Q_f = Per unit price of other relevant (by-product)ofboro rice (Tk. /kg);

P_f = Total quantity of other relevant (by-product)boro rice (kg/ha);

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

X_i = Quantity of the i-th inputs (kg/ha); and

TFC = Total fixed cost (Tk.)

i = 1, 2, 3…..n (number of inputs).

3.21 Benefit Cost Ratio (BCR)

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

BCR= Total Return /Total Cost.

3.22 Problem Faced in Collecting Data

During the period of data collection, the researcher faced the following problems.

i) Most of the farmers felt disturbed to answer questions since they thought that the researcher might use the information against their interest. To earn the confidence of the farmers a great deal of time was spent.

ii) The farmers do not keep records of their activities and day to day expenses. Therefore, the author had to depend upon their memory.

iii) The farmers were usually busy with their filed works. So, the researcher sometimes also had to pay extra visits to meet the farmer.

CHAPTER 4
SOCIOECONOMIC CHARACTERISTICS

4.1 Introduction

The socioeconomic characteristics of sample farmers are covered in this section. In inferring the planning of production, the socioeconomic features of farmers are significant. The sample households finished by studying socioeconomic aspects. These included age distribution and family size. Occupation, Annual Income, employment, pattern of land ownership, etc. These aspects are discussed briefly below.

4.2 Age Distribution

The study classifies all groups of farmers in the study area as set out in the table 4.1 shows that average 31.86 years was 23.33% in the 20-35 year age group, 41.66% belonged to the 36-50 year age group with average age 45.28 and, 35.01% fall into the over 51 year age group where their average age were 46.61 years.

Table 4.1 Age distribution

Age category	Average age	Number	Percent (%)
20-35 years	31.86	14	23.33
36-50 years	45.28	25	41.66
Above 51 years	62.71	21	35.01
Total	46.61	60	100

Source: Field Survey, 2020

4.3 Educational Status

Education improves people's effectiveness. Table 4.2 indicates that 45% of the farmers were illiterate, 13.33% were in primary level.15% of the farmers were belongs toSecondary level, 25% were into HigherSecondary level.

Table 4.2 Educational status

Level of education	**Number**	**Percent (%)**
Illiterate	27	45
Primary(1-5)	8	13.33
Secondary(6-10)	9	15
Higher Secondary(11-12)	15	25
Higher Education (Above 12)	1	1.67
Total	60	100

Source: Field Survey, 2020

4.4 Experience in Boro Rice Cultivation

The table 4.3 shows that average 10.79 years' experience farmers were 23.33% , average age 26.14 years farmers were 36.67% which expressed the highest, the farmers were average age 39.07 and 52.5 were 23.33 % and 16.67% respectively.

Table 4.3 Experience in boro rice cultivation

Experience years	Average Experience(years)	Number	Percent (%)
1-15 years	10.79	14	23.33
16-30 years	26.14	22	36.67
31-45 years	39.07	14	23.33
Above 46	52.50	10	16.67
Total	32.13	60	100

Source: Field Survey, 2020

4.5 Occupational Status

Different types of occupation and rice production were used by selected farmers in this study area. It was noted that agriculture as a main occupation 95% of farmers, other sector as a main occupation was 5% only.

Table 4.4 Occupational status

Types of occupation	Number	Percent (%)
Agriculture as main occupation	57	95
Other as main occupation	3	5
Total	60	100

Source: Field Survey, 2020

4.6 Farm Size and Ownership

The study farmers are categorized as: landless farmers (less than 49 decimal), small farmer (50-249 decimal), medium farmer (250-749 decimal) and large farmer (above 750 decimal) (GOB, 2019). The table shows that in the sample, 33.33 percent were landless farmer with average land 17.36 decimal , 61.67 percent were small farmer and their average land 128.67 decimal, 5 percent were medium farmer with 506 decimal average land and the large farmer were not found in the area.

