FINANCIAL PROFITABILITY AND RESOURCE USE EFFICIENCY OF AROMATIC RICE PRODUCTION IN SOME SELECTED AREAS OF DINAJPUR DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled **"FINANCIAL PROFITABILITY AND RESOURCE USE EFFICIENCY OF AROMATIC RICE PRODUCTION IN SOME SELECTED AREAS OF DINAJPUR DISTRICT"** submitted to the department of Agricultural Economics, Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka in partial fulfilment of the requirements for the degree of **Master of Science (MS) in Agricultural Economics**, embodies the result of a piece of bona fide research work carried out by **NUSHRAT JAHAN, Registration No: 12-04754** 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, as has been availed of during the course of this investigation has been duly acknowledged by the Author.

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MY PARENTS

FINANCIAL PROFITABILITY AND RESOURCE USE EFFICIENCY OF AROMATIC RICE PRODUCTION IN SOME SELECTED AREAS OF DINAJPUR DISTRICT

ABSTRACT

The study was conducted to examine the profitability and resource use efficiency of aromatic rice production in some selected areas of Dinajpur district in Bangladesh. Besides, attempt had given to examine the profitability of aromatic production by the farmers in the study area, to identify the factors behind the yield variations of aromatic rice production in the study area,to assess the resource-use efficiency of aromatic rice production and to find out the problems faced by the farmers and to recommend some policy guidelines. Dinajpur district was selected purposively for the study on the basis of extensive aromatic rice production. A total of 101 aromatic rice cultivators were randomly selected to conducting farm level survey with pre-tested questionnaire. After analysing the data, per hectare gross return, net return and gross margin were found to be Tk. 203570, Tk. 51606 and Tk. 93906 respectively. Total cost of aromatic rice production was calculated at Tk. 148464 per hectare.Benefit Cost Ratio (BCR) was found 1.37. Thus, it was found that aromatic rice production was highly profitable. From Cobb-Douglas production function analysis, it was observed that the coefficients of cost of human labor, cost of seed, cost of urea, gypsum, cost of pesticide and Cost of irrigation were positively significant at different level of probability for aromatic rice production. But the coefficients of cost of animal labor & power, cost of manure, cost of TSP, cost of MoP and Zinc sulphate cost was not significant. Resource use efficiency indicated that all of the resources were under used for aromatic rice production except overutilization of human labour cost and TSP cost. So there was a positive effect of key factors in the production process of aromatic rice production. Low yield and unstable price was most acute problem for aromatic rice production followed by high price and spot scarcity of fertilizers and pest and disease infestation.

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ABBREVIATIONS

DAE	Department of Agricultural Extension
BRRI	Bangladesh Rice Research Institute
GDP	Gross Domestic Product
FAO	Food and Agricultural Organization
GM	Geometric Mean
BBS	Bangladesh Bureau of Statistics
SPSS	Statistical Package For Social Sciences
BCR	Benefit Cost Ratio
NGOs	Non-Governmental Organizations
MVP	Marginal Value Product
MFC	Marginal Factor Cost
MPP	Marginal Physical Product
TC	Total Cost
GR	Gross Returns
TVC	Total Variable Costs
GOs	Government Organizations
FC	Fixed Cost
TFC	Total Fixed Cost
DTW	Ministry of Agriculture and Rural Development
HYV	High Yielding Variety
MT	Metric Tons
BER	Budget Execution Report
DRC	Domestic Resource Cost
SRI	System of Rice Intensification
MoP	Murate of Potash
TSP	Triple Super Phosphate
LUC	Land Use Cost

CHAPTER I
INTRODUCTION

1.1 Background of the Study

Bangladesh is predominantly an agricultural country where agriculture sector plays a vital role in accelerating the economic growth. It is therefore important to have a profitable, sustainable and environment-friendly agricultural system in order to ensure long-term food security for people. Broad agriculture sector has been given the highest priority in order to make Bangladesh self-sufficient in food. The Government determined to develop the overall agriculture sector keeping in view of the goals set out in the Seventh Five Year Plan and National Agriculture Policy. Agriculture sector plays an important role in overall economic development of Bangladesh (BER, 2017). The agricultural sector (crops, animal farming, forests and fishing) contributes 14.23 percent to the country’s GDP, provides employment about 40.6 percent of the labor force according to Fiscal Year 2018. Moreover, agriculture is the source of wide range of consumer demanded agricultural commodity markets, especially in rural areas (BER, 2017).In FY2016-17 food grains production stood at 388.14 lakh MT of which Aus accounted for 21.33 lakh MT, Aman 136.56 lakh MT, Aromatic 180.24 lakh MT (BER, 2017).In northern region 2017 has seen that 13,017 hectares of land brought under cultivation of aromatic rice to 12,650 hectares last year. Total production in northern area was 39626 tons while it was 29727 tons last year. In this season 13,779 hectares across the northern region devoted to aromatic rice strains, this is an increase of 762 hectares from the previous season. Rice grain is categorized into coarse, medium and fine with different colors based on physical properties. In Bangladesh, a number of fine rice cultivars are grown by the farmers. Some of them have special appeal for their aroma. Such common cultivars are Chinisagar, Basmati, Badshabhog, BRRI dhan34, Kalizira, Tulsimla, Dulabhog, BRRI dhan37 and BRRI dhan38. Fine rice is mainly used by the people in the preparation of palatable dishes and sold at a higher price in the market due to its special appeal for aroma and acceptability. Bangladesh has bright prospect for export of these fine rice thereby earning foreign exchange.

The majority of the population is poor and has been suffering from malnutrition and cannot afford balanced diet. They have to meet their protein requirement by taking cereals like rice, wheat etc. Rice provides the major portion of protein and calories of daily requirement. The economy of Bangladesh mainly depends on agriculture, which contributes 22 percent total gross domestic product and it is dominated by the crop sector, which contributed 14.10 percent of total GDP (BBS, 2019). In the recent years, the share of agriculture in GDP showed a declining trend, however, the share of food grains, particularly rice had increased over time due to HYV and hybrid seed, proper management, fertilizer, irrigation facilities and other relevant technologies. Considering the above facts, it is evident that rice has an inevitable role in the food grains production of Bangladesh.

1. 2 Importance of Rice in the Economy of Bangladesh

Rice is the principal staple food and lifeline in Bangladesh. More than 5 percent of the world's rice is produced over here, providing the country’s 160 million people more than 75.6 percent of their total calories and 54 percent of protein in the average diet of the people. It occupies about 73.39 percent of total cropped area and constitutes about 72 percent of the agricultural production (BBS, 2019).

Bangladesh has a land area of 1.76 million hectares. With a cropping intensity of 192percent and the total cropped area comes to approximately 13.69 million hectares (BBS, 2019). Rice is grown in Bangladesh in the three seasons, namely Aus,Aman and Boro. Aman rice is considered as most important in the economy of Bangladesh particularly for solving the chronic food deficiency of the country (Kabir, 2000). Total cultivated area under rice is 11.20 million hectares and total production is 43.50 million metric tons (FAO, 2007).

Bangladesh ranks fourth among rice producing countries in the world after China, India, and Indonesia, although USA occupies the highest position in respect of rice yield 7.70 ton/ha. In the past, the country largely depended on imported food grains with its deficit production, mainly due to rising of population. However, now-a-days the population growth rate (1.36) runs behind the growth rate of food grains which was found to increase at the rate of 15.86 percent during last decade (BER, 2018). Due to the introduction of seed-fertilizer-irrigation technologies in Bangladesh agriculture, food grains production has almost been triple since independence.

1.3 Objectives

1. To identify the socio-economic status of aromatic rice producing farmers.
2. To measure the profitability of aromatic rice production by the farmers in the study area.
3. To assess the resource-use efficiency of aromatic rice production.
4. To find out the problems faced by the farmers and recommend some policy guidelines.

1.5 Justification of the Study

Rice is the staple food in the everyday diet of Bangladeshis. The government of Bangladesh is consistently pursuing policies to attain food self-sufficiency and also to improve the farmer economic condition. Aromatic rice is also constitutes a n important part of this dietary requirements of the Bangladeshi people. Aromatic rice cultivation plays a vital role on changing our farmer's living condition in the northern region of Bangladesh and achieves self-sufficiency in income.Most countries in the Asian rice belt have become self-sufficient in rice production and some have exportable surpluses. This study will be conducted in the northern region (Dinajpur district) of Bangladesh. The region is very important for aromatic rice production and most of the people are involved with the aromatic rice cultivation. So it is important to observe the socio-economic condition in those areas. Availability of rice varieties with multiple resistance reduced the need for application of agrochemicals and facilitated the adoption of integrated pest management practices. The management practices and input use are likely to be influenced by socio-economic factors such as farmer's age, education, occupation, resource base and access to information. This type of study on aromatic rice production focused on mainly resource use efficiency, socio-demographic profile of the respondent, profitability of aromatic rice production were not conducted before in these study areas.

