PROFITABILITY OF SUGARCANE CULTIVATION IN SOME SELECTED AREAS OF GAIBANDHA DISTRICT IN BANGLADESH

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PROFITABILITY OF SUGARCANE CULTIVATION IN SOME SELECTED AREAS OF GAIBANDHA DISTRICT IN BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled **"PROFITABILITY OF SUGARCANE CULTIVATION IN SOME SELECTED AREAS OF GAIBANDHA DISTRICT IN BANGLADESH"** submitted to the Department of Agribusiness & Marketing, 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** Agribusiness & Marketing, embodies the result of a piece of bona fide research work carried out by **MD. RAJAUL KARIM, Registration No. 11-04490** 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.

Dated: December, 2019
Dhaka, Bangladesh

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THIS THESIS IS LOVINGLY DEDICATED TO MY PARENTS

PROFITABILITY OF SUGARCANE CULTIVATION IN SOME SELECTED AREAS OF GAIBANDHA DISTRICT IN BANGLADESH

ABSTRACT

The objectives of this study were to describe the selected socio-economic characteristics of the sugarcane farmers; to measure the profitability of sugarcane production in the study area; to examine the productivity of different inputs used in sugarcane production and to identify the constraints in sugar production and develop the policy initiatives for increasing its production. The study was conducted in four villages of Palashbari union under Palashbari upazila of Gaibandha district. Data were collected by using interview schedule from the randomly selected 60 respondents during 5th August to 29th August, 2019. After analyzing the data, total cost of production was Tk. 113976.5. Per hectare gross return was Tk. 176228.5. Per hectare gross margin was Tk. 78924.5. Net return was calculated by deducting gross cost from gross return and these was Tk. 62252. Benefit cost ratio was 1.55. From Cobb Douglas production function analysis, it was observed that the coefficients of human labor, urea, TSP and irrigation were significant at different level of probability sugarcane production and the coefficients of organic fertilizer was negatively significant while the coefficients of gypsum and pesticide was negative and insignificant for sugarcane production. The findings revealed that lack of adequate crusher machine was most severe problem followed by low price of sugarcane and Political disorder was last obstacle of sugarcane production in the study area.

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ABBREVIATIONS

BB	Bangladesh Bank
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
BSRI	Bangladesh Sugarcrop Research Institute
DTW	Deep Tube-Well
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
HYV	High Yielding Variety
LUC	Land Used Cost
MP	Muriate of Potash
NGOs	Non-Governmental Organization
NR	Net Return
SPSS	Statistical Package for Social Science
STP	Settling Transplanting
STW	Shallow Tube Well
TSP	Triple Super Phosphate
TVC	Total Variable Cost

CHAPTER-I
INTRODUCTION

1.1 Background of the Study

In Bangladesh, on an average 7.3 million ton sugarcane is produced from 0.18 million hectares (roughly 0.086 million hectares in sugar mill zones and 0.084 million hectares in non-mill zones for sugarcane production) of land and on an average 0.150.20 million ton sugar and 0.35-0.40 million ton molasses (r is produced from the 7.3 million ton sugarcane per year (BSRI, 2011). It is estimated that 32.36 percent sugarcane is used for sugar production, 52.69 percent is used for molasses production and 14.39 percent is used for seed and juice. Besides sugar and molasses (gur) production, sugar produces numerous valuable byproducts like, alcohol used in pharmaceutical industry, ethanol used as a fuel, bagasse used for paper, and chip board manufacturing and press mud used as a rich source of organic matter and nutrients for crop production. According to ITC Trade Map (2010) the export value of sugar in Bangladesh was $ 19 million US dollar in 2009 and it was only 8% of South-Africans' export market. Around 5.0 million people depend on sugarcane production and 66.0 million man-days labour force directly engage in sugarcane cultivation. According to the Food and Agricultural Organization (FAO), every individual needs to consume 13 Kg of sugar or 17 Kg of gur per annum. In Bangladesh the quantity is still less than 3 kg per annum. With the projected population of 183.33 million in the year 2020, the requirement of sugar will be 0.92 million ton even if we consider to intake 6 kg per person per year (BSRI, 2013). To meet the demand of sugar and gur, 11.1 million tons of sugarcane needs to be produced per year. As such the yield of sugarcane must be increased from its present level to at least 65 tons per acre.

Sugarcane is a long duration crop and it is the main source of white sugar and goor. According to FAO recommendation for 153.60 million people (BER, 2013) annual requirements of sugar/goor is 19.97 lakh metric tons in Bangladesh. Bangladesh is producing 6.8 mMT of sugarcane of which 2.3 mMT are used by sugar mills to produce 0.20 to 0.21 mMT of sugar and 3.10 mMT are used to produce 0.30 mMT of goor and remaining 1.40 mMT are used for seed and chewing (Alam & Haque 2005). Shortfall of

sugar is met from importation. Shortfall in goor cannot be met from importation, because goor is not available in the international market (KA, 1996). It is essential to increase the sugarcane area and production to meet up our national demand. But sugarcane area is decreasing day by day. During the period of 2009-10, 2010-11 and 2011-12 total sugarcane area were 1.18 lack ha, 1.16 lack ha and 1.08 lack ha respectively (BBS, 2013). 50% of sugarcane area is located in the mill zones, where sugarcane is utilized for sugar production and remaining 50% is situated in the non-mill zone, which is used for goor and juice production (Alam et al., 2005). At this moment there is no scope to increase the sugarcane area in plain land. But there is a scope to increase sugarcane cultivation in char lands, saline belt and hilly area. Cultivation of sugarcane on fallow char lands is getting popularity as the farmers are getting financially benefited through its cultivation. But cost of production of sugarcane cultivation is higher than any other crops in Bangladesh. The Shares of cost of major inputs for sugarcane production in the mills zones are seed (11.44%), Fertilizer (12.58%), pesticide (3.40%), irrigation (1.90%) and transportation for cane supply to the mills (8.79%) (Kabir & Alam, 2000). Due to geographical isolation from the mainland, chars are considered most backward areas in Bangladesh. Sugarcane cultivation has been creating employment and self-employment opportunities for the unprivileged people living in hardly reachable and remote reverie char areas round the years to improve their life and livelihood. Sugarcane cultivation is now become one of most profitable crops in char areas of Bangladesh. Hence the study was undertaken to examine the financial condition, factors affecting of sugarcane cultivation in selected areas and constraints of sugarcane cultivation in selected areas of Gaibandha district.

Sugarcane is an important cash crop of Bangladesh and played an important role in the up lift of socioeconomic conditions of the growers, rapid growth of sugar industry and contributed in economic development of the country as a whole. Sugarcane is the biggest source of revenue to the government because this crop fetches billions of Taka to the government in the form of duties and taxes. In recent industrial advances sugarcane is not only confined to sugar production, but its bi-products such as alcohol, chipboard, and dozens of others industrial chemical compound can be manufactured during the sugarcane processing.