Table 4.5 Farm size and ownership

Types of farmers	Number	Average Land	Percentage (%)
Land less (less than 49 decimal)	20	17.36	33.33
Small Farmer (50-249 decimal)	37	128.67	61.67
Medium Farmer (250-749 decimal)	3	506	5
Large Farmer (above 750 decimal)	0	0	0
Total	60	217	100

Source: Field Survey, 2020

4.7 Income Status

In the study area, the rice farmers ' incomes were divided into less than 150,000, from 150,000 to 250,000 and more than 250,000. It is evident from the table most of the farmer's yearly income belonged to the category of 150,000 to 250,000. About 40 percent of the rice farmers were earned Tk. 151,000 to 250,000 per year where their average income 202,250. 35 percent of the farmers were earned Tk. less than 150,000 per year with their average income 120,476.2 and 25 percent farmers were earned Tk. above 250,000 per year where the average income was 359,333.3 Taka.

Table 4.6 Annual income status

Level of income	Average income (Tk.)	Number	Percentage (%)
Less than 150,000 Tk.	120476.2	21	35
151,000-250,000 Tk.	202250.0	24	40
Above 251,000 Tk.	359333.3	15	25
Total	227353.2	60	100

Source: Field Survey, 2020

4.8 Annual Income Sectors

From the table it can be seen that of the total income 59.46 percent come from crops 28.07% come from Livestock and 12.47% come from Off farm sources.

Table 4.7 Annual income sectors

Source of income	Total amount(Tk) Average	Percentage (%)
Income From Crops	126583.33	59.46
Income from Livestock	59750.00	28.07
Income from Off farm	26566.67	12.47
Total	212900	100

Source: Field Survey, 2020

4.9 Dependency Ratio

The ratio of dependency is an age-population ratio in economics, geography, and demography of those usually not employed (the dependent portion) and those traditionally employed (the productive portion). The real (or effective) dependence ratio examines the ratio between economically active and inactive employees. The successful dependency ratio not only discusses the age profile but also whether people are economically active.

It is used for calculating the strain on the population of production. With the proportion increase the responsibility of maintaining the education and pensions of economically dependent citizens on the active part of the population can be increased. This results in direct impacts on financial expenditures on things like social security, as well as many indirect consequences. Each and every family is rationally composed of both income earners and dependents.

The table present the depending members per income earner. In this present study the average dependency ratio was found 2.03.

Table 4.8 Dependency ratio

Types of farmers	Percentage (%)
Total family members	273
Total dependent members	183
Total earning members	90
Dependency ratio	2.03

Source: Field survey, 2020

4.10 Sources of Credit Facilities of the Respondent

For all forms of agriculture, the funding available is an important factor. Banks, NGOs, relatives and their own funds are the source of credit facilities for shrimp farmers. The study includes numerous NGOs including BRAC, ASA, CARE, etc. that use this fund in the boro-rice-growing industry, to provide loans to the lower farmer’s prices. Around 73.33% of the farmers had ability of cash capital of farming operationwithout borrowing from banks, 26.67% were not able to run of their farm financial activities. The credit facilities for agricultural crop production is only 30%. Institutional loan was far behind from 70% people.

Table 4.9.1 Ability of fund capacity of the sample farmers

Items Name	Number	Percent (%)
Availability of cash capital of farming operation (No)	16	26.67
Availability of cash capital of farming operation(yes)	44	73.33
Total	**60**	**100**

Table 4.9.2. Availability of institutional loan

Institutional not available	42	70
Institutional available	18	30
Total	**60**	**100**

Source: Field survey, 2020

4.11 Size of Land Holdings of the Sample Farmers

The scale of the land held by boro rice farmers is listed in various categories in the present study. Size of land holdings includes homestead land, own land, leased in, leased out,Boro rice cultivated land and Cultivated Land for other crops as reported by the sample farmers. It is evident from the table showed the average area 12.38 decimal, 112.21 decimal, 22.69 decimal, 24.22 decimals, 39.08 decimals ,71.60 decimals, were includes homestead land, own land, leased in, leased out,Boro rice cultivated land and Cultivated Land area for other crops are respectively hold by the sample farmers on an average.