In order to increase the production of aromatic rice to the maximum possible extent, it was necessary to identify the factors behind the yield variations so that policy interventions might be made accordingly. So, this study will be helpful in identifying the factors responsible for yield variations. This study provides appropriate suggestion and policy recommendations which will help the policy makers of the country for improving the livelihood of the people in the northern region (Dinajpur district).

CHAPTER II
REVIEW OF LITERATURE

2.1 Introduction

The purpose of this chapter is to provide a selective review of the past research works which are pertinent to the present study. The available literature germane to "Comparative Profitability and Technical Efficiency of Aromatic Rice Production in Dinajpur District" was so scanty. However, relevant findings directly or indirectly related to this study are briefly described below:

2.2 Rice Production Related Studies

Mondal et al. (1995) explained resources use efficiency of irrigated Aromatic rice cultivation in their study entitled "Resource Use Efficiency of Irrigated Aromatic rice Cultivation by Different Farm Size Groups and its Impact on Employment and Distribution of Income in DTW II Project Area of Mymensingh". The results of their study revealed that only the small farms were allocatively efficient in cost of human labor, both small and medium farms were able to allocate draft power more or less efficiently and fertilizer was underused for Aromatic rice cultivation. Therefore, they concluded that no farm was found to be allocatively and thereby economically efficient in using input for Aromatic rice cultivation in the study area.

Kamruzzaman et al.(1995) shows the growth rates, technical change in agriculture and factor demand status of the rice sector of Bangladesh. The growth of production, acreage and yield of local. HYV and total rice were positive and significant during the pre-independence period. During the post-independence period the growth of local acreage and production were native but the yield was positive. In the period of the study(1980-81 to 1992-93) the elasticity co-efficient started declining implying that the farmers of Bangladesh become more conscious about the use of fertilizer, seed and irrigation in agriculture.

Ali and Saif (1996) conducted a study on," Costs and Returns of Aromatic Paddy with Reference to Resource Use in an Area of Mymensingh District in Bangladesh". The study identified some problems faced by the farmers for producing and marketing of Aromatic paddy. Small farmers were found to face acute problems with regard to fertilizers and institutional credit. Problems of marketing system included the efficiency of the government procurement programme and unsatisfactory condition of the rural markets.

Islam et al.(1996) made a study on "Socio-Economic Aspects of Fine Quality Rice Cultivation in Bangladesh." They found that under irrigated ecosystem the grain yield of course, fine and aromatic rice were 3.00, 2.48 and 1.9 0 ton/ha, respectively. On the other hand, the yields of course, fine and aromatic rice were 2.72, 2.20 and 2.00 ton/ha respectively, under rainfed ecosystem. The BCR of coarse, fine and aromatic rice were 2.17, 1.98 and 1.92, respectively under irrigated ecosystem, and under rainfed ecosystem the BCR of the respective varieties were 1.88, 1.98 and 2.05 on full cost basis. They also identified some problems and constraints like unsuitability of land, low yield, non-profitability, lack of alternative good quality seed and low output price.

Quayum et al.(1997) in their study titled "Economics of Aromatic Rice Cultivation under Power Tiller at Bogra District" found that current inputs earned the highest share of outputs, which was 38% for MV Aromatic rice cultivation followed by human labor (23%). According to income share analysis, the farmers earned 72% of the total income of which 25% was generated by land, 8% by family labor (both human and animal), 8% by power tiller and 32% as residual, in case of small group of farmer, whereas the medium group of farmer earned 71% of the total income of which 25 % was generated by land. 7% from family labor (human and animal). 7%by power tiller and 32% as residual. Similar results were found in case of large group of farmers.

Mustafi et al. (1999) conducted a study on "Input- output Relationship for Rice -Wheat Production System Sustainability at Chuadanga research site." The study showed that human labor itself earned the highest share of output, which were 41% and 31% in case of MV Aman and LV Aus rice respectively but these were 27 % and 30 % respectively in case of MV Aman and LV Aman rice. Variable inputs cost were 21% and 13 % in case of MV Aman and LV Aus whereas in Aman season these were 16 % and 20 % for MV and LV Aman rice, respectively. The residual, which goes to the operator, was found negative for MV Aus but for LV Aus it was 10 % compared to 30 % and 12 % for MV and LV Aman rice. The farmers earned 49 % of the total income of which 38 % was generated by land. 17 % by family labor (both human and animal) and 6 % as residual .In case of MV Aus rice, the farmers earned 63 % of this total income of which 40 % was generated by land. 1 I % by family labor (both human and animal) and 12 % as residual. On the other hand, the farmers earned 73 % of the total income of which 26 % was from land. 12 % by family labor (both human and animal) ant1 35 % as residual for MV T Aman.

Bhuayan (2000) conducted a study on "Profitability Analysis of Aromatic Rice Cultivation in Some Selected Sites of Kishoreganj, district." It was revealed that in general, farmers did not use their resources efficiently. Farmers had ample opportunities to increase return from Aromatic rice production by using resources efficiently. The study also identified some major problems that were faced by the farmers for producing HYV rice, such as high price of insecticides and lack of cooperation from block supervisor, shortage of hired labor at the critical stages, high wage rate of hired animal or power tiller and lack of capital, seed, and irrigation facilities.

Kabir (2000) conducted a study on “An Economic Analysis of Aromatic and Non-Aromatic Rice Cultivation in Some Selected Areas of Dinajpur District”. The result of the study state that aromatic rice is more profitable than non-aromatic rice. In the study gross return were found to be Tk. 37466.88, Tk. 32291.63, Tk 29881.00 and Tk. 30860.97 per hectare for kataribhog. Kalijira/Chinigura, Shama and Pajam/BR varieties respectively. Gross return form aromatic (Kataribhog) rice was highest (Tk. 37466.88 per hector) followed by the non-aromatic (Pajam/BR varieties) rice (Tk. 30860.97 per hectare).

Mustafi et al. (2000) in their study titled "Production and Export Potential of Fine Rice in the Barind Tract Area". The results of the study stated that the gross returns of Basmoti (grown in Aromatic season) and C'hiniatab (grown in T. Aman season) were Tk.54513 and Tk. 38903 per hectare, respectively and the production cost of Basmoti and C'hiniatab were Tk. 26040 and Tk.12337 per hectare. The average yield of Basmoti and C'hiniatab were 4.3 ton/ha and 2.14 ton/ha in the Barind Tract area.

Mythili and Shanmugam (2000) estimated technical efficiency of rice growers in Tamil Nadu using an unbalanced panel data. The study uses the stochastic frontier production function approach. Results showed that the technical efficiency varied widely (ranging from 46.5 percent to 96.7 percent) across sample farm and was time variant. The mean technical efficiency was computed as 82 percent, which indicated that on an average, the realized output could be increased by 18 percent without any additional resources. The existing gap between realized and potential yield highlighted the need for improving farmers' practice through extension service and training programs.

Rahman et al.(2000) found that the average level of technical efficiency among sample farmers for Aromatic, 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 Aromatic 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 Aromatic 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.

Tasnoova (2000) conducted a study on" Kataribhog Rice Marketing System in Some Selected Areas of Dinajpur District." It was reported that farmers faced some problems for Kataribhog rice marketing such as low market price at harvesting time, lack of capital, lack of adequate storage facilities and higher markets tolls.

Khan et al. (2002) was conducted a study to find out the level of input uses and input output relationship with respect to Aromatic and HYV Aman rice cultivation. The result showed that the amount of human labour, animal labour, and fertilizer used per hectare of Aromatic 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 Aromatic were Tk 1818.93, Tk4591.33, and Tk 536.34 respectively. Human labour and animal labour are positively significant but irrigation cost is negatively significant in case of Aromatic rice production. On the other hand, human labour is negatively but animal labour 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 Aromatic, animal labour, seed and pesticide of HYV Aman should be increased, pesticide of Aromatic should be decreased and the additional use of the irrigation water of Aromatic, human labour and fertilizer of HYV Aman should be decreased.

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

Rahman (2002) used stochastic production and cost frontier models in rice production in Bangladesh. He estimated 14%, 7% and 20% technical inefficiencies at aggregate level for Aromatic, Aus and Aman rice crops, respectively. The mean economic efficiency were 79%, 72% and 71% for Aromatic. Aus and Aman rice crops, respectively. This indicated that without changing output the production cost of Aromatic. Aus and Aman rice could be reduced by 21%, 28% and 29%, respectively. The mean economic efficiencies estimated from Trans log stochastic normalized cost frontiers for Aromatic, Aus and Aman-rice crops were 80%, 60% and 74%, respectively. He found economic inefficiencies to increase with the increase in education of farm operators. Older farmers tended to have smaller technical inefficiency than younger farmers and farmers with more experience tended to have smaller technical inefficiencies than farmers with less experience.