FACT SHEET ON SUGAR MILLS IN BANGLADESH		
NAME OF THE MILLS	**PRODUCTION COST/KG**	**SELLING PRICE/KG**
Mobarakganj Sugar Mill	Tk154.93	**Tk60**
Carew and Company	Tk186.34	**Tk60**
Faridpur Sugar Mill	Tk281.16	**Tk60**
Kustia Sugar Mill	Tk324.93	**Tk60**
Pabna Sugar Mill	Tk291.62	**Tk60**
North Bengal Sugar Mill	Tk154.76	**Tk60**
Rajshahi Sugar Mill	Tk218.47	**Tk60**
Joypurhat Sugar Mill	Tk166.22	**Tk60**
Shyampur/Rangpur Sugar Mill	Tk174.60	**Tk60**
Setabganj Sugar Mill	Tk177.09	**Tk60**
Thakurgaon Sugar Mill	Tk182.46	**Tk60**
BirBangla/Jamalpur Sugar Mill	Tk132.54	**Tk60**
Panchagarth Sugar Mill	Tk161.30	**Tk60**
Rangpur/Mahimaganj Sugar Mill	Tk285.93	**Tk60**
Natore Sugar Mills	Tk138.14	**Tk60**
	Source: Annual reports of the sugar mills for 2016-17	

Source: BSRI, 2018

Figure 1.1 Production and selling price of sugarcane in Bangladesh

The profit simply defines as the difference between the revenue the firm gains from selling its output minus the cost of producing that output (Lipsey, 1989). Also he mentioned that

owner-managed firms should take care to include an imputed cost for the owner's time (for management as well as any manual element). Any risk premium necessary to compensate the owners of capital for the risk associated with its use should be deducted. Moreover, he refers to 'normal profits' and 'supernormal profit' and described that if markets are competitive then the profit level will be 'normal', meaning that firms are making 'normal profits' i.e. recovering just the opportunity costs of the owner's money and time. Likewise, in oligopolistic or monopolistic markets, it is possible for firms to maintain higher profits 'supernormal' for a longer period. Under oligopolistic conditions, collusion of market traders and barriers to entry for firms may maintain "supernormal profits" (Scarborough and Kydd, 1992). In the accounting terms 'profit' is simply sales revenue minus cost against the goods sold (Samuelson, 1989). He also reported that profit is merely the return to the owners of the firm for their own labor or their own invested funds. Whereas, in the economic theory 'profit' is the difference between sales revenue and opportunity cost involved in producing goods. Essentially, 'profit' is the reward for risk bearing, including a reward for innovation and enterprise, and often incorporates monopoly earnings. The general requirement of this criterion is that in the long run, profit margins should be at a level which is just sufficient to pay a normal interest on owner's investment plus a reward for risk taking which is sufficient to offset the losses for unsuccessful ones.

1.2 Objectives of the Study

To obtain this main objective, the following specific objectives are set as mentioned below. The following objectives will be formulated keeping in view the importance of farm mechanization and challenges faced by it.

i. To describe the selected socio-economic characteristics of the sugarcane farmers;
ii. To measure the profitability of sugarcane production in the study area;
iii. To examine the productivity of different inputs used in sugarcane production;
iv. To identify the constraints in sugar production and develop the policy initiatives for increasing its production.

In this context, the proposed research has an immense significance to the literature of productivity and profitability measurement, and to the policy makers and agricultural

experts. The objectives of this research, the methodological approach employed to achieve those objectives, and the nature of problems investigated would serve to contribute the expansion of knowledge in the following aspects.

There are several methods to estimate the profitability of an enterprise, but the standard method for calculating profitability is the rate of return to capital invested for a particular enterprise. The profitability of any enterprise can be examined by estimating details of quantity and value of inputs and outputs over the period of time. The aim of this study was to estimate the profitability of sugarcane in the major sugarcane growing areas in Bangladesh.

1.3 Origin and Countries where it Grown

Sugarcane is considered to have originated in India. Now it is grown in India, Bangladesh, Brazil, Cuba, Pakistan, Philippines, Argentina, Colombia, Indonesia, South-Africa and Egypt. In Bangladesh it is grown all over the country; however, the major sugarcane growing district are Rajshahi, kustia, jessore, Dinajpur, Gaibandha, Rangpur, Faridpur, Mymensingh, Tangail, jamalpur, and Dhaka.

1.4 Production Technology of Sugarcane

Cropping Pattern of Sugarcane

The cropping patterns recommended by the BSRI are:

1. Jute – sugarcane.
2. Jute – sugarcane + intercrop.
3. Jute – Black gram – sugarcane.
4. Aus rice – sugarcane + intercrop.

Land and Soil

High land and medium high land with well drained loamy soil neutral in reaction ($_{p}$H 6.5 to 7.5) is most suitable.

Climate

Sugarcane is a tropical crop grows best in hot and sunny areas. It grows both in tropical and sub-tropical region. Optimum temperature for sprouting is 28 – 30^0C and absolute lowest temperature is around 12^0C. Optimum rainfall for obtaining high yield is 2000 – 2500 mm is ideal. During growth phage rainfall encourages rapid cane formation. But during ripening stage rainfall is undesirable because it leads to poor juice quality.

Land Preparation

For ideal land preparation 5-6 ploughing followed by leveling and incorporating organic manure is suitable.

Selection of Planting Material

Sugarcane is propagated vegetative by stem cuttings, known as setts. Immature cane portion that are in vigorous growth stage rich in nitrogen content having healthy fresh buds are considered as the best planting material.

Planting Methods of Sugarcane

1. Conventional sett planting method.

(i) Ridge deep furrow method.

Conventional sett planting method

2. Settling transplanting (STP) method.

Settling transplanting (STP) method

(i) Bag settling.

(ii) Bed settling.

(iii) Rayungun settling.

(iv) Lateral shoot settling.

(v) Bud chip settling.

(vi) Stalk less settling.

Time of Planting

Best planting time-August to February.

Spacing

R-R spacing-75 to 100 cm and P-P spacing-45 to 60 cm.

Setting Rate

In STP method- 30000 to 40000 settling/ha and in conventional method–10t setts/ha.

Fertilizer Application Method

(a) In heavy textured soil:

50% Nitrogen and Potassium and 100% phosphorus, Sulphur and Zinc should be applied as basal prior to planting and rest should be applied at tillering stage. Zn and P should not be mixed together and applied at a time.

(b) In light textured soil:

N should be applied in 3 installments. 1/3 in furrow prior to planting, 1/3 as top dressing at tillering stage, 1/3 as top dressing at grand growth stage.

(c) For settling transplanted sugarcane:

Basal N and K applied 20-30 days after transplanting and top dressing of N and K are done when the soil contains adequate moisture.

Intercultural operation

Gap Filling:

It is essential if sprouting is not satisfactory. It should be done just after 10-15 days of planting.

Mulching:

It is essential for proper aeration into root zone.

Weeding:

Sugarcane matures within 12-15 months. Maturity test can be done artificially by using hand refract meter. It is harvested by cutting at soil level. Then it should be crushed within 24 hours.

Yield

In conventional method average cane yield is around 801t/ha and in STP method average cane yield is around 125t/ha.

Variety

BSRI (Bangladesh Sugarcane Research Institute) released 36 varieties. Of which Ishurdi 16, 21, 26, 28, 32, 33, 35 and Ishurdi 36 are suitable for cultivation in medium and high land. Ishurdi 20, 21, 22, 24, 25 and Ishurdi 26 are suitable for low land. More Or less tolerant adverse condition varieties are Ishurdi 20, 21, 22, 24, 25, 26, 28, 29, 30, 31, 32, 33, 34, and 35.

There is another sugar producing crop which is Sugar beet. Its sugar content is high than the sugarcane but it is suitable for Temperate region. As Bangladesh is a sub-tropical country sugarcane is best to meet our daily requirement.

CHAPTER-II
REVIEW OF LITERATURE

The literature on productivity and profitability in Bangladesh agriculture is emerging. Nationally as well as globally, there is very little empirical research on sugarcane production both in the developed and developing countries. The profit function and Cobb Douglas production function are used by some researchers in measuring profitability and productivity in agricultural economics.

Hasan et al. (2018) conducted a study on a comparative economic analysis of sugarcane cultivation with and without intercrops in selected areas of Pabna district in Bangladesh. Cobb-Douglas production function technique was employed to determine the effects of some selected variables in the production process. The study found that most of the sugarcane farmers were illiterate and sugarcane cultivation was the main occupation of them. The study found that the per hectare total costs stood at Tk. 126663 and Tk. 110143 with and without intercropping farm, respectively. Per hectare, total cash cost of with and without intercrops farms was accounted for 74.46 and 72.90 per cent of their total cost, whereas the total non-cash costs per hectare amounted for 25.53 and 27.10 per cent of their respective total cost. Gross returns per hectare stood at Tk. 249416 and Tk. 159204 for with intercropping and without intercropping farms, respectively. The study explores that sugarcane farming for both with and without intercropping systems was profitable but with intercropping was more profitable than without intercropping system. The findings reveal that sets, human labour, fertilizer, power tiller and manure had a significant impact but insecticide had an insignificant impact on per hectare output for with intercrops farm, while for without intercrops farm manure and insecticide had negligible impact. Lack of adequate operating capital, lack of certified sets of sugarcane, labour scarcity and ownership are major acute problems that farmers had to face in producing the sugarcane.