Table 4.10 Size of land holdings of the sample farmers

Types of land	Average area (Decimal)
Homestead	12.38
Own land	112.21
Leased in	22.69
Leased out	24.22
Total boro rice cultivated land	39.08
Total cultivated land for other crops	71.60
Total	(282.18-24.22)=257.96

Source: Field survey, 2020

4.12 Cultivated Land Ratio

The table shows that 35.31% cultivated land are used for boro rice cultivation and other 64.69% land are used to produce other crops.

Table 4.11Cultivated land ratio

Name of area	Land area (Decimal) Average	Percentage %
Boro rice cultivated land	39.08	35.31
Other crops cultivated land	71.60	64.69
Total cultivated land	110.68	100

Source: Field survey, 2020

CHAPTER 5
COST AND RETURN OF BORO RICE FARMERS

5.1 Introduction

The main aim of this chapter is to evaluate boro rice costs and returns. In addition, the costs and returns of cultivation per hectare of the boro rice have been measured. Therefore, this chapter estimates cost and return for boro rice. Cost items are divided into two categories for the cost estimation and return of boro rice production: (1) variable cost and (2) fixed cost. Variable cost included the cost of all variable factors like human labor, land preparation, seed, fertilizer, manure, irrigation and insecticides. On the other hand, fixed cost was calculated for interest on operating capital. On the return side net return and benefit cost ratio (BCR) were determined in this chapter.

5.2 Variable Cost

5.2.1 Labor Cost

The most important and mostly used input for the development of boro was human labor. It contributed a large share of the total cost of production of boro rice. Human labor, including preparing land, weeding, fertilization, using insecticides and harvesting, is required for various activities and management. In the study area, there were two sources of work for human beings, one for families and one for hired labor. The appraisal of the hired labor was made as compensation of the farmers ' marginal cash salaries. The amount of work used for the production of boro rice is 224-man days per hectare from Table 5.1. Total human labor costs are equal to Tk. 56000/ha.

The valuation of family supplied labor was done as the average wage of the hired labor was taken as the opportunity cost of the family supplied labor. It can be observed that boro rice growers used on an average 183 man-days/ha total human labor where on an average 41 man-days/ha was family supplied labor. In the study area on an average wage rate was Tk. 250.00 per man-day. So, total cost of family supplied laborforboro rice amounted to Tk. 10250.00

per hectare and hired labor cost Tk. 45750.00 As the boro rice production is the labor intensive work. It reduces the unemployment problem.

5.2.2 Cost of Land Preparation

For boro rice production the average per hectare land preparation cost was Tk.9158.00 (Table 5.1)

5.2.3 Cost of Seeds

The seed cost is the main cost item for the production of boro rice. In the area under consideration, farmers were found to use both seeds supplied and bought at home. The total seed demand for boro rice per hectare was 63 kg / ha.. The average prices of seeds were Tk. 50 per kg for boro rice production. Table 5.1 shows that the total cost of seeds for boro rice production was Tk. 3150.00. To maintain the higher production high yield verity is required for the production.

5.2.4 Cost of Urea

The cost of urea is Tk. 4662.00. It is very useful to get the bumper production.

5.2.5 Cost of TSP

The cost of TSP is Tk. 5746.00. It provides nutrient to plant to become more vigor.

5.2.6 Cost of MoP

The cost of MoP is Tk. 2928.00.

5.2.7 Cost of DAP

The Cost of DAP is Tk. 11070.00.

5.2.8 Cost of Gypsum

The cost of Gypsum is Tk. 1320.00.