Anik and Talukder (2003) was conducted a study on "Economic and financial profitability of aromatic and fine rice production in Bangladesh" The study was undertaken to evaluate the economic and financial profitability of aromatic and fine rice production, using both primary and secondary data. 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. Finally, some policy guidelines were suggested.

Hasan (2006) conducted a study on "Yield gap in wheat production: a perspective of farm specific efficiency in Bangladesh". The study employed frontier production function method to estimate technical efficiency in wheat production. He estimated mean technical efficiency of wheat growers as 0.84, allocative efficiency as 0.91 and economic efficiency as 0.76. The coefficients of farmers' education, wheat farming experience, and training on wheat were negatively significant in the inefficiency effect models implying that inefficiency decreases with the increase in farmers' education, wheat farming experience, and training on wheat.

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Dinesh et al.(2007) conducted a case study in Chhattisgarh about aromatic rice. In recent years there has been a serious concern among the farmers, scientists, policymakers and environmentalists regarding the continuous erosion of genetic biodiversity of rice cultivars in Chhattisgarh which has traditionally been known as bowl of scented rice's in central India. In view of India's potential competitiveness in aromatic rice's in the international market, it is imperative to understand the dynamics of domestic trade in aromatic rice. In this study, marketing and price-spread patterns of aromatic rice in the state of Chhattisgarh have been examined. A few policy interventions have been suggested for promoting aromatic rice's in the state.

Akhtar et al. (2007) was conducted a study on "Economic efficiency and competitiveness of the rice production systems of Pakistan's in Punjab". The results indicate that an expansion of the production of Basmati rice can lead to an increase in exports. The production of IRRI in Pakistan's at Punjab is characterized by a lack of economic efficiency implying inefficient use of resources to produce the commodity. The analysis shows that the prevailing incentive structure affected farmers negatively. A negative divergence between private and social profits implies that the net effect of policy intervention is to reduce the farm level profitability of both rice production systems in Punjab.

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 BRRI dhan 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.

Majumder et al. (2009) analyze a study on "Productivity and resource use efficiency of aromatic rice production". This study was attempted to measure and compare resource use efficiency and relative productivity of farming under different tenure conditions in an area of Bhola district. A random sampling technique was used in the study. Sample farmers were classified as owner, crop share tenant and cash tenant farmers. A total of 90 samples, 30 from each class were selected on the basis of random sampling technique. The study explored the difference in the efficiency and productivity among owner, cash tenant and crop share tenant. Total cash expenses as well as total gross costs for producing Aromatic rice was highest in owner farms and lowest in crop share tenant's farm. When individual inputs were concerned it was observed that expenses on human labor shared a major portion of expenses in the production of Aromatic rice where owner operators used more hired labor in compare to other groups. However, the cash tenant farmers were more efficient than owner and crop share tenant farmers. Due to poor resource base the crop share tenants were unable to invest on modern farm inputs.It may be mentioned that in Bangladesh the predominant tenancy arrangement is share cropping, which is an inefficient form of tenure arrangement in compare to cash tenancy.

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.

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.

Parasar et al. (2016) conducted a study on "Resource use efficiency in rice production under SRI and conventional method in Assam, India." To meet the rising demand for rice, the staple food in Assam, the production of rice has to be increased by many folds. Considering the shrinkage of agricultural lands, productivity increase is the only way out to increase the production. System of Rice Intensification (SRI) is reported to enhance rice yield to considerable extent. However, the acceptability of the method by the tradition rice growers of the state is a matter of concern. Further, the resource use status of SRI is yet to be studied systematically in Assam. The present study on resource use in SRI has shown that the resources used in SRI need to be increased for enhanced rice production the state.

CHAPTER-III

METHODOLOGY

3.1 Introduction

This chapter deals with the tools and techniques used for collecting the necessary information of this study. It also addresses the methodology through which the collected data were categorized and analyzed in order to achieve the objective of the study. The design of research involved in the present study has been described in this chapter.

3.2 Selection of the Study Area

The area where the selected varieties of rice has been grown successful was considered as the study area. Dinajpur district was purposively selected for the study because of the fact that it is one of the leading aromatic rice producing areas of Bangladesh. The researcher had an easy access to this area, on the other hand, the following considerations were kept in mind for selecting Dinajpur as a study area. Keeping in mind the main objectives of the present study, kaharole upazila of Dinajpur district was selected for collecting data.

3.3 Sampling Techniques and Data Collection Procedure

There are different types of sampling techniques depending on the nature of population, objectives of the study. Data collection procedures are the activities involved in collecting the desired data from the sample. The desired data can be collected through the interview schedule, questionnaire and direct observation. The following sampling techniques and data collection procedures were followed for the present study.

3.4 Sampling technique

All the aromatic and non-aromatic rice growers in Dinajpur 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 Dinajpur district, one upazilas namely, Kaharole was selected randomly from13 upazilas. Subsequently, five villages from Kaharole upazila were also selected randomly. Therefore, a list of 101 aromatic rice producers were constructed with the help of village leaders and field level extension personnel. After preparing the sampling frame 101 farmers were selected randomly for primary data collection.

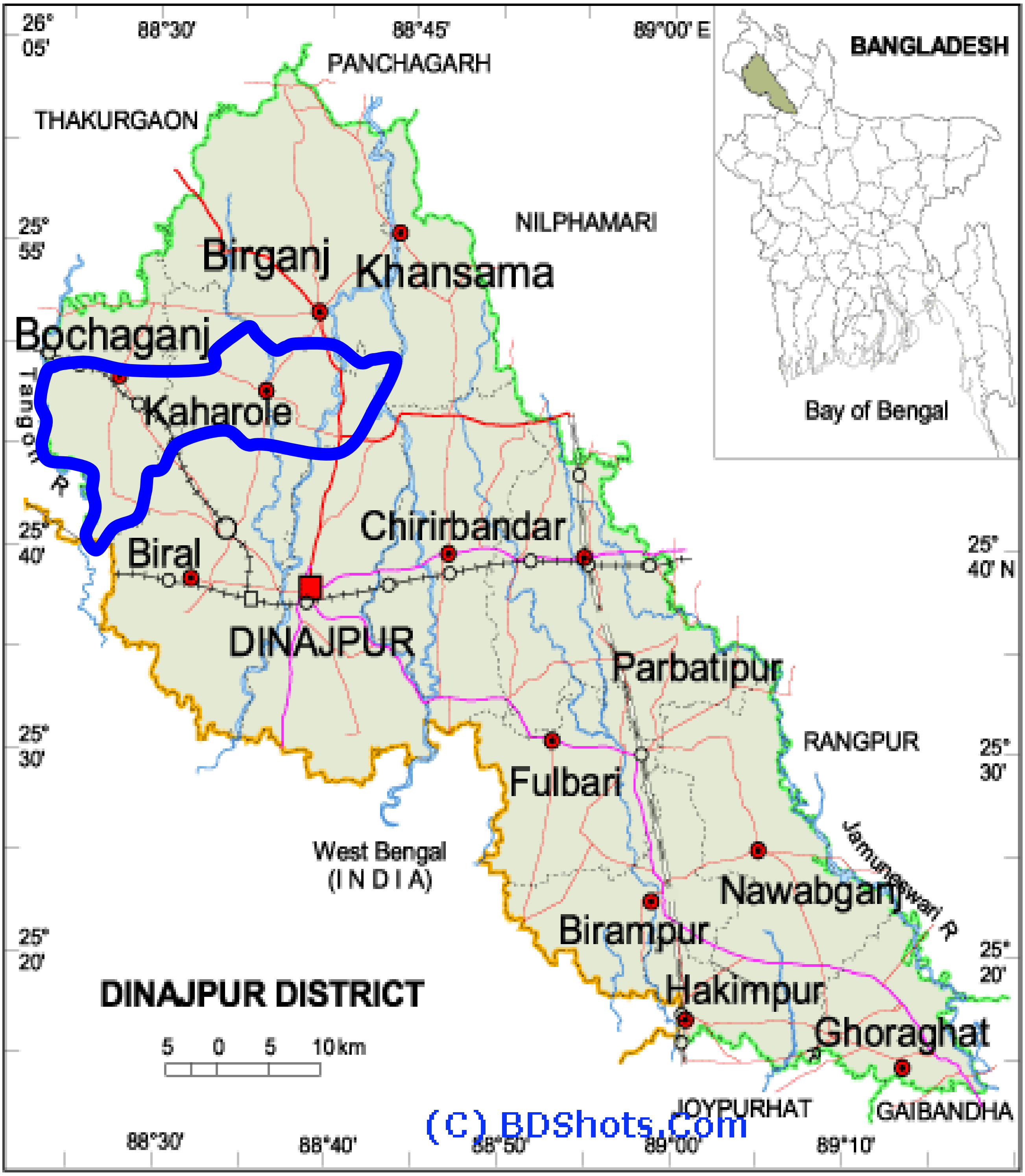

Figure 3.1 Map of Dinajpur district showing Kaharole upazila

Figure 3.2 Map of Kaharole upazila showing the study area

Table 3.1 List of villages with sample size

Upazila	Union	Villages	Sample size
Kaharole	Ramchandrapur	Sundoil	20
		Soronja	20
		Pouria	21
		Joyrampur	20
		Uchitpur	20
Total			**101**

3.5 Preparation of the Interview Schedule

In conformity with the objectives of the study, a preliminary interview schedule was designed in an effort to collect the data from the farmers. It was then pre-tested to verify the relevance of the questions and the nature of responses of the farmers. After pretesting of the questionnaire necessary modifications were made in consultation with the relevant experts.