Sulaiman et al. (2015) conducted a study on profitability of sugarcane production and its contribution to farm income of farmers in Kaduna State, Nigeri. The net farm income of

sugarcane farmers in the study area per hectare was realized to be N7 8,036.05 k. The results also revealed that the average return on investment was N1 .83 k; meaning that for every N1 invested in sugarcane production in the study area, a profit of N1.83 k was realized by the farmers. Also, sugarcane production in the study area contributed averagely to about 19.55% of the farmers' annual farm income. It is concluded that sugarcane production in the study area was profitable despite the problems encountered; that none of the farmers solely depended on sugarcane farming as his only source of income; rather majority of them (i.e. about 80%) earned most of their income from other sources annually.

Haider, Ahmed and Mallick (2010) indicated in their study that the farming experience of the farmers and the availability of the credits significantly and positively affect the profitability and productivity level of the farms. They also found the necessity of redefining and redesigning the credit instrument for maintaining sustainability in the long run.

Islam et al. (2016) conducted a study on economics of sugarcane cultivation in some selected char lands of Bangladesh and found that Per hectare cost of sugarcane cultivation in char areas were Tk. 113976.5 which was higher in Gaibandha districts (Tk.121113) followed by Kurigram district (Tk.106840). Average yield of sugarcane in two districts were 62.04 t ha-1. Per hectare net return was Tk. 62252 in the study area. Average BCR over variable cost of two districts was 1.81 which was higher in Gaibandha district 2.06 followed by Kurigram district 1.53. Human labor, Urea, TSP and irrigation were positively significant but organic fertilizer was negatively significant in the study areas. Irrigation problem, lack of clean seed, lack of adequate crusher machine, infestation of disease and pests, low price of sugarcane, lack of transportation facility and lack of money are the major constraints of char sugarcane farmers.

Nazir et al. (2012) conducted a study on profitability of sugarcane in the major growing areas of Pakistan and found that Outcomes depicted that average production cost of sugarcane fresh crop was higher Rs.109,040/ha, in NWFP followed by the Punjab Rs.98,234/ha and in Sindh Rs.76,157/ha. In contrast, production cost of sugarcane for 1st ratoon was higher Rs.72, 986/ha in Punjab, followed by NWFP Rs.66, 082/ha and in Sindh

Rs.46, 565/ha. Gross margins of sugarcane production in Sindh was higher Rs.48, 578/ha than the other province Rs.24, 315/ha and Rs.-1, 294/ha in Punjab and NWFP respectively. Visualizing sugarcane as bumper crop during study period, the growers in all provinces did not received the support price from the sugar mills. The entire industry was on the negotiating position to buy the sugarcane at the lowest value. As occurrence of high frost in Punjab and NWFP provinces resulted damaged to sugarcane crop and sugar mills reduced the weight of sugarcane averagely by 22% in Punjab and 25% in NWFP. Comparing the gross margin with other competing crops, it was accounted that gross margin of sugarcane is lower than of rice crop in Pakistan.

Nazir et al. (2013) found that the costs of inputs of sugarcane i.e. urea, DAP, FYM, land preparation, seed and its application, weeding and cost of irrigation were the important factors which influenced on the returns of sugarcane growers. The effectiveness was examined by using the Cobb Douglas production function, MVP and allocative efficiency were also calculated. They also found that the high prices of inputs, low price of output, delay in payments and lack of scientific knowledge were the major problems in sugarcane production. In order to enhance the productivity of sugarcane in the country, government should solve the identified problems to increase the income of sugarcane growers.

Kamruzzaman and Hasanuzzaman (2007) conducted a study on factors affecting profitability of sugarcane production as monoculture and as intercrop in selected areas of Bangladesh. The study reveals that the sugarcane plus potato combination produced the highest net return followed by sugarcane plus maize, sugarcane plus lentil and sole sugarcane production. Family labour cost, cost of urea, number of fertilizing, sowing/planting time of intercrop, cost of sett were the important factors which influence the profitability of sugarcane production both as intercrop and as monoculture. High prices of inputs, lack of scientific knowledge, and dishonesty of officials are the major problems in sugarcane production. In order to promote intercropping in a large scale with sugarcane, government and other related organizations must encourage farmers to produce sugarcane as intercrop in order to earn higher net return.

The cost and returns analysis was used to assess the profitability, whilst multiple linear regression analysis was used in identifying the determinants of profitability (Dlamini and Masuku 2012). It is, therefore recommended that good crop husbandry practices like timely weeding, fertilization, and irrigation should be adopted to produce a good crop which will enhance profitability. Collective action will enable smallholder sugarcane farmers to buy in bulk and be entitled to discounts and that can enhance sustainability of profitability of the farmers. The literatures discussed above didn't include inter-crop with sugarcane which has a significant impact on productivity and profitability.

Reza et al. (2018) conducted a study on productivity and profitability of sugarcane production in Northern Bangladesh. To find the profitability and productivity of sugarcane producers, profit function and linear regression analysis are used. The result has shown that farmers gain profit from sugarcane production and the profit margin increases if the farmers grow inter-crop with sugarcane. Fertilizer, seed and pesticides significantly affect the sugarcane production where the use of fertilizer and pesticides are positively and seed is negatively related with sugarcane production. In case of sugarcane production with inter-crop, tilling and pesticides are positively and significantly and human labor is significantly but negatively related with sugarcane production. As is shown from the study, to increase production and profit level of sugarcane, government as well agricultural organizations should encourage farmers for inter-cropping. More scientific research is necessary for improving the variety of sugarcane that will likely to reduce the gap of per acre yield between Bangladesh and other sugarcane producing countries.

Khan et al. (2002) 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 lobour, animal lobour, 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, Tk 4591.33, and Tk 536.34 respectively. Human lobour and animal lobour are positively significant but irrigation cost

is negatively significant in case of aromatic rice production. On the other hand, human lobour is negatively but animal lobour and seed are positively significant for HYV Aman rice production. For achieving maximum efficiency, the use of human labour, animal labour , seed and fertilizer of 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 lobour and fertilizer of HYV Aman should be decreased.

Khan et al. (2002) 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 late 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 Translog 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.

Bhuayan (2000) conducted a study on "profitability analysis of aromatic rice cultivation in some selected sites of Kishoregang 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 aconomic 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.

CHAPTER-III
RESEARCH METHODOLOGY

In social sciences the subsequent survey methodology is normally used to collect cross-section primary data from the target population. A wide range of problems can be investigated by using this approach. Survey methodology provides the plan for the study and overall framework for collecting data. Survey design is an effective way to measure responses on fairly easy fashion as it uses well developed and interviewed questionnaire. The methodology includes data source, study area, sampling procedure, data collection and data analysis procedure. Lastly, it ends up with the farm budget calculation of sugarcane production.

3.1 Methods of Data Collection and Data Collecting Instruments

Both technical and socio-economic data were needed for this research. The researcher himself was collected the data by interviewing the selected respondents.

The measures taken were:

- ✓ Built-in-check in the interview schedule;
- ✓ Field checking and
- ✓ Independent re-interviewing of the respondents.

3.2 Selection of the Study Area

The study areas are located in the northern region of Bangladesh. The selection of the area in which a research concerning a farm business survey is conducted depends on the particular purpose of the survey and the possible cooperation from the farmers. The purposes would, therefore, be better served in this area where there were various types of farmers available. Gaibandha district were purposively selected because there were a large number of sugarcane growers in the areas of Bangladesh and sugarcane is the main producing crop in these areas besides the researcher had easy access to these areas. The area had relatively homogeneous soil type and topographical conditions. On the basis of higher concentration of sugarcane production and considering easy road communication, Palashbari upazila under Gaibandha district was purposively selected for this study. The

producer's information was collected from four selected villages namely, Udoypur, Jamalpur, Suigram and Gridharipur under Palashbari upazila. The study areas are shown by an arrow on the map (Fig.3.1 & 3.2).