Table 5.1 variable cost

Items of returns/costs	Unit	Quantity	Price per unit(Tk.)	Total Cost (Tk.)
Human (hired) labor	Man-day	183	250	45750
Human (family) labor	Man-day	41	250	10250
Land preparation	Hour-ha	15.26	600	9158
Seeds	Kg	63	50	3150
Urea	Kg	259	18	4662
TSP	Kg	169	34	5746
MoP	Kg	183	16	2928
DAP	Kg	369	30	11070
Gypsum	Kg	11	120	1320
Zinc Sulphate	Kg	10	150	1500
Magnesium Sulphate	Kg	14	18	252
Boron/Boric Acid	Kg	4	119.5	480
Organic Fertilizer	Kg	5000	.5	2500
Average cost on total Fertilizer	Kg		**56.5**	
Insecticides	Kg	27.11	140	3796
Irrigation	Hour	332.67	45	14970
Total	Tk.	-	-	117532

Source: Field Survey, 2020

5.2.9 Cost of Zinc Sulphate

The cost of Zinc Sulphate is TK 1500.00.

5.2.10 Cost of Magnesium Sulphate

The cost of Magnesium Sulphate is Tk.252.00.

5.2.11 Cost of Boric Acis/Boron

The cost of Boric Acid is Tk. 480.00.

5.2.12 Cost of Organic Fertilizer

The cost of total organic fertilizer cost is Tk. 2500.00 per hectare.

5.2.13 Cost of Irrigation

Irrigation water is an important input in winter boro rice cultivation. Per hectare cost of irrigation water was Tk.14570.00 for boro rice (Table 5.1).

5.2.14 Cost of Insecticides

In the study area, farmers applied insecticides to protect from the attack of pests and diseases. Cost of insecticides amounted to Tk.3796.00 per hectare for boro rice (Table 5.1).

5.2.15 Total Variable Cost

Summation of the costs of variable inputs gave the total variable costs which were Tk.117532.00 per hectare for boro rice production.

5.3 Fixed Cost

5.3.1 Interest on Operating Capital

Interest on operating capital was calculated by taking into account all the operating costs incurred during the production period of boro rice. Per hectare interest on operating capital was Tk.3917.10.

5.3.2 Rental Value

Rental value of one-hectare land is Tk. 20000.00 for boro rice production.

So total fixed cost is Tk. 23917.10

Table 5.2: Fixed cost

Items of returns/costs	Unit	Quantity	Price per unit (Tk)	Total value (Tk)
Interest on OC for 4 months	Tk	117532	@10%	3917.10
Rental value	Tk	20000.00	1	20000
Total	Tk	-	-	23917.10

5.4 Total Cost

In order to estimate total cost per hectare all the resources used in boro rice production has been recapture together. Per hectare total cost of boro rice production was Tk. 141449.10(Table 5.3).

Table: 5.3 Total cost

Items of returns/costs	Unit	Variable cost	Fixed cost	Total (Tk.)
Total cost	Tk.	117532	23917.10	141449.10

Source: Field Survey, 2020

5.5 Return of Boro Production

5.5.1 Gross Return (GR)

Here gross returns of the boro rice production is= (Main product+ By-product). Total value of by products is Tk. 67050.00the quantity of main product is 5989.00Kg. If the price of the boro rice per unit is 17.50 then it becomes the total value of boro rice main product is Tk. 104825.00 So the gross return of the boro rice production is= (104825+ 67050) = 171857.00.

Table 5.4 Gross return

Items of returns/cost	Unit	Quantity	Priceper unit(Tk.)	Total value(Tk.)
Main product	Kg	5989	17.50	104807
By-product	Kg	5830	11.50	67050
Gross returns	Tk.	-	-	171857

Source: Field Survey, 2020

If the gross return of the boro rice production is increased and the production cost of boro rice decrease then we will get highest rate of return through boro rice cultivation.

5.5.2 Gross Margin

Gross margin = Gross return- Total variable cost = (171857- 117532) = Tk. 54325.00

The gross margin of boro production in that area was Tk. 54325.00

5.5.3 Net Return

The net return of boro rice production is depending on both gross return and total cost of the boro rice production.Net return is Tk. 30407.90.