3.6 Study and Survey Period

The data were collected through survey during the period of1st June, 2019 to 30th July, 2019.

3.7 Method of Data Collection

For the present study, data were collected through personal interviewing of the rice growers. Interviews were mainly conducted at the leisure of the farmers with a view to keeping them undisturbed and securing accurate information. Before going to administer the interview, the respondents were made clear about the purpose and objectives of the study. It was explained to the farmers that the study was purely academic. Each time when every interview was completed, the interview schedule was thoroughly checked and properly recorded. If there were such items, which were overlooked or contradictory, they were amended accordingly to suit the purpose. In addition to survey, observation method was also applied to collect information by the researcher. It is better to mention that some items were recorded initially in local units and finally convened those into standard units while processing data.

3.8 Problems Faced by the Researcher in Data Collection

There were some problems faced by the researcher during the period of data collection. The problems which are enlisted below:

1. Although most of the farmers in the study area were literate, they did not have adequate knowledge on the value of a research study and it was therefore, really difficult to convince them as to the utility of this research.

2. The farmers were afraid of imposition of taxes and because of that they always tried to avoid providing authentic information relating to the actual size of holding and annual income.

3. The farmers were not available at their home because they often remained busy dealing with farm activities in the field, thus sometimes; two or three visits were made for a single interview which was really very time consuming and costly as well.

4. Sometimes it was observed that the farmers would try to reply quickly to the questions in order to get rid of researcher somehow or anything like this.

5. The researcher had to depend solely on the memory of the farmers for collecting data because they did not care to keep any written records for their farm business.

3.9 Analytical Techniques

Both descriptive tabular analysis and statistical analysis will be used for analyzing the data.

3.10 Descriptive Analysis

Tabular and graphical analysis is generally used in order to find out socio-economic status of the respondents. The tabular technique of analysis will be used to determine the cost, returns and profitability of aromatic rice producing farmers. It will used to get the simple measures like average, percentage and ratio. Tabular technique included production practices and input use, cost and returns of aromatic rice production.

3.11 Statistical Analysis

Cob-Douglas production function analysis will be used to estimate the productivity and resource use efficiency of aromatic rice production. Marginal productivity of selected inputs will be calculated to ascertain the level of efficiency of individual input use. To determine the contribution of the most important variables in the production process, the following specification of the model will be applied:

$Y= a\ X_1b_1\ X_2b_2\ X_3b_3\ X_4b_4\ X_5b_5\ X_6b_6\ X_7b_7X_8b_8X_9b_9X_{10}b_{10}X_{11}b_{11} + Ui$ -------------- (1)

This equation may be alternatively expressed as:

$lnY= lna + b_1ln\ X_1 +b_2lnX_2 + b_3lnX_3 +b_4lnX_4 + b_5lnX_5 + b_6lnX_6 + b_7lnX_7 + b_8lnX_8+b_9lnX_9+ b_{10}lnX_{10}+ b_{11}lnX_{11}+Ui$ ------------------------- (2)

Where,

Y = Per hectare yield of aromatic paddy (Tk. /ha)

a = Intercept

X_1 = Cost of animal labor and power tiller (Tk. /ha)

X_2=No. of human labor (man days/ha)

X_3 = Quantity of seed in producing aromatic paddy (Kg/ha)

X_4= Quantity of manure in producing aromatic paddy (Kg/ha)

X_5= Quantity of urea in producing aromatic paddy (Kg /ha)

X_6= Quantity of TSP in producing aromatic paddy (Kg /ha)

X_7= Quantity of MoP in producing aromatic paddy (Kg /ha)

X_8= Quantity of gypsum in producing aromatic paddy (Kg /ha)

X_9= Quantity of Zinc sulphate in producing aromatic paddy (Kg /ha)

X_{10}= Cost of pesticide in producing aromatic paddy (Tk. /ha)

X_{11}=Cost of irrigation in producing aromatic paddy (Tk. /ha)

$b_1,b_2\ldots\ldots\ldots b_7$=Coefficient of relevant variables.

Ui=Disturbance term

ln=Natural logarithm.i= 1, 2…,11.

3.12 Procedure of Computation of Costs

The farmers producing aromatic 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, cowdung 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:

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

3.12.1 Cost of Human Labor

Human labor cost was one of the most important and largest cost items of aromatic rice production in the study area. It is required for different farm operations like land preparation, planting, 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 aromatic rice human labor were used for the following operations:

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

3.12.2 Cost of ploughing and laddering

Human labor and mechanical power were jointly used for ploughing and laddering. Ploughing and laddering cost was the summation of hired and home supplied draft power and human labor. Hired ploughing 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.

3.12.3 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.

3.12.4 Cost of Cow dung or Manure

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.

3.12.5 Cost of Fertilizer

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

3.12.6 Cost of Insecticide

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

3.12.7 Cost of Irrigation

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

3.12.8 Interest on operating capital

Interest cost was compute at the rate of 5% 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:

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

This actually represented the average operating costs over the period because all costs were not incurred at the beginning or at any fixed time. The cost was charged for a period of 6 months at the rate of Tk. 5 per annum.

3.12.9 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.

3.13 Measurement of Resource Use Efficiency of Aromatic Rice Production

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.

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

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,

$$MVP(Xi) = \beta_i \frac{\bar{Y}(GM)}{\ddot{X}i(GM)}$$

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

3.13 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 aromatic rice is calculated by the following way-

3.13.1 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.

3.13.2 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 – Total variable cost.

3.13.3 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 the aromatic 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 aromatic rice (Tk/ha);

P_m = per unit price of aromatic rice (Tk/kg);

Q_m = Total quantity of the aromatic rice production (kg/ha);

P_f = per unit price of by products (Tk/kg);

Q_f = Total quantity of by products (kg/ha);

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

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

TFC = Total fixed cost (Tk); and

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

To assess the profitability level of aromatic rice undiscounted Benefit Cost Ratio (BCR) will be checked. Where BCR = (Gross return)/ (Gross cost).

3.13.4 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.

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

CHAPTER IV

SOCIO-DEMOGRAPHIC PROFILE OF AROMATIC RICE PRODUCTION FARMERS

4.1 Introduction

In this chapter the findings of the study and its interpretation are presented in four sections according to the objectives of the study. This section deals with the selected characteristics of the aromatic rice farmers.

4.2 Selected Characteristics of the Aromatic Rice Farmers

In this section, the results of the aromatic rice farmers have been discussed. The salient feature of the respondents with their seven selected characteristics has been presented in Table 4.1.

Table 4.1 The salient features of the selected characteristics of the farmers

Categories	Measuring Unit	Rang		Mean	S D
		Minimum	Maximum		
Age	Years	20	66	38.98	10.02
Education	Year of schooling	00	18	7.62	5.44
Family Size	Person	2	9	4.20	1.28
Farm Size	Hectare	0.14	4.71	1.46	1.01
Annual family income	(‘000’ tk)	20	565	155.84	120.81
Agricultural training exposure	Days	2	16	10.27	3.28
Organizational Participation	Score	0	1	.54	.50

Source: Field Survey, 2019

4.2.1 Age distribution of the farmers

The age score of the aromatic rice farmers ranged from 20 to 66 with an average of 38.98. Considering the recorded age farmers were classified into three categories namely young, middle and old aged following (MoYS, 2012).

Table 4.2 Distribution of the farmers according to their age

Categories (years)	Farmers		Mean
	Number	Percent	
Young aged (20-35)	43	42.6	38.98
Middle aged (36-50)	46	45.5	
Old aged (above 50)	12	11.9	
Total	**101**	**100**	

Source: Field Survey, 2019

Table 4.2 indicates that the majority (45.5 percent) of the respondents fell into the middle-aged category while 42.6 percent and 11.9 percent were found young and old aged categories respectively.