3.3 Data Source

The data source used in this study consists of both primary and secondary sources. The primary data was collected from the sugarcane growers by the use of well-structured pre-tested questionnaire. Data was collected during the crop year 2019, with a well structures questionnaire. Information was collected on farm size, cropping pattern, varietal composition, labor costs, inputs costs, transportation, processing costs and returns of sugarcane production. Also efforts were made to collect the information of other competing crops for analyzing the profitability of major competing crops.

3.4 Selection of Sample and Sampling Technique

Sampling is an important part of survey work. It was not possible to interview all the farmers of the study area due to time limits and resource constraints. The sugarcane farmers were selected purposively from the study area. Sixty farmers from four selected villages under Palashbari Upazila for this study.

3.5 Preparation of questionnaires

Once the survey objectives and associated data needs and analyses were specified, a questionnaire was developed to record the information needed for analysis. Attention was given to the general form of the questionnaire to see that the questions followed a logical and appropriate sequence. Care was taken in wording questions to ensure that they were unambiguous and easily understood to ensure cooperation by respondents. According to the objectives of the study three sets of interview schedules were prepared for collecting data. Questionnaire was used for collecting information from sugarcane farmers. All schedules were pre-tested and finalized after necessary correction, modification and adjustment. Questionnaire had contained such type of questions which are relevant (i.e. cost of production and selling price of sugarcane etc.) to the study.

Figure 3.1 Map of Gaibandha district showing Palashbari upazila

Figure 3.2 Map of Palashbari upazila showing the study area

3.6 Data Collection and processing

Generally most farmers in Bangladesh do not keep written records on annual or daily transactions or activities. So, it was very difficult to collect data and the researcher had to rely completely on the memory of the farmers. Data for the study were collected from 5th August to 29th August, 2019. Data were collected from the respondents through face to face interviews by the researcher herself. During data collection the objectives of the study were clearly explained to the respondents so that they could respond freely. Producers were interviewed at two selected villages under Palashbari upazila in Gaibandha district. The respondents were interviewed during their leisure time so that they could respond easily. To overcome errors and to ensure collection of accurate data from the field/study area, all possible measures were taken. Such as, after completion of each interview, each schedule was checked and verified to make sure that answer to each item had been properly recorded. If there were any items which were overlooked or contradictory, the respondents were again interviewed for relevant corrections. Adequate measures were taken to make the information was reliable and accurate and thereby to make them meaningful for the present study. Secondary data regarding areas, production, market value and other related aspects of sugarcane production and sugarcane marketing were collected from various published books, reports and journals. For this study the data obtained refers to last sugarcane season. After the collection of data, each schedule was verified for the sake of consistency and completeness. Editing and coding were done before putting the data in the master sheets. All the collected data were summarized and scrutinized carefully and necessary summary tables were made from the master sheets.

3.7 Analytical Framework

The data was subject to tabular analysis for examining the socio-economic conditions of the study area and cost and returns at different levels of adoption for farm business as a whole and for different crop enterprises separately. The standard cost and income measures were used in this part. The information on level of adoption by constructing suitable indexes has been presented separately.

3.8 Profit Function

The activity budget as suggested by Reza et al. (2018) is employed for deriving the profit equation. The profit equation of the following from is used:

Π_1 = Pyi Yi + Pbi Bi - $\sum_{j=i}^{n}$($Pxji\ Xji$)-TFC

Where,

Π_1 = profit per acre from ith output,

Pyi = per unit price of ith output,

Yi = total quantity per acre of ith output,

Pbi = per unit price of ith by-product,

Bi = total quantity per acre of ith by-product,

Pxji = per unit price of jth input used in producing ith output,

Xji = total quantity of jth input used for the production of per acre ith output,

TFC = total fixed costs involved in producing per acre ith output,

i = the number of individual crops produced by the farmers,

j = the number of individual inputs used for producing the relevant product,

j = 1, 2, 3, ... n.

3.9 Resource Productivity

Production function analysis was used to obtain the marginal value productivity of inputs used for production. For judging the resource productivity in sugarcane production by applying different inputs such as labour, seed, fertilizers and insecticides on sample farms, the Cobb-Douglas production function was used. The utility of Cobb-Douglas production function in solving such type of problems precisely and quickly is well known. In general, Cobb-Douglas production function can be written as:

$$Y_{ij} = a\ \ X_{ij1}^{b1}\ \ Xi_{j2}^{b2}\ \ X_{ij3}^{b3}\ \ X_{ij4}^{b4}\ \ X_{ij5}^{b5}\ \ X_{ij6}^{b6}\ \ e^{ui}$$

In log-linear form the above function can be written as:

$$\ln Yij = \ln a + b_1 \ln Xij_1 + b_2 \ln Xij_2 + b_3 \ln Xij_3 + b_4 \ln Xij_4 + b_5 \ln Xij_5 + b_6 \ln Xij_6 + u_i$$

Where, Yij = the per acre output of ith crop on jth area,

Xij_1 = the cost of human labour used per acre for ith crop on jth area

Xij_2 = the value of manures and fertilizers per acre for ith crop on jth area

Xij_3= the value of seed per acre for ith crop on jth area,

Xij_4= the cost of irrigation per acre for ith crop on jth area

Xij_5= the cost of tillage per acre for ith crop on jth area,

Xij_6 = the cost of insecticide per acre for ith crop on jth area

a = the technical efficiency coefficient,

u_i = error term

b_1, b_2, b_3 = production elasticity of the corresponding inputs

3.10 Procedure for computation of Cost and revenue

The cost of inputs for agricultural production is an important factor which affects the decision making process of farmers. Farmers in the study area used purchased as well as home supplied inputs which were valued at the prevailing market rate and sometimes at government rates in the area during the surveys period or as per the price at which farmers bought the inputs. Pricing of the purchased inputs was easy whereas the prices of home supplied inputs were estimated by using the opportunity cost principle. Opportunity cost of an input is defined as the income which an input is capable of earning in an alternative employment in or outside the farm. The profitability of sugarcane cultivation was calculated by the following indices.

These indices were previously used by (Hossain et al. 2013). In our study we used this method. In calculating cost of the farmer the following components of costs were considered: (a) Human labor (b) power tillers (c) Seed/sett (d) Fertilizers (e) Pesticides (f) Irrigation (g) Interest on operating capital (h) Land use cost.

3.10.1 Cost of human labor

Human labor is the most important input in producing and marketing every agricultural product. It was required for different operations as land preparation, sowing/ transplanting,

weeding, fertilizer application, irrigation using, insecticides, harvesting and carrying, threshing and drying, loading and unloading etc. Usually there were two different types of human labor: (a) family labor and (b) hired labor. Family labor included the farmer himself, the adult males and females as well children of a farmer's family and the permanent labor appointed by him. The cost of hired labor was calculated at the wage rate actually paid by the farmers. In this study, human labor was measured in terms of man-days. The cost of human labor was calculated on the basis of the average wage rate.

3.10.2 Cost of power tillers

In the study area, power tillers were available for cultivating the land. The users of power tillers paid a fixed rate per ha. It was estimated that the average cost of power tiller was Tk. 2943.18 in Palashbari upazila under Gaibandha District per ha for one time cultivating the crop land.

3.10.3 Sett cost

For sugarcane cultivation, farmers used both home supplied and purchased seeds. The costs of home supplied seeds were determined at the ongoing market rate in the study area and costs of purchased seeds were calculated on the basis of actual prices paid by the farmers.

3.10.4 Cost of fertilizers

In general, farmers used a higher level of fertilizer than manure. The farmers used four kinds of fertilizer namely, Urea, Triple Super Phosphate (TSP), Muriate of Potash (MP) and Gypsum in these areas. Costs of these fertilizers were estimated at prevailing market prices during the period of study.