Table 5.5: Net return **(**GR– TC**)**

Items of returns/costs	Unit	Gross return	Total cost	Total value (Tk.)
Net return	Tk.	171857.00	141449.10	30407.90

Source: Field Survey, 2020

5.7 Benefit Cost Ratio (BCR)

Benefit cost ratio was calculated by dividing gross return by gross cost or total cost. It implies return per taka invested. It helps to analyze financial efficiency of the farm. It was evident from the study that the benefit cost ratio of boro rice farming was accounted for 1.21 implying that Tk. 1.21 would be earned by investing Tk. 1.00 for boro rice production. So, the boro rice farming was found to be profitable for farmers (Table 5.6).

Table 5.6: BCR

Items of returns/cost	Gross Return	Gross cost	Ratio
BCR	171857	141449.10	1.21

Source: Field Survey, 2020

CHAPTER 6

FACTORS AFFECTING OF BORO RICE PRODUCTION

6.1 Introduction

In this Chapter, the effects of main variables on boro rice production are identified and measured. In order to assess the contribution of the major variables to the boro rice production process the Cobb-Douglas production function has been chosen. Table 6.1 presents the estimated values of the model.

6.2 Functional Analysis for Measuring Production Efficiency

Output function is a relationship or mathematical function, which indicates the total output to be achieved with certain inputs to a certain technological level. In order to estimates the effect of the inputs on output six explanatory variables are selected taking into account the objectives of the study and considering the effects of explainable variables on production of boro rice. Other independent variables like water quality, soil condition, time etc., which might have affected production of farm enterprises, were excluded from the model on the basis of some preliminary estimation. A brief description is presented here about the explanatory variables included in the model.

6.3 Estimated Values of the Production Function Analysis

- F-value was used to measure the goodness of fit for different types of inputs.
- The coefficient of multiple determinations (R^2) indicates the total variations of output explained by the independent variables included in the model.
- Coefficients having sufficient degrees of freedom were tested for significance level at 1 percent, 5 percent and 10 percent levels of significant.

.Table 6.1 Estimated values of coefficients of Cobb-Douglas production function

Explanatory variables	**Values of coefficients**	**Standard error**	**P-value**
Intercept	5.4643***	1.213	0.0000
Seed	0.1273	0.087	0.1472
Insecticide	0.0671**	0.032	0.0393
Fertilizer	0.0908**	0.042	0.0338
Irrigation	0.0901	0.092	0.3302
Land Preparation	-0.2396**	0.112	0.0374
Labor	0.4417***	0.078	0.0000
F-value	31.984		
R^2	0.78359		

Source: Field survey, 2020

Note:

**p< 0.05

***p< 0.001

6.4 Interpretation of the Results

6.4.1 Seed (X_1)

It can be seen from Table 6.1that the magnitude of the regression coefficient of Seed was **0.127**for boro rice. It was positive and was statistically insignificant.

6.4.2 Insecticide (X_2)

The value of insecticide for boro rice in magnitude regression was **0.067**. At 5% probability level, it was positive and significant. It indicates that an increase in insecticide value of one percent would result in a gross profit rise of 0.067 percent and that other variables would remain constant.

6.4.3 Fertilizer (X_3)

The magnitude of the regression coefficient of fertilizer was **0.091**with a positive sign. It was significant at five percent probability level. It implies that one percent increase of fertilizer, keeping other factors constant, would lead to an increase in the gross return by 0.091 percent for boro rice.

6.4.4 Irrigation (X_4)

The magnitude of the irrigation cost regression coefficient was **0.090**with a positive sign. It was insignificant.

6.4.5 Land Preparation (X_5)

The magnitude of the regression coefficient of land preparation was **-0.2396** with a negative sign. It was significant at five percent probability level. It implies that one percent increase of land preparation cost, keeping other factors constant, would lead to a decrease in the gross return by -0.2396 percent for boro rice.

6.4.6 Human Labor ((X_6)

The value ofhumanlabor for boro rice in magnitude regression was **0.442**. At 1% probability level, it was positive and highly significant. It indicates that an increase in labor value of one percent would result in a gross profit rise of 0.442percent and that other variables would remain constant.

6.4.7 Coefficient of Multiple Determinations (R^2). It is evident from Table 6.1that the value of the coefficient of multiple determinations (R^2) was **0.78359**for boro rice. It indicates that about 78 percent of the total of the gross returns are explained by the explanatory variables included in the model.