4.2.2 Education status of the farmers

Educational qualification of the respondents' had been categorized as done by Poddar (2015). Education of the farmers ranged from 0 to 18years of schooling having an average of 7.62 years. On the basis of their education, the respondents were classified into five categories as shown in Table 4.3.

Table 4.3 Distribution of the farmers according to their education

Categories	Farmers		Mean
	Number	Percent	
Illiterate (0)	4	4.0	7.62
Can sign only (0.5)	21	20.8	
Primary education (1-5 class)	16	15.8	
Secondary education(6-10 class)	31	30.7	
Above secondary level	29	28.7	
Total	**101**	**100**	

Source: Field Survey, 2019

Data contained in Table 4.3indicates the 30.7 percent of the farmer's secondary level of education. It was found that 15.8percent had primary level of education, 20.8 percent can only sign category, and 28.7 percent had above secondary level of education. Only 4 percent were illiterate (don't read and write).

4.2.3 Family size of the farmers

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 with an average of 4.20.

According to family size, the respondents were classified into three categories as shown in Table 4.4.

Table 4.4 Distribution of the farmers according to their family size

Categories	Farmers		Mean
	Number	Percent	
Small family (2-3)	29	28.7	4.20
Medium family (4-5)	58	57.4	
Large family (above 5)	14	13.9	
Total	**101**	**100**	

Source: Field Survey, 2019

Data contained in Table 4.4indicates that (57.4%) of the farmers had medium family while 13.9percent of them had large family and 28.7 percent of them had small family. Thus, about two third (71.3%) of the farmers had medium to large family.

4.2.4 Farm size of the farmers

Land possession of the respondents varied from 0.14 to 4.71 hectare and the average being 1.46 hectare and standard deviation of 1.01. Depending on the land possession the respondents were classified into three categories according to DAE (1999) as appeared in table 4.5.

Table 4.5 Distribution of the farmers according to their farm size

Categories (hectare)	Farmers		Mean
	Number	Percent	
Small land (up to 0-1 ha)	34	33.7	1.46
Medium land (1.01-2 ha)	45	44.5	
Large land (above 2 ha)	22	21.8	
Total	**101**	**100**	

Source: Field Survey, 2019

Similar result was observed Nasreen et al. (2013) where highest respondents were medium farm sized. Data contained in table 4.5indicates the 44.5percent of the farmers had medium land while 33.7percent of them had small and only 21.8 percent of them were large farmer.

4.2.5 Land under aromatic rice cultivation

Land under **aromatic** cultivation of the farmers varied from 0.06 to 2.27 hectare. The average Land under aromatic cultivation was 0.67 hectare with the standard deviation of 0.44. Based on Land under aromatic cultivation, the farmers are classified into three categories as shown in Table 4.6.

Table 4.6 Distribution of the farmers according to their aromatic rice cultivation land

Categories (ha)	**Farmers**		Mean
	Number	Percent	
Marginal (upto .20 ha)	15	14.9	.67
Small (0.21-1 ha)	62	61.3	
Medium (above 1ha)	24	23.8	
Total	**101**	**100**	

Source: Field Survey, 2019

Data contained in Table 4.6 indicates that the largest proportion (61.3 percent) of farmers had small aromatic rice cultivation area compared to 23.8 percent having medium and 14.9 percent had marginal aromatic rice cultivation land. It was again found that most (85.1 percent) of the farmers had small to medium aromatic rice cultivation land.

4.2.6 Annual family income

The annual family income of the farmers ranged from Tk.20 thousand to Tk. 565 thousand with an average of Tk. 155.84 thousand and standard deviation of 120.81 thousand. Based on the annual income, the farmers were divided into three categories as shown in Table 4.7.

Table 4.7 Distribution of the farmers according to their annual family income

Categories (‘000’ Tk.)	Farmers		Mean
	Number	Percent	
Low (up to 35)	11	10.9	155.84
Medium (36-275)	72	71.3	
High (above 275)	18	17.8	
Total	101	100	

Source: Field Survey, 2019

From the Table 4.7 it was observed that the highest portion (71.3 percent) of the farmers had medium annual family income compared to 10.9 percent having low and only 17.8 percent had high annual family income.

4.2.7 Training exposure

The score of training exposure of the farmers ranged from 2 to 16 days, the mean being 10.27 and standard deviation of 3.28. Based on observed range, the farmers were classified into three categories as shown in Table 4.8.

Table 4.8 Distribution of the farmers according to their training exposure

Categories (days)	Farmers		Mean
	Number	Percent	
Low training (2-7)	18	17.8	10.27
Medium training (8-13)	71	70.3	
High training (above 13)	12	11.9	
Total	**101**	**100**	

Source: Field Survey, 2019

Data contained in Table 4.8indicates that 70.3 percent of the farmers had medium training exposure; while 17.8 percent of the farmer’s low training exposure and 11.9percent had high training exposure Thus, about 88.1% of farmers had low to medium training exposure.

4.2.8 Organizational participation

The score of organizational participation of the farmers ranged from 0 to 1, the mean being 0.54 and standard deviation of 0.50. Based on observed range, the farmers were classified into two categories as shown in Table 4.9.

Table 4.9 Distribution of the farmers according to their organizational participation

Categories (Scores)	Farmers		Mean
	Number	Percent	
No participation (0)	46	45.5	0.54
Yes participation (1)	55	54.5	
Total	**101**	**100**	

Source: Field Survey, 2019

Data contained in Table 4.9indicates that 54.5 percent of the farmers had yes participation and45.5 percent of the farmers had no organizational participation.

CHAPTER V
ECONOMIC ANALYSIS OF AROMATIC RICE PRODUCTION

5.1 Introduction

This chapter is designed to analyze and compare the profitability of aromatic rice production of the farmers. The related cost items include fertilizer cost, seed cost, animal and power tiller cost, manure cost, insecticide cost, irrigation cost, threshing cost, labor cost, land rental value, land preparation cost, and interest on operating capital. 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 Profitability of Aromatic Rice Production

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

5.3 Estimation of Costs

Costs are the expenses incurred in organizing and carrying out the production process (Doll and Orazem, 1984).In the production process farmers used two categories of cost, variable cost and fixed cost. The variable costs of Aromatic paddy 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 interest on operating capital and land rental value. Farmers used both home 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 Cost of animal labor &power

Tiller In the study area, power tiller was mainly used for land preparation. Power tiller was used on contact basis. Most of the farmer used home supplied 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 6.2 indicates that per hectare animal labor and power tiller cost costs for producing Aromatic paddy was Tk. 3404 for farmers which was 2.29 percent of their total costs of production (Table 5.1).

5.3.2 Cost of human labor

For Aromatic paddy production human labor is the most important inputs. It was required for different operations like land preparation, transplantation ,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.

The per hectare human labor cost of aromatic rice is shown in table 6.1. The per hectare human labor costs was Tk 70000 for the farmers which comprised 47.15 percent of their respective total costs of production (Table-5.1).

5.3.3 Cost of seed

In the study area, farmers used both home supplied and purchased seed. The costs of home supplied seed were determined at the ongoing market rate and costs of purchased seed were calculated on the basis of actual prices paid by the farmers in the study area. Per hectare costs of seedlings of aromatic paddy was Tk 5880 for farmers which was 3.96 percent of their total costs of production (Table-5.1).

5.3.4 Cost of manure

Per hectare costs of Manure was Tk 4375 for the farmers, respectively and their percentages of total cost of production was2.95 percent.

5.3.5 Cost of fertilizer

In the study area farmers used five types of chemical fertilizer namely, Urea, Triple Supper Phosphate (TSP), Murate of Potash (MP), Gypsum and Zinc Sulphate ($Znso_4$). These chemical fertilizers were charged at the rate of price paid by the farmers. Table 5.1 shows per hectare costs of chemical fertilizers.

Per hectare costs of Urea was Tk 4515 for the farmers and their percentages of total cost of production was 3.04 percent.

Per hectare costs of TSP was Tk5180 for farmers and their percentages of total cost of production was 3.49 percent.

Per hectare costs of MoP wasTk1520 for the farmers and their percentages of total cost of production was 1.02 percent.

Per hectare costs of Gypsum was Tk 780for the farmers and their percentages of total cost of production was .53 percent.

Per hectare costs of Zinc were Tk 600 for farmers and their percentages of total cost of production was .41 percent.

5.3.6 Cost of pesticides

The pesticides used by the farmers in the study area were Basudin, Dimocrone, Sumithion, Theovit, Furadon, Malathianon, etc. Table 5.1 reveals that per hector cost of pesticides were Tk. 2550 for the farmers and their percentages of total cost of production was 1.71 percent.