3.10.5 Cost of irrigation

Irrigation is an important input for the production of sugarcane. In the study area, shallow tube wells were used for irrigation purpose. The cost of irrigation paid at a fixed rate per acre.

3.10.6 Land use cost

According to the location, topography and fertility of the soil, the cost of land use was different for different plots. The cost of the land use may be estimated by using one of the following alterative concepts:

1. Rental value of land
2. Forgoing income from alternative use

At present the second method is used. In this research cost of land was considered by taking into account the rental value of land. Some of the selected farmers rented in cultivable land for a season and they had to pay a certain amount of money (per ha basis) as rental value of land. Other farmers produced crops on their own land. If the owners cultivated their own land by themselves, they could also get rental charge by renting out that land. The money which they could receive (per ha) was considered as rental value of land. In computing land use cost, the average rental value of land per acre for a season considered based on the information provided by the farmer in the study area.

3.10.7 Total variable cost

Total variable cost was estimated adding all the variable costs such as seed cost, hired labor cost, power tiller cost, cost of Urea, TSP, MP, Gypsum, cost of pesticide, and Irrigation cost.

Total variable cost = Seed cost + Power tiller cost +Labor cost + Fertilizer cost + Pesticides cost + Irrigation cost.

3.10.8 Total Fixed cost

Total Fixed cost was estimated adding all the fixed costs such as Land use cost and Interest on operating capital. Total Fixed cost= Land use cost + Interest on operating capital.

3.10.9 Total cost

Total cost was summation of Total variable cost and Total Fixed cost.

Total cost (full cost) = Total variable cost + Total Fixed cost.

Enterprise costing was followed in calculating cost and revenue. Economic performances as well as relative profitability of sugarcane cultivation were calculated on the basis of gross margin and net return analysis.

3.10.10 Margins of farmer

Gross margin of farmer is difference between total revenue and total variable cost used this method.

- ✓ Gross Margin of farmer = Total revenue - Total variable cost.

3.10.11 Net farm income farmers

Per acre net farm income was defined by subtracting the total cost (variable cost + fixed cost) from the total revenue obtained from sugarcane cultivation.

Net farm income = Total revenue - Total cost.

3.10.12 Benefit cost ratio (BCR)

Benefit cost ratio (BCR) of sugarcane cultivation was estimated as the following way

$$\text{Benefit cost ratio (on total cost)} = \frac{\text{Total revenue}}{\text{Total cost}}$$

3.11 Problems faced in collecting data

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

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

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

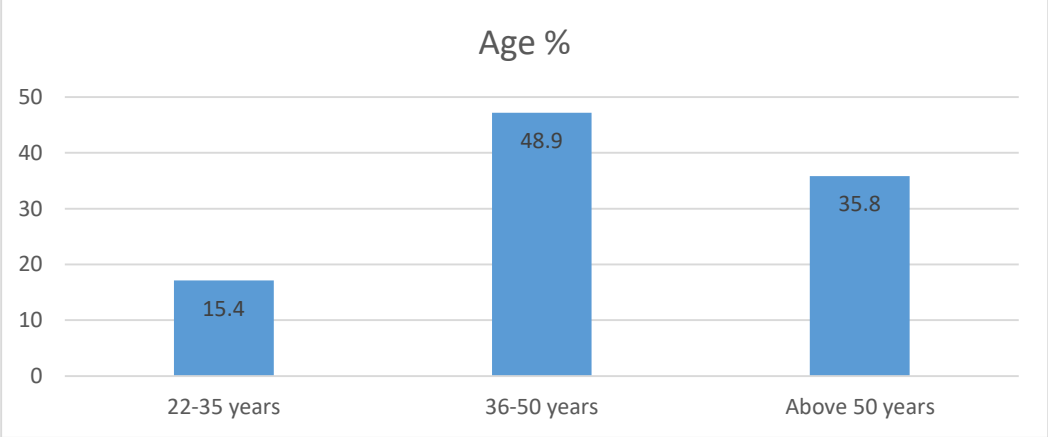
- ✓ Sometimes, the farmers were not available at their home because they remained busy with outside work. That is why sometimes more than two visits were required to get information from them.

CHAPTER IV
SOCIOECONOMIC CHARACTERISTICS OF THE SUGARCANE FARMERS

In this chapter the findings of this study have been discussed in relation to the present findings and also to those found in other studies. Eight characteristics of the farmers were selected for this research. The characteristics include: age, education, family size, farm size, annual family income, occupation, experiences in sugarcane cultivation and land under sugarcane cultivation. However, for ready reference, separate tables are provided while presenting categorizations, discussing and /or interpreting results concerning each of the characteristics in this chapter.

4.1 Age

Age of the farmers ranged from 22 to 69 years. On the basis of age, the farmers were classified into three categories: 22-35 years, 36-50 years and above 50 years. The distribution of the farmers according to their age is shown in Figure 4.1.



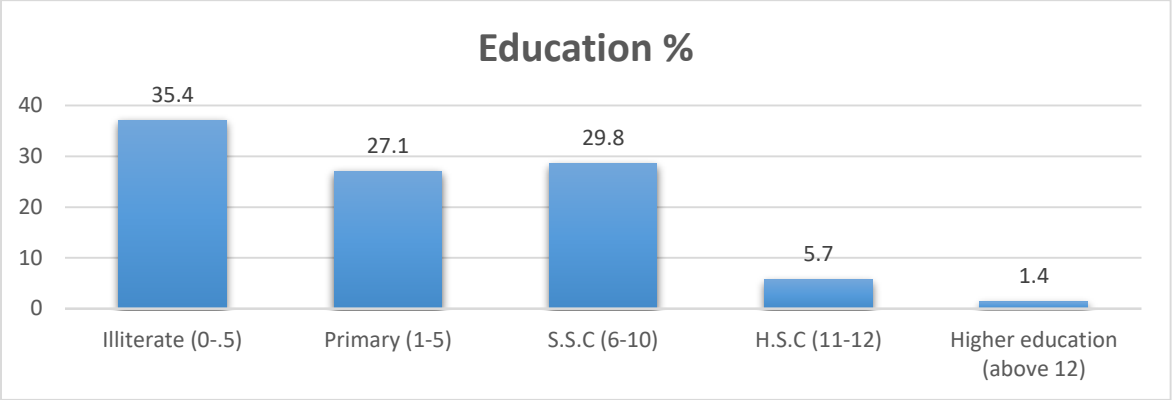
Source: Field Survey, 2019

Figure 4.1 Distribution of the farmers according to their age

Figure 4.1 showed that the highest proportion 48.9 percent of the sugarcane farmers fell into the 36-50 years age, while 35.8 percent of them fell into the above 50 years age category and 15.4 percent in the 22-35 years age category.

4.2 Education:

The education scores of the farmers ranged from 0 to 16. On the basis of their educational scores, the farmers were classified into five categories, namely "illiterate (0-0.5), primary (1-5), S.S.C. (6-10), H.S.C (11-12) and higher education (above 12). The distribution of the farmers according to their education is shown in Figure 4.2.