6.4.8 Goodness of Fit (F - value). The F-value was **31.984** for boro rice, which implies good fit of the model. That is, all the explanatory variables included in the model were important for explaining variation of boro rice production.

6.5 Resource Use Efficiency in Boro Rice Production

A ratio equal to unity indicated the optimal use of this variable, a ratio more than a unit indicated that yield might be improved through use of more resources, in determining the efficiency of resource usage. The unprofitable asset rate has been shown to be less than unit cost, which is to be decreased to minimize losses as farmers use this factor over time. The negative MVP value indicates that the resource is used indiscriminately and inefficiently. To calculate MVP their per unit yield price was Tk.15.05.

6.5.1 Seed

It was evident from the (table 6.2)that the ratio of MVP and MFC of seed (**2.091)** for boro rice farming was positive and more than one, which indicated that in the study area use of seed for boro rice farming was under used. So, farmers should increase the use of seed to attain efficiency in boro rice production.

6.5.2 Insecticide

The ratio of MVP and MFC of insecticide **(0.311)** for boro rice production was positive and less than one, which indicated that in the study area, insecticide was over used (Table 6.2). So, farmers should decrease the use of insecticide to attain efficiency considerably.

6.5.3 Fertilizer

It was evident from the (table 6.2) that the ratio of MVP and MFC of fertilizer **(0.136)** for boro rice farming was positive and less than one, which indicated that in the study area use of fertilizer for boro rice farming was over used. So, farmers should decrease the use of fertilizer to attain efficiency in boro rice production.

6.5.4 Irrigation

It was evident from the table 6.2 that the ratio of MVP and MFC of irrigation **(0.346)** for boro rice farming was positive and less than one, which indicated that in the study area use of irrigation for boro rice farming was over used. So, farmers should decrease the use of irrigation to attain efficiency in boro rice production.

6.5.5 Land Preparation

The ratio of MVP and MFC of land preparation **(-4.232)** for boro rice production was negative and less than one, which indicated that in the study area land preparation was indiscriminately over used **(**Table 6.2). So, farmers should decrease the use of land preparation costto attain efficiency considerably.

6.5.6 Human Labor

It was evident from the (table 6.2) that the ratio of MVP and MFC of human labor **(0.0832)** for boro rice farming was positive and less than one, which indicated that in the study area use of human labor for boro rice farming was over utilized. So, farmers should decrease the use of human labor cost to attain efficiency in boro rice production.

Table 6.2 Estimated resource use efficiency of boro rice production

Variables	**Mean (Y, X_i)**	**Y/Xi**	**Coefficient**	**MVP(Xi)= (Y/Xi)*Coff*P_{yi}**	**MFC**	**r=MVP/ MFC**	**Comment**
Yield	171857						
Seed	3150	54.56	0.1273	104.53	50	2.091	Under utilized
Insecticide	3796	45.27	0.0671	45.72	140	0.311	Over utilized
Fertilizer	30458	5.64	0.0908	7.71	56.5	0.136	Over utilized
Irrigation	14970	11.48	0.0901	15.57	45	.346	Over utilized
Land Preparation	9730	17.66	-0.2396	-4.23	600	-4.232	Over utilized
human labor	54939.16	3.13	0.4417	20.79	250	.0832	Over utilized

Source: Field survey, 2020

CHAPTER SEVEN

CONCLUSION, POLICY IMPLICATIONS AND LIMITATION

7.1. Introduction

This chapter summarizes the main finding of the study and provides some recommendations and future research direction. The organization of this chapter is as follows: Section 7.2 summarizes the main findings to answer the three research objectives. Section 7.3 provides some policy recommendations based on the findings and Section 7.4 presents further research directions.

7.2 Conclusion

The study classifies all groups of farmers in the study area shows that average 31.86 age were 23.33% in the 20-35 year age group, 41.66% belonged to the 36-50 year age group with average age 45.28 and, 35.01% fall into the over 51 year age group where their average age were 46.61 years.