5.3.7 Cost of irrigation

Aromatic rice needs a huge amount of water. In the study area, farmers had to depend on one 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 fixes rate for per unit area of irrigated land .All irrigation water charges were paid in cash. Per hectare costs of irrigation cost were Tk. 8160 for the farmers and their percentages of total cost of production was 5.50 percent.

5.3.8 Total variables cost

It was observed from the Table-5.1 study that, the per hectare total variable costs of aromatic rice production was Tk. 106964.00for the farmers and their percentages of total cost of production was 72.05 percent.

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5.3.9 Interest on operating capital

Interests on operating capital per hectare were Tk. 4450 in Table 5.1 reveals that interest on operating capital for Aromatic rice production was highest than other crops.

5.3.10 Land use cost

In the present study the cost of land use was estimated on the basis of cost rental value per hectare land for the period of 6 months. The land use cost per hectare was Tk. 37050 for the farmers.

5.3.11Total cost

It was observed from the Table-5.1 study that, the per hectare total costs of aromatic rice production was Tk. 148464.00for the farmers.

Table 5.1 Per hectare cost of aromatic rice production

Particulars	Quantity	Rate (Tk/unit)	Cost (Tk/ha)	% of Total Cost
Cost of animal labor and power tiller (Tk/ha)		550	3404	2.29
Human labor cost (No. of Man-days/ha)	175	400	70000	47.15
Seed (Kg/ha)	49	120	5880	3.96
Manure (Kg/ha)	1250	3.5	4375	2.95
Urea(Kg/ha)	215	21	4515	3.04
TSP (Kg/ha)	185	28	5180	3.49
MoP (Kg/ha)	95	16	1520	1.02
Gypsum (Kg/ha)	65	12	780	0.53
Zinc Sulphate (Kg/ha)	10	60	600	0.41
Cost of Pesticides (Tk/ha)			2550	1.71
Cost of irrigation (Tk/ha)			8160	5.50
A. Total Variable Cost (TVC)			**106964**	72.05
Interest on operating capital @ of 12% for 6 months			4450	2.99
Rental value of land			37050	24.96
B. Fixed Cost (FC)			**41500**	**27.95**
C. Total Cost (A+B)			**148464.00**	**100**

Source: Field Survey, 2019

5.4 Return of Aromatic Rice Production

5.4.1 Gross Return

Return per hectare of aromatic rice is shown in table 5.2. Per hectare gross return was calculated by multiplying the total amount of product with respective per unit price. It is evident from table that the average yield of rice per hectare was 5335.2kg and the average price of rice was Tk. 37.5 and by-product yield 1400 Kg per hectare and the average price of by-product was 2.5 Tk. per Kg. Therefore, the gross return was found to be Tk. 203570.00per hectare (Table 5.2).

5.4.2 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. 93906.00 per hectare (Table 5.2).

5.4.3 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 was estimated as Tk. 51606.00 per hectare (Table 5.2).

Table 5.2: Per hectare cost and return of aromatic rice production

Sl. No.	Items	Amount (Tk. hectare)
A.	Gross return (GR)	203570
B.	Total variable costs (TVC)	106964
C.	Total costs (TVC+TFC)	148464
D.	Net return (GR-TC)	51606
E.	Gross margin (GR-TVC)	93906
F.	Benefit-cost ratio (BCR) = GR/TC	1.37

Source: Field Survey, 2019

5.4.4 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 1.37 which implies that one taka investment in aromatic rice production generated Tk. 1.37 (Table 5.2). From the above calculation it was found that rice cultivation is profitable in Bangladesh.

5.5 Concluding remarks

From the above discussion and the results presented in Table 5.2 it is clear that aromatic rice production is a profitable business for farmers.

CHAPTER VI

FACTORS AEFFECTING AND RESOURCE USE EFFICIENCY OF AROMATIC RICE PRODUCTION

6.1 Introduction

This chapter is designed to estimate and compare the relative economic potential of aromatic 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 Aromatic rice.

6.2 Factors Affecting Production of Aromatic Rice

For producing aromatic rice 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 aromatic rice production. Multiple regression analysis was employed to understand the possible relationships between the production of aromatic rice and the inputs used.

6.3 Method of Estimation

For determining the effect of variable inputs to the production of aromatic rice, Cobb-Douglas production function was chosen on the basis of best fit and significance result on output. 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.

$$Y= a\ X_1b_1\ X_2b_2\ X_3b_3\ X_4b_4\ X_5b_5\ X_6b_6\ X_7b_7X_8b_8X_9b_9X_{10}b_{10}X_{11}b_{11} + Ui \text{ -------------------- } (1)$$

This equation may be alternatively expressed as:

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

Where,

Y = Per hectare yield of aromatic paddy (Tk. /ha)

a = Intercept

X_1 = Cost of animal labor and power tiller (Tk. /ha)

X_2=No. of human labor (man days/ha)

X_3 = Quantity of seed in producing aromatic paddy (Kg/ha)
X_4= Quantity of manure in producing aromatic paddy (Kg/ha)
X_5= Quantity of urea in producing aromatic paddy (Kg /ha)
X_6= Quantity of TSP in producing aromatic paddy (Kg /ha)
X_7= Quantity of MoP in producing aromatic paddy (Kg /ha)
X_8= Quantity of gypsum in producing aromatic paddy (Kg /ha)
X_9= Quantity of Zinc sulphate in producing aromatic paddy (Kg /ha)
X_{10}= Cost of pesticide in producing aromatic paddy (Tk. /ha)
X_{11}=Cost of irrigation in producing aromatic paddy (Tk. /ha)

$b_1, b_2 \ldots\ldots\ldots b_7$=Coefficient of relevant variables.
Ui=Disturbance term
ln=Natural logarithm.
This equation is individually applicable for aromatic paddy 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 produced aromatic rice have been shown in Table 7.1. The following features were noted.

1. Cobb-Douglas production function fitted well for aromatic paddy growing farms as indicated by F-values and R^2.

2. The values of coefficients of multiple determinations R^2 was 0.887 for farms which indicates that 88 percent of the total variations in returns were explained by the independent variables included in the model.

3. The F-values were highly significant implying that all the included explanatory variables are important for explaining the variation of income of farmers in aromatic rice production.

4. The results from the summation of all production co-efficient of farmers was 1.65. These figures imply that production function for farmers presents increasing returns to scale.

5. The relative contribution of individual key variables affecting productivity of aromatic rice 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/seedling (X_3), human labor (X_2), cost of urea (X_5), cost of gypsum (X_8), cost of pesticide (X_{10})and irrigation (X_{11}) were found to have significant effect on production in aromatic farms, but animal labor and power tiller cost (X_1), manure (X_4), cost of TSP (X_6), cost of MoP (X_7) and cost of Zinc sulphate (X_9) was found to have insignificant effect on production of aromatic rice.

6.4.1 Aromatic rice production farmer

Cost of Animal Labor & Power (X_1):

It is evident from Table 6.1 that the coefficient of cost of animal labor & power was 0.264 which was insignificant for aromatic rice production. That means, 1 percent in cost of this input keeping other factors constant would result in an increase of gross return by 0.264 per cent.

Human labor cost (X_2):

The co-efficient for human labor was 0.119and was significant at 5 per cent level. This indicates that 1 percent increase in human labor cost keeping other factors constant, would increase the gross returns by 0.119percent.

Seed cost (X_3):

The estimated co-efficient of seed was 0.342 which was significant at 1 percent level for aromatic 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 gross return by 0.342 per cent.

Manure cost (X_4):

Table 6.1 reveals that the coefficient of manure cost was 0.012 and which was insignificant for aromatic rice production. That means in 1 percent increase of manure cost increased gross return by 0.012percent while other factors were kept constant.

Urea cost (X_5):

The estimated value of the co-efficient of urea fertilizer was 0.225for aromatic rice farmer and was significant at 1 per cent level .It can be said that 1 percent increase in urea cost keeping other factors constant, would increase the gross returns by 0.225percent.

TSP cost (X_6):

The estimated value of the co-efficient of TSP fertilizer was -0.035for rice farmer and was insignificant .It can be said that 1 percent increase in TSP cost keeping other factors constant, would decrease the gross returns by 0.035percent.

MoP cost (X_7):

The estimated value of the co-efficient ofMoP fertilizer was 0.086for rice farmer and was insignificant .It can be said that 1 percent increase in MoPfertilizer cost keeping other factors constant, would increase the gross returns by 0.086percent.

Gypsum cost (X_8):

The estimated value of the co-efficient of gypsum fertilizer was 0.57for rice farmer and was significant at 1 per cent level .It can be said that 1 percent increase in gypsum fertilizer cost keeping other factors constant, would increase the gross returns by 0.57percent.