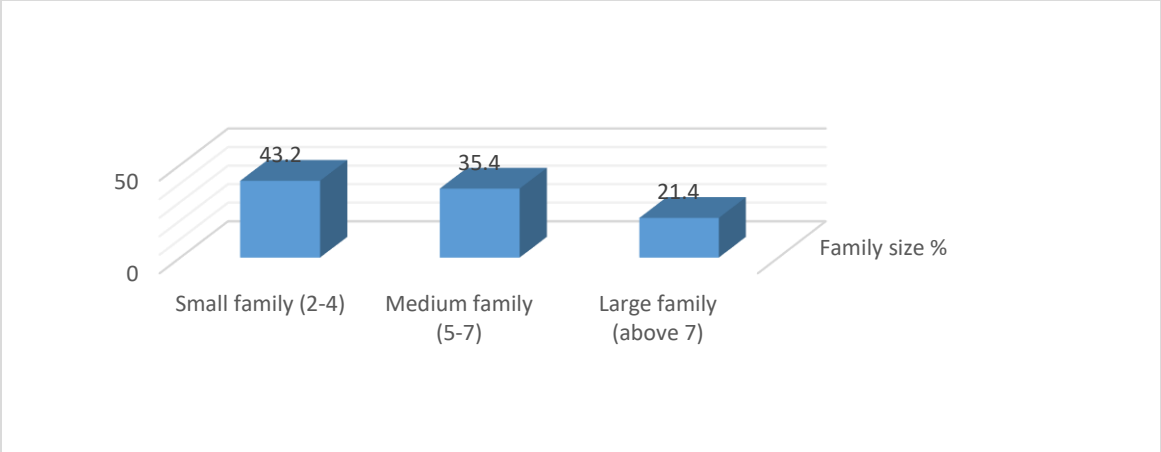
Source: Field Survey, 2019

Figure 4.2 Distribution of the farmers according to their education

Figure 4.2 indicated that the majority (35.4 percent) of the farmers had illiterate compared to 29.8 percent of them having S.S.C level education. About 27.1 percent of the farmers were primary level of education, while 5.7 percent had H.SC level of education. Only 1.4 percent of the farmers were higher level of education.

4.3 Family size

The family size of the farmers ranged from 2 to 10 members. On the basis of their family size the farmers were classified into the following three categories: "small family" (2-4), "medium family" (5-7) and "large family" (above 7). Figure 4.6 contains the distribution of the farmers according to their family size.



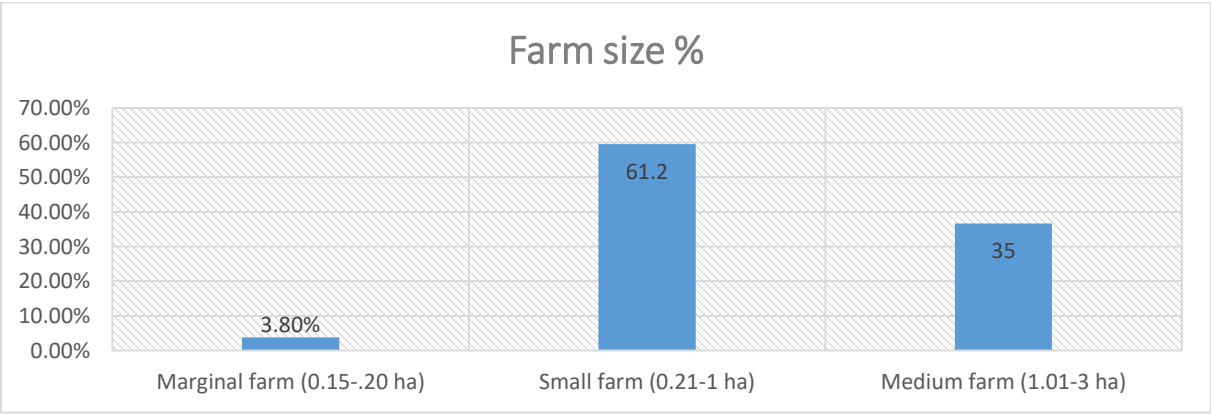
Source: Field Survey, 2019

Figure 4.3 Distribution of the farmers according to their family size

Figure 4.3 showed that the majority of the 43.2 percent of the sugarcane farmers had "small family" of 2-4 members compared to 35.4 percent of them having "medium family" of 5-7 members. The proportion of "large family" was 18.70 percent.

4.4 Farm size

Farm size of the respondents varied from 0.15 to 2.98 hectare. The average farm size was 0.94 decimal with a standard deviation of 0.60. The respondents were classified into the following three categories based on their farm size: "marginal land" (0.15-0.20 ha)", small land" (0.21-1 ha) and "medium land" (1.01-3 ha).The distribution of the farmers according to their farm size is shown in Figure 4.4.



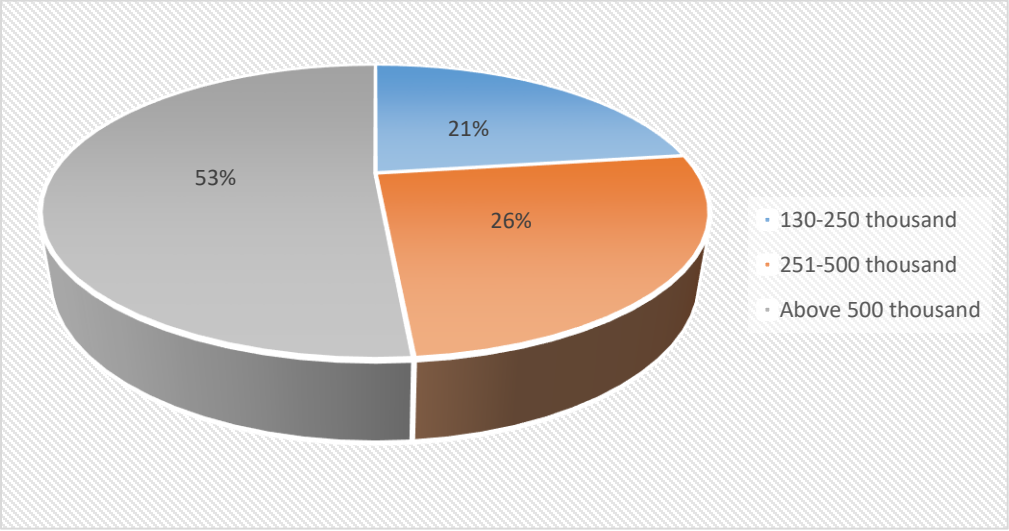
Source: Field Survey, 2019

Figure 4.4 Distribution of the farmers according to their farm size

Figure 4.4 indicated that more than half (61.2 percent) of the farmers possessed small farm size compared to 35 percent of them having medium farm size and 3.80 percent of the farmers having marginal farm size.

4.5 Annual family income

Annual family income of the respondents varied from 130 to 740 thousand. The respondents were classified into the following three categories three categories: 130-250 thousand, 251-500 thousand and above 500 thousand. The distribution of the farmers according to their annual family income is shown in Figure 4.5.



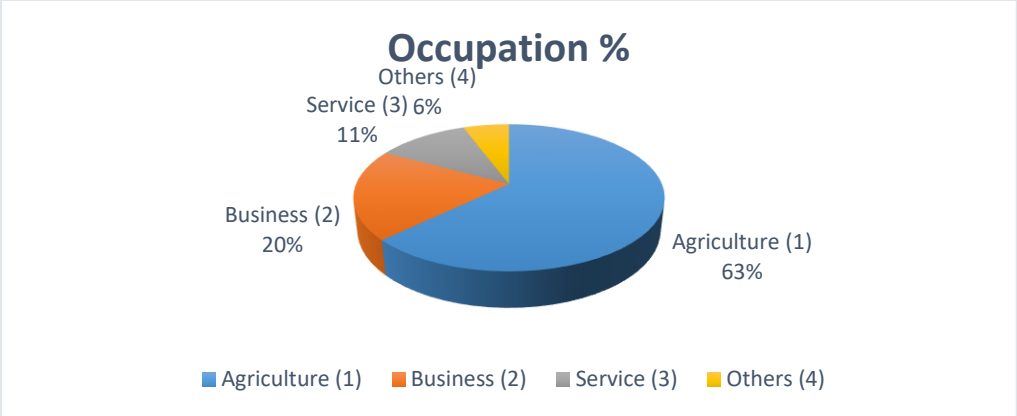
Source: Field Survey, 2019

Figure 4.5 Distribution of the farmers according to their income

Figure 4.5 indicated that more than half (53 percent) of the farmers possessed 53 percent 130-250 thousand income compared to 26 percent of them having 251-500 thousand income and 21 percent of the farmers having above 500 thousand income.

4.6 Occupation

Occupation scores of the farmers ranged from 1 to 4. On the basis of their occupation, the respondents were classified into four categories namely, agriculture, business, service and others. The scale used for computing the occupation score of a respondent is given Figure 4.6.