In this area 45% of the farmers were illiterate, 13.33% were in primary level. 15% of the farmers were belongs to Secondary level, 25% were into Higher Secondary level.

The sample showed that average 10.79 years' experience farmers were 23.33% , average age 26.14 years farmers were 36.67% which expressed the highest, the farmers were average age 39.07 and 52.5 were 23.33 % and 16.67% respectively. It was noted that agriculture had taken as a main occupation of 95% farmers, other sectors as a main occupation was 5% only who have involvement with agriculture. From the sample area, 33.33 percent were landless farmer with average land 17.36 decimal, 61.67 percent were small farmer and their average land 128.67 decimal, 5 percent were medium farmer with 506 decimal average land. About 40 percent of the rice farmers were earned Tk. 151,000 to 250,000 per year where their average income Tk.202, 250.00. About 35 percent of the farmers were earned Tk. less than 150,000 per year with their average income 120,476.2 and 25 percent farmers were earned Tk. above 250,000 per year where the average income was Tk.359,333.30T. It is evident from the area showed the average area 12.38 decimal, 112.21 decimal, 22.69 decimal, 24.22

decimals, 39.08 decimals, 71.60 decimals, were includes homestead land, own land, leased in, leased out, boro rice cultivated land and cultivated land area for other crops are respectively hold by the sample farmers on an average where 35.31% cultivated land are used for boro rice cultivation and other 64.69% land are used to produce other crops.

The amount of work used for the production of boro rice is 224-man days per hectare. Total human labor costs are equal to Tk. 56000 /ha. In the study area on an average wage rate was Tk. 250.00 per man-day. So, total cost of family supplied labor for boro rice amounted to Tk.10250.00 per hectare and hired labor cost Tk. 45750.00The total seed demand for boro rice per hectare was 63 kg / ha. The average prices of seeds were Tk. 50 per kg for boro rice production. The total cost of seeds for boro rice production was Tk. 3150.00, urea is Tk. 4662.00, TSP is Tk. 5746.00, MoP is Tk. 2928.00, DAP is Tk. 11070.00 Gypsum is Tk. 1320.00, Zinc Sulphate is Tk. 1500.00, Magnesium Sulphate is Tk.252.00,Boric Acid is Tk. 480.00 and Organic fertilizer cost is Tk. 2500.00 per hectare. Irrigation water is an important input in winter boro rice cultivation. Per hectare cost of irrigation water was Tk. 20801.00 for boro rice, land preparation cost Tk. 5158.00 per hectare and cost of insecticide was Tk.3796.00.

Summation of the costs of variable inputs gave the total variable costs which were Tk. 117532.00 per hectare for boro rice production. Per hectare interest on operating capital was Tk 3917.7 and rental value of one-hectare land is Tk. 20000.00 for boro rice production. So total fixed cost is Tk. 23917.7. Total value of by products is Tk. 67050. The quantity of main product is 5989 Kg. If the price of the boro rice per unit is Tk. 17.50 then it becomes the total value of boro rice main product is Tk. 104807. So the gross return of the boro rice production is Tk.171857.00, net return is Tk. 30407.90,Benefit cost ratio was 1.21.

The magnitude of the regression coefficient of Seed was 0.127 for boro rice. It was positive but statistically insignificant. The value of insecticide for boro rice in regression was 0.067 at 5% probability level, it was positive and significant, and fertilizer was 0.091 with a positive sign. It was significant at five percent probability level. The irrigation cost regression coefficient was 0.0901 with a positive sign. It was insignificant and the coefficient of land preparation was -0.2396 with a negative sign, significant at five percent probability level. The value of Labor for boro rice in magnitude regression was 0.442. At 1% probability level, it was positive and highly significant.

The coefficient of multiple determinations (R2) was 0.78359 for boro rice. It indicates that about 78 percent of the total of the gross returns are explained by the explanatory variables included in the model.The F-value was 31.984 for boro rice, which implies good fit of the model. That is, all the explanatory variables included in the model were important for explaining variation of boro rice production.