Zinc Sulphate cost (X_9):

The estimated value of the co-efficient of Zinc sulphate was 0.256for rice farmer and was insignificant .It can be said that 1 percent increase in fertilizer cost keeping other factors constant, would increase the gross returns by 0.256percent.

Pesticide cost (X_{10}):

The co-efficient of the variable was 0.156and significant at 5 percent level. This suggests that an additional spending of 1 percent on pesticide would enable the farmers to earn 0.156percent of gross return from aromatic rice.

Irrigation cost (X_{11}):

The co-efficient of the variable was 0.168 and significant at 5 percent level. This suggests that an additional spending of 1 percent on irrigation water would enable the farmers to earn 0.168percent of gross return from aromatic rice.

Table 6.1 Estimated values of coefficients and related statistics of Cobb- Douglas production function

Explanatory variables	Coefficient	Standard error	p- value
Intercept	6.305	0.317	0.000
Cost of Animal Labor & Power (X_1)	.264	0.084	0.504^{NS}
Cost of human labor (X_2)	.119	0.017	.042*
Cost of seed (X3)	.342	0.053	0.000***
Cost of manure (X_4)	.012	0.033	$.876^{NS}$
Cost of urea (X_5)	.225	0.046	0.001***
Cost of TSP (X_6)	-.035	0.036	0.492^{NS}
Cost of MoP (X_7)	.086	0.035	$.198^{NS}$
Gypsum (X_8)	.057	0.078	0.001***
Zinc Sulphate(X_9)	.256	0.318	0.267^{NS}
Cost of pesticide (X_{10})	.156	0.055	0.030*
Cost of irrigation (X_{11})	.168	0.029	0.019*
R^2	0.887		
Adjusted R^2	0.877		
Return to scale	1.65		
F-value	89.002***		

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 0.887 for owner farmer which indicates that about 88 percent of the total variation in return of aromatic paddy production is explained by the variables included in the model. In other words the excluded variables accounted for 12 percent of the total variation in return of aromatic paddy.

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 returns of aromatic rice production.

Returns to Scale

The summation of all the production coefficients indicates returns to scale. For aromatic paddy production in farmers the summation of the coefficients was 1.65. This indicated that the production function showed increasing returns to scale.

6.5 Resource Use Efficiency of Aromatic 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.

The ratio of MVP and MFC of cost of animal labor &power (6.88) for aromatic rice production was positive and more than one, which indicated that in the study area land preparation was under-utilization (Table 6.2). So, farmers should increase the use of land preparation to attain efficiency considerably.

Table 6.2 showed that the ratio of MVP and MFC of human labor (0.35) for aromatic rice cultivation was positive and less than one, which indicated that in the study area human labor for aromatic 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 19.25 for aromatic rice cultivation was positive and more than one, which indicated that in the study area use of seed for aromatic rice production was under-utilization (Table 7.3). So, farmers should increase the use of seed for aromatic rice production to attain efficiency considerably.

It was evident from the table 6.2 that the ratio of MVP and MFC of manure (3.30) for aromatic rice cultivation was positive and more than one, which indicated that in the study area use of manure for aromatic rice cultivation was under used. So, farmers should increase the use of urea to attain efficiency in aromatic rice cultivation.

It was evident from the table 6.2 that the ratio of MVP and MFC of urea (6.07) for aromatic rice cultivation was positive and more than one, which indicated that in the study area use of urea for aromatic rice cultivation was under used. So, farmers should increase the use of urea to attain efficiency in aromatic rice cultivation.

Table 6.2 Estimated resource use efficiency of aromatic rice production

Variable	Geometric mean (GM)	$\bar{Y}$ (GM)/$\ddot{x}_i$ (GM)	Co-efficient	MVP (Xi)	r=MVP/MFC	Decision rule
Yield (Y)	89625.14					
Cost of Animal Labor & Power (X_1)	3440.67	26.05	.264	6.88	6.88	Under-utilization
Human labor cost (X_2)	30882.19	2.91	0.119	0.35	0.35	Over-utilization
Seed cost (X_3)	1592.23	56.29	0.342	19.25	19.25	Under-utilization
Manure (X_4)	3258.65	27.50	0.012	3.30	3.30	Under-utilization
Urea cost (X_5)	3323.53	26.96	0.225	6.07	6.07	Under-utilization
TSP cost (X_6)	3836.20	23.36	-0.035	-8.17	-8.17	Over-utilization
MoP (X_7)	2541.08	35.27	0.086	3.03	3.03	Under-utilization
Gypsum(X_8)	974.63	91.96	0.057	5.24	5.24	Under-utilization
Zinc sulphate (X_9)	1295.81	69.16	0.256	17.76	17.76	Under-utilization
Pesticide cost (X_{10})	4636.34	19.33	0.156	3.02	3.02	Under-utilization
Irrigation cost(X_{11})	4613.84	19.43	0.168	3.27	3.27	Under-utilization

Source: Field Survey, 2019

The ratio of MVP and MFC of TSP (-8.17) for aromatic rice cultivation was negative and less than one, which indicated that in the study areas use of TSP for aromatic rice cultivation was over-utilization (Table 6.2). So, farmers should decrease the use of TSP to attain efficiency considerably.

It was evident from the table 7.3 that the ratio of MVP and MFC of MoP (3.03) for aromatic rice cultivation was positive and more than one, which indicated that in the study area use of MoP for aromatic rice cultivation was under-utilization. So, farmers should increase the use of MoP to attain efficiency in aromatic rice cultivation.

It was evident from the table 6.2 that the ratio of MVP and MFC of gypsum (5.24) for aromatic rice cultivation was positive and more than one, which indicated that in the study area use of gypsum for aromatic rice cultivation was under-utilization. So, farmers should increase the use of gypsum to attain efficiency in aromatic rice cultivation.

It was evident from the table 6.2 that the ratio of MVP and MFC of Zinc sulphate (17.76) for aromatic rice cultivation was positive and more than one, which indicated that in the study area use of Zinc sulphate for aromatic rice cultivation was under-utilization. So, farmers should increase the use of Zinc sulphate to attain efficiency in aromatic rice cultivation.

It was evident from the table 6.2 that the ratio of MVP and MFC of pesticide (3.02) for aromatic rice cultivation was positive and more than one, which indicated that in the study area use of pesticide for aromatic rice cultivation was under-utilization. So, farmers should increase the use of pesticide to attain efficiency in aromatic rice cultivation.

Table 6.2 revealed that the ratios of MVP and MFC of irrigation used for aromatic rice cultivation was positive and more than one (3.27), which indicated that irrigation application was under-utilization. So, farmers should increase the use of irrigation to attain efficiency in aromatic rice cultivation.

6.6 Concluding remarks

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

CHAPTER VII

PROBLEM OF AROMATIC RICE PRODUCTION

7.1 Introduction

The aromatic rice producer were found to face different problems and constraints were non-available of 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 contact and drought. The nature and extent of these problems are discussed below**:**

- **Lack of quality seed:**

Though all the farmers were found to produce high yielding varieties of aromatic rice, 35 percent of them mentioned that they had lacking of quality seed and this constraint ranked 8th among the constraints (Table 7.1).Most of the own preserved seeds and the seeds collected from local markets or neighbors were not quality seeds as their germination was poor.

- **Low yield and unstable price:**

The problem of low price and unstable price was noticed by 64 percent of aromatic rice growers in the study areas (Table 7.1). It was a severe problem for aromatic rice production and ranked lst mong the constraints.

- **Lack of suitable land:**

It was observed that 37 percent of aromatic rice producers in the study areas had lacking of suitable land for the cultivation of these aromatic rice varieties respectively (Table 7.1). This constraint ranked 7thfor aromatic rice farmers.

- **Pest and disease infestation:**

Insects and diseases were one of the most sever constrains to produce aromatic rice. About 52 percent of aromatic rice producers, reported that they were facing this constrains (Table 7.1). This constraint ranked 3rdfor the aromatic rice cultivar.

- **High price and spot scarcity of fertilizers:**

Based on farmers' opinion, another to pranking constraint was high price and spot scarcity of fertilizers. Majority of the farmers (56%) cultivating aromatic rice mentioned that they faced the problem of high price and spot scarcity of one or more of the chemical fertilizers in aromatic 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 constraint was ranked $2^{nd}$for aromatic rice growers (Table 7.1).

- **Lack of capital**

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. Forty four of the aromatic rice growing farmers mentioned that they had dearth of cash for aromatic rice cultivation (Table 7.1) and ranked 6^{th}constraints.