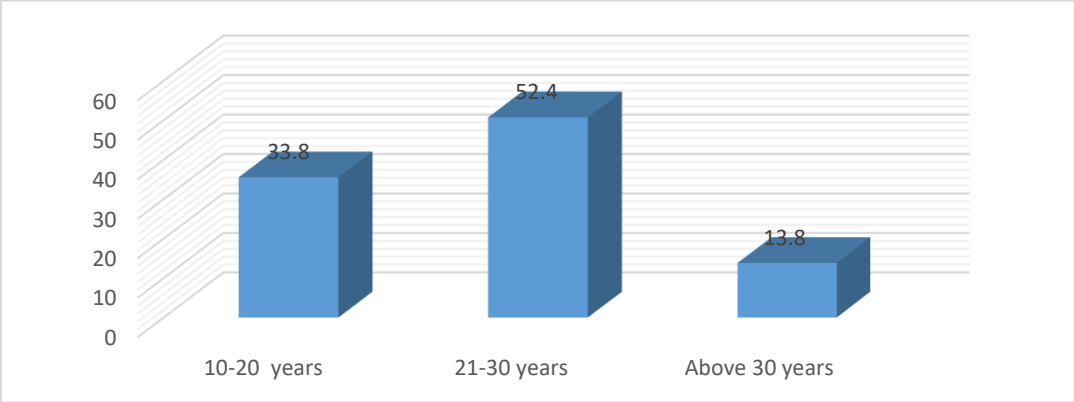
Source: Field Survey, 2019

Figure 4.6 Distribution of the farmers according to their occupation

Data contained in the Figure 4.3 indicated that the highest proportion (63.0%) of the respondents had agriculture and (20%) had business, (11%) had service holder and 6% had others occupation, respectively.

4.7 Experience in sugarcane cultivation

Experience in sugarcane cultivation of the farmers ranged from 10 to 36 years. On the basis of experience, the farmers were classified into three categories: 10-20 years, 21-30 years and above 30 years. The distribution of the farmers according to their experience is shown in Figure 4.7.



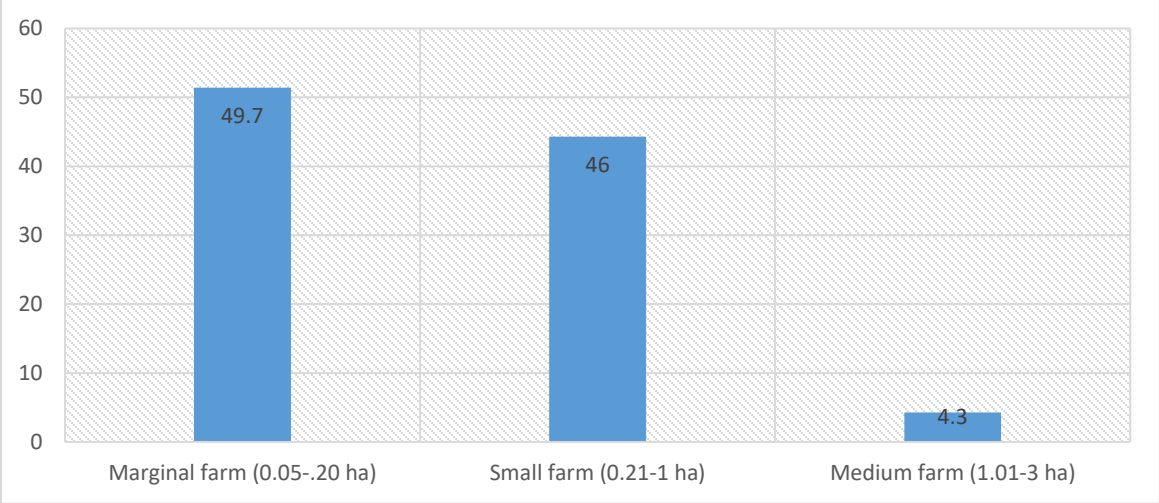
Source: Field Survey, 2019

Figure 4.7 Distribution of the farmers according to their experience

Figure 4.7 showed that the highest proportion 52.4 percent of the sugarcane farmers had 21-30 years' experience, while 33.8 percent of them had 10-20 years' experience category and 13.8 percent had above 30 years' experience.

4.8 Land under sugarcane cultivation

Land under sugarcane cultivation of the respondents varied from 0.05 to 1.23 acre. The respondents were classified into the following three categories based on their land under sugarcane cultivation: "marginal land" (0.05-0.20 acre)", small land" (0.21-1 acre) and "medium land" (1.01-3 acre). The distribution of the farmers according to their land under sugarcane cultivation is shown in Figure 4.8.



Source: Field Survey, 2019

Figure 4.8 Distribution of the farmers according to sugarcane cultivation land

Figure 4.8 indicated that less than half (49.7 percent) of the farmers possessed marginal land under sugarcane cultivation compared to 46 percent of them having small land and only 4.3 percent medium land under sugarcane cultivation.

CHAPTER V
PROFITABILITY OF SUGARCANE CULTIVATION

5.1 Human labor cost

In this study average human labor cost was Tk. 47500 per ha for production of sugarcane which was 41.7 percent of their total costs of production (Table 5.1).

5.2 Cost of power tillers

Average power tillers cost was Tk. 6812 per ha for sugarcane farmers which was 6.0 percent of their total costs of production (Table 5.1).

5.3 Sett cost

The costs of home supplied sett were determined at the ongoing market rate in the study area and costs of purchased sett were calculated on the basis of actual price paid by the farmers. Sett cost per ha was Tk. 15150 for sugarcane farmers which was 13.3 percent of their total costs of production (Table 5.1).

5.4 Cost of fertilizer

In the study area farmers used five types of chemical fertilizer namely, Urea, Triple Supper Phosphate (TSP), Muriate of Potash (MP), Gypsum, Zinc Sulphate ($Znso_4$), boron, magnesium and organic fertilizer. 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. 3696.5 for the farmers and their percentages of total cost of production was 3.2 percent.

Per hectare costs of TSP was Tk. 2391.5 for farmers and their percentages of total cost of production was 2.1 percent.

Per hectare costs of MoP was Tk. 1843.5 for the farmers and their percentages of total cost of production was 1.6 percent.

Per hectare costs of Gypsum was Tk. 990.5 for the farmers and their percentages of total cost of production was .90 percent.

Per hectare costs of Zinc were Tk. 911.5 for farmers and their percentages of total cost of production was .80 percent.

Per hectare costs of boron were Tk. 350 for farmers and their percentages of total cost of production was .0.3 percent.

Per hectare costs of magnesium were Tk. 911.5 for farmers and their percentages of total cost of production was .1 percent.

5.5 Cost of organic fertilizer

Per hectare costs of organic fertilizer was Tk. 3800 for the farmers and their percentages of total cost of production was 3.3 percent.

Table 5.1 Cost of sugarcane cultivation in the study areas (Tk. /ha)

Cost items (Tk./ha)	**Cost Tk./ha**	**% of total cost**
Human labor	47500	41.7
Tractor/Animal labor	6812	6.0
Sett	15150	13.3
Urea	3696.5	3.2
TSP	2391.5	2.1
MoP	1843.5	1.6
Gypsum	990.5	0.9
ZnSO4	911.5	0.8
Boron	350	0.3
Magnesium	140.5	0.1
Organic	3800	3.3
Pesticides	4542.5	4.0
Irrigation	7937	7.0
Carrying	1238.5	1.1
A. Total variable cost	**97304**	**85.4**

B. Fixed cost		
Land use cost	16672.5	**14.6**
Total cost (A+B)	**113976.5**	**100**

Source: Household survey, 2019

5.6 Cost of pesticides

Sugarcane growers used insecticides to protect their crop from the attack of pest and diseases. They used insecticides like Regent, Furadon, Bashudin, Bavistin, Ronster etc. Costs of these pesticides were estimated on the basis of market price. On an average total cost price of pesticides in the study area was Tk. 4542.5 per ha for sugarcane farmer and their percentages of total cost of production was 4.0 percent (Table 5.1).