The resource use efficiency of the sample land areas explained as Seed (2.091) was only underutilized. The other variables as insecticides (0.3110), fertilizer (0.136), irrigation (0.346) and human labor (0.0832) were over utilized and the land preparation cost was indiscriminately over utilized.

7.3 Recommendations

- In the study area it was observed that most of the farmer are very much traditional, they had lack of interest to accustom with new varieties.
- According to the farmers motive, block supervisor are not familiar to them, there was a huge gap between farmer and block supervisor.
- According to the block supervisor drive, they tried to provide information about production and new variety to the farmers , some farmers accepted but a handsome percentage were not followed their direction.
- It was observed that some resource were over used and some under used. In this regard, the officials of DAE should make more meeting with farmers, celebrate campaign after a certain period of time through these activities farmers would be aware regarding using the resources.
- Extension service should be more available, farmers do not get enough service from DAE. They can disseminate the modern technologies to the farmers to increase the production of rice. More access of modern technologies to farmers can bring wellbeing economically.
- The year 2020 is Covid-19 pandemic year. There are probability to be faced economic vulnerability. It is very important to focus on agricultural productivity. Government provided subsidies and easy loan facilities to farmer. In boro production, fertilizer subsidies and proper allocation of Govt. facilities may bring fruitful outcome.

- Loan facilities should improve in the study area. Lack of finance is a common phenomenon of our farmers. Policymakers have to reconsider about the financial facility of farmers because farmers are maker of the nation; their sound existence is the sign of wellbeing. Krishi Bank can provide loan without any interest to small and landless farmers because they are more vulnerable to climate change or any natural calamities. But real scenario is different farmers go to rural usury for finance and they victims with the high interest rate; they get impoverished day by day and vicious cycle of poverty. To survive our farmer's government should be attentive on financial facility of farmers and create an easiest way of providing loan to small and landless farmers.

- It needs to make different types of activities like new verities adopting training program, khrishimela through different agricultural wing on that area.

- Government subsidy is also very essential for the small and landless farmers but very negligible percentage of farmers get facilitated from the subsidy of government. Here some mismanagements also occurred as a result they cannot reach the subsidy what government announced for them. So, policy makers should rethink about the system of providing subsidy. We think that cash money is better as subsidy and dissemination system should not be traditional, SAASs can provide a list of real receptors of subsidy then the agriculture ministry can provide the subsidy as cash money to the farmers bank account; otherwise the real suffers cannot catch the benefit of subsidy.

- Agricultural marketing should be a vital issue of policy makers, because now-a-days it's a very common scenario; farmers don't get fair price of their products and become looser every year. In the study area we saw that they are facing problem of selling agricultural products. In true sense there is no active government institute to monitor the agricultural marketing system. Department of Agricultural Marketing is also liable to monitor and supervise this system but it is a matter of regret that it's totally an inactive institute for lack of efficient officials. To ensure the fair price of agricultural products government should deeply rethink about the DAM; it must be redesigned with the official who are expert about agricultural marketing and agribusiness like graduate of agricultural economics and agricultural marketing.

7.4. Limitations and Future Research Focus

The present study suffers from a number of limitations. The limitations of the study area's follows:

Inadequate fund and time availability for the study was an important limitation. Due to shortage of fund and time the study could not cover wide areas for collection of necessary information from the farmers; only 60 farmers were selected for the purpose of the study. The researcher had to depend on the memory of the farmers for collecting necessary information because many of them did not keep any written record or kept record partially. Despite a few limitations, the findings of the present study may provide some valuable information for the farmers, extension worker sand researchers.

It could be mentioned here that the future researchers could take up a broad - based study with large samples, for resource use efficiency quantity based questionnaire is important to make. The variable would able to convert unit with cost. A further study can be undertaken by taking into account different farm sizes to assess the impacts on income generation through boro cultivation. This may provide an avenue for policymakers to devise region-specific adaptation policies that will have the potential to address way of producing employment to reduce poverty.

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