- **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 aromatic rice production. Shortage of human labor hampered different intercultural management and delayed harvesting which ultimately reduced yield. About 48 percent of aromatic rice growers faced the problem of shortage of human labor. This problem ranked $5^{th}$for aromatic rice cultivation.

Table 7.1 Problems of aromatic rice production

Problems and Constraints	Farmers responded (%)	Rank
a) Lack of quality seed	35	7^{th}
b) Low yield and unstable price	64	1^{st}
c) Lack of suitable land	37	6^{th}
d) Pest and disease infestation	52	3^{rd}
e) High price and spot scarcity of fertilizers	56	2^{nd}
f) Lack of capital	44	5^{th}
g) Shortage of human labour at the critical stage	48	4^{th}
h) Declining soil fertility	12	8^{th}

Source: Field Survey, 2019

- **Declining soil fertility:**

Farmers in the study areas were concerned about the declining soil fertility. About 12 percent of the respondents mentioned that declining soil fertility hampered aromatic rice production. Reports are already available that fertility of our soils has deteriorated over the years and the productivity of some crops have either stagnated or declined. Declining of soil fertility is further aggravated due to deficiency of more and more micronutrients in the soil. Farmers also mentioned that they got less yield from same amount of fertilizers than before due to declining soil fertility.

7.2 Suggested solutions

The rice-growing farmers were asked to suggest solutions to the above mentioned problem. They pointed out some suggestions to solve the problems. The suggested solutions are ensuring output price, input should be available with minimum price, high yielding and short duration variety is needed, subsidy may be given and credit facility should be extended, regular extension contact is needed and ensuring supplementary irrigation (Table 7.2).

Table 7.2 **Farmers suggestions to overcome problem**

Suggestions	**Farmers responded (%)**	**Rank obtained**
Ensuring output price	66	1st
Input should be available with minimum price	62	2nd
High yielding and short duration variety is needed	54	3rd
Subsidy may be given and credit facility should be extended	46	4th
Regular extension contact is needed	45	5th
Ensuring supplementary irrigation	34	6th

Source: Field Survey, 2019

CHAPTER VIII
SUMMARY, CONCLUSION AND RECOMMENDATIONS

8.1 Summary

Rice is one of the major cereal crop and staple food in Bangladesh. Rice occupies about 73.39 percent of total cropped area and constitutes about 72 percent of the agricultural production. There are three categories of rice produced in Bangladesh such as coarse, aromatic and non-aromatic fine rice. All these rice are cultivated mainly in T.Aman season. Yield of coarse rice is higher than the fine rice and the yield of fine rice is higher than the aromatic rice. On the other hand, market price of aromatic rice is almost double than that of coarse rice. Dinajpur region is one of the best aromatic rice growing area of Bangladesh where aromatic rice varieties namely. Deshi Kataribhog, Philippines Katarihhog. Zola Katarihhog, Kalijira, Chirtigura, BRRI dhan 34 etc. are cultivated largely.

At present aromatic rice is the most popular rice throughout the country but still the farmers' arc less interested to cultivate this variety of rice. Kaharole upazila under Dinajpur district was randomly selected as the locale of the study, where concentration of aromatic rice are high. A total of 101 aromatic rice cultivars was randomly selected for primary data collection. In this study revenues and expenditures data used as proxies for output and input quantities. To determine technical efficiency, stochastic production Cobb-Douglas method was used. In this context, the specific objectives of the study were formulated to determine relative profitability and to assess the resource use efficiency of aromatic rice cultivation in selected areas of Dinajpur district. The specific objectives were as follows:

1. To know the socio-economic status of aromatic rice producing farmers.
2. To measure the profitability of aromatic production by the farmers in the study area.
3. To identify the factors behind the yield variations of aromatic rice production.
4. To assess the resource-use efficiency of aromatic rice production.
5. To find the problems faced by the farmers and recommend some policy guidelines.

The majority (45.5 percent) of the respondents fell into the middle-aged category while 42.6 percent and 11.9 percent were found young and old aged categories respectively. The majority 30.7 percent of the farmer's secondary level of education. It was found that 15.8 percent had primary level of education, 20.8 percent can only sign category, and 28.7 percent had above secondary level of education. Only 4 percent were illiterate (don't read and write).The most (57.4%) of the farmers had medium family while 13.9 percent of them had large family and 28.7 percent of them had small family. Thus, about two third (71.3%) of the farmers had medium to large family .Data contained in table 4.5 indicates the 44.5 percent of the farmers had medium land while 33.7 percent of them had small land and only 21.8 percent of them were large farmer. The highest portion (71.3 percent) of the farmers had medium annual family income compared to 10.9 percent having low and only 17.8 percent had high annual family income. The most 70.3 percent of the farmers had medium training exposure; while 17.8 percent of the farmer's low training exposure and 11.9percent had high training exposure. The majority 54.5 percent of the farmers had yes participation and 45.5 percent of the farmers had no organizational participation.

Per hectare animal labor and power tiller costs for producing aromatic paddy was Tk. 3404 for farmers. The per hectare human labor costs was Tk.70000 in aromatic rice farmers which comprised 47.15 percent of their respective total costs of production.

The results of profitability analysis was found that per hectare costs of seed was Tk. 5880 for aromatic rice farmer. Per hectare manure cost was Tk. 4375 for aromatic rice farmer. Per hectare fertilizer cost were Tk.4515, Tk.5180. Tk. 1520, Tk. 780 and Tk.600 for urea, TSP, MoP, gypsum and zinc sulphate for the farmers, respectively. Per hectare pesticides cost was Tk. 2550 for aromatic rice production .Per hectare costs of irrigation cost was Tk.8160 for farmers. Interests on operating capital per hectare was Tk. 4450andland use cost per hectare was Tk. 37050 for aromatic rice farmers. The average yields of aromatic rice was5335.5 kg per hectare for the farmers. The average gross returns per hectare was Tk.203570for farmers. It was observed that per hectare net return was Tk. 51606for the farmers.

Cobb-Douglas production function analysis was carried out for examining the effect of input use and resource use efficiency. In most of the cases, the explanatory variables like seeds (X_3), human labor (X_2), cost of urea (X_5), cost of gypsum (X_8), cost of pesticide (X_{10}) and irrigation (X_{11}) were found to have significant effect on production in aromatic farms, but animal labor and power tiller cost (X_1), manure (X_4), cost of TSP (X_6), cost of MoP (X_7) and cost of Zinc sulphate (X_9) was found to have insignificant effect on production of aromatic rice. The summation of co-efficient of different inputs were greater than one implying that the production functions exhibited increasing returns to scale.

Finally, it was observed that most of the MVPs of inputs were positive or more than one which indicate that more profit can be obtained by increasing each input included in production function. Resource use efficiency indicated that all of the resources were under used for aromatic rice production except overutilization of human labor cost and TSP cost. So there was a positive effect of key factors in the production process of aromatic rice cultivation. This study also identified some of the problems and constraints associated with aromatic rice production. The findings revealed that lack of good quality seed, low yield and unstable price, lack of suitable land, pest and disease infestation, high price and spot scarcity of fertilizers, dearth of cash, shortage of human labor at the critical stage, declining soil fertility etc. were the major obstacle which stand in the way of aromatic rice production in the study area.

8.2 Conclusion

From the above discussions it can be said that that aromatic rice producer farmer were more profitable than other farmers if we consider their total production. But they didn't receive their full production. They receive only half of the produce after investing in all the costs of production along with the share of their labor and management inputs. Bangladesh is predominantly an agriculture country. Agricultural development is still synonyms with the economic development. At present agricultural sector are largely dominated by the rice production. Rice is the staple food of Bangladesh and basically rice cultivation is the major source of livelihood of the people of Bangladesh. About 90 percent of the population in Bangladesh depends on rice as a major staple food. Aromatic rice is mainly cultivated in the northern district in Bangladesh. Most of the people in Bangladesh eat aromatic rice in different festivals and makes various kinds of food stuff using aromatic rice by its proper processing. So, aromatic rice production is equally important side by side with rice production. This study will try to find out the research gap with the previous study and provide a better solution for the farmers in the study area. An attempt will be made in the present study to examine the profitability and resource use efficiency of aromatic rice producing farms. The overall objectives of the study will be to measure the profitability and resource use efficiency of aromatic rice producing farms and identify the socio-economic characteristics of the farmers in the study area. This study will also try to identify some of the problems faced by the aromatic rice producing farmers and provide some policy guidelines.

8.3 Policy Recommendations

Based on the findings of the present research, the following recommendations are put forward.

- Measures should be taken to ensure more equitable distribution of resources in rented land of farmers;
- The cost of farmers should be 50:50 in the case of all inputs except land and labor;
- Farmers should be given proper training on optimum application of inputs;
- Measures should be taken to provide credit facilities or banking facilities in rural areas.

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