5.7 Cost of irrigation

Farmers used shallow tube well (STW) for irrigation. Irrigation cost differs from land quality. Average cost of irrigation of the farmers in Palashbari upazila under Gaibandha district was Tk. 7937 ha for sugarcane farm respectively and their percentages of total cost was 7.0 percent (Table 5.1).

5.8 Total variable cost

In the study, total variable cost was Tk. 97304 per ha for sugarcane farmer and their percentages of total cost was 85.4 percent (Table 5.1).

5.9 Total Production Cost

To get the average total production cost of all the resources used by farmer of study area per ha production cost were Tk. 113976.5 (Table 5.1). Total cost is the sum of total fixed cost and total variable cost.

Per ha costs were calculated for all inputs both home supplied and purchased for producing sugarcane. In calculating the cost of sugarcane, the following components of production cost were considered.

5.10 Land use cost

In the study area, it was found that most of the farmers had land of their own for producing sugarcane. Land use cost was calculated on the basis of cash rental value per acre land for the cropping period of one year. It was estimated according to farmers' statement. In the study area, average land use cost in a season was Tk. 16672.5 per ha of land for sugarcane farmer and their percentages of total cost of production was 14.6 percent (Table 5.1).

5.11 Total fixed cost

In study area, total fixed cost was Tk. Tk. 16672.5 per ha of land ha for sugarcane farmer and their percentages of total cost of production was 14.6 percent (Table 5.1).

5.12 Profitability of sugarcane cultivation

Profitability of sugarcane cultivation in the study areas are described below:

5.13 Production of sugarcane in the study area

Farmers in the study areas are produce different types of sugarcane. Average production of sugarcane in the study area was 62.04 ton per ha for sugarcane farmer in a cropping season (Table 5.2).

5.14 Gross Return

Average Price of sugarcane was Tk. 2625 per ton in the study area. So, revenue from selling sugarcane in the study area was Tk. 170610 per ha in the study area for sugarcane farmer by-product yield was sold Tk. 5618.5 per ha. Therefore, the gross return was found to be Tk. 176228.5 per hectare (Table 5.2).

Table 5.2 Profitability of sugarcane cultivation per hectare

Particulars	**Amount (Tk. hectare)**
Total Production (ton/ha)	62.04
Price of sugarcane (Tk./ton)	2625
Return (Tk./ha)	170610
Average sett sell (Tk./ha)	5618.5

Gross return	176228.5
Total variable cost (Tk./ha)	97304
Fixed cost (Tk./ha)	16672.5
Gross margin (Tk./ha)	78924.5
Total cost (Tk./ha)	113976.5
Net return (Tk./ha)	62252
BCR (Total cost basis)	1.55

5.15 Gross margin

Gross margin equal to total variable cost subtracted from gross return. In the study total gross farm income was Tk. 78924.5 for sugarcane farmer (Table 5.2).

5.16 Net Return

Net return equals to total cost subtracted from gross return. In study area total net return was Tk. 62252 for sugarcane farmers (Table 5.2).

5.17 Benefit cost ratio (BCR)

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 1.55 which implies that one taka investment in sugarcane production generated Tk. 1.55 (Table 5.2). From the above calculation it was found that sugarcane cultivation is profitable in Bangladesh.

CHAPTER VI
FACTORS AFFECTING OF SUGARCANE CULTIVATION

6.1 Factor affecting of sugarcane production

Human labor cost (X_1):

The co-efficient for human labor was 0.285 and was positive and significant for sugarcane cultivation. This indicates that 1 percent increase in human labor cost keeping other factors constant, would decrease the gross returns by 0.285 percent.

Tractor/Animal labor (X_2)

It is evident from Table 6.1 that the coefficient of tractor/animal labor cost was 0.023 which was insignificant for sugarcane production. That means, 1 percent in cost of this input keeping other factors constant would result in an increase of gross return by 0.023 percent.

Sett cost (X_3):

The estimated co-efficient of sett was 0.172 which was insignificant for sugarcane 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 0.172 percent.

Urea cost (X_5):

The estimated value of the co-efficient of urea fertilizer was 0.112 for sugarcane production and was significant at 10 percent level. It can be said that 1 percent increase in urea cost keeping other factors constant, would increase the gross returns by 0.112 percent.

TSP cost (X_6):

The estimated value of the co-efficient of TSP fertilizer was 0.174 for sugarcane farmer and was significant at 5 percent level. It can be said that 1 percent increase in TSP cost keeping other factors constant, would increase the gross returns by 0.174 percent.

MoP cost (X_7):

The estimated value of the co-efficient of MoP fertilizer was 0.047 for sugarcane farmer and was insignificant. It can be said that 1 percent increase in MoP fertilizer cost keeping other factors constant, would increase the gross returns by 0.047 percent.

Gypsum cost (X_7):

The estimated value of the co-efficient of gypsum fertilizer was -0.040 for sugarcane farmer and was negatively insignificant. It can be said that 1 percent increase in gypsum fertilizer cost keeping other factors constant, would decrease the gross returns by 0.047 percent.

Zinc sulphate cost (X_8):

The estimated value of the co-efficient of Zinc sulphate fertilizer was 0.004 for sugarcane farmer and was insignificant. It can be said that 1 percent increase in Zinc sulphate fertilizer cost keeping other factors constant, would increase the gross returns by 0.004 percent.

Organic fertilizer cost (X_9):

The estimated value of the co-efficient of MoP fertilizer was -0.019 for sugarcane farmer and was negatively significant at 1 percent level. It can be said that 1 percent increase in organic fertilizer cost keeping other factors constant, would decrease the gross returns by 0.019 percent.

Pesticide cost (X_{10}):

The co-efficient of the variable was -0.020 and insignificant. It can be said that 1 percent decrease in pesticide cost keeping other factors constant, would increase the gross returns by 0.020 percent.

Irrigation cost (X_{11}):

The co-efficient of the variable was 0.069 and significant at 1 percent level. This suggests that an additional spending of 1 percent on irrigation water would enable the farmers to earn 0.069 percent of gross return from sugarcane cultivation.

Table 6.1 Estimated coefficient and their related statistics of sugarcane cultivation in the study areas

Regression Variables	Coefficient	Standard error	t- value
Intercept	4.391	3.017	.000
human labor (X1)	0.285**	0.117	2.443
Tractor/Animal labor (X_2)	0.023	0.077	0.306
Sett (X_3)	0.672	0.255	0.675
Urea (X_4)	0.112*	0.057	1.943
TSP (X_5)	0.174**	0.075	2.331
MoP (X_6)	0.047	0.0555	0.847
Gypsum (X_7)	-0.040	0.029	-1.397
ZnSO4 (X_8)	0.004	0.010	0.442
Organic fertilizer (X_9)	-0.019***	0.007	-2.854
Pesticide (X_{10})	-0.020	0.017	-1.178
Irrigation (X_{11})	0.069**	0.027	2.541
R^2	0.71		
Adjusted R^2	0.64		
Return to scale	1.307		
F-value	10.45 ***		

Source: Field Survey, 2019

Note: ***, ** and * show the values that are statistically significant at 1 percent, 5 percent and 10 percent significant levels respectively.

Value of R^2:

The co-efficient of multiple determinations, R^2 was 0.71 for sugarcane farmer which indicates that about 71 percent of the total variation in return of sugarcane production is

explained by the variables included in the model. In other words the excluded variables accounted for 29 percent of the total variation in return of sugarcane.

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 sugarcane production.

Returns to Scale

The summation of all the production coefficients indicates returns to scale. For sugarcane production in farmers the summation of the coefficients was 1.307. This indicated that the production function showed increasing returns to scale.

6.2 Concluding remarks

It is evident from the Cobb-Douglas production function model, that the included key variables had significant and positive effect on sugarcane production except the negative and insignificant effect of other variables. So there is a positive effect of key factors in the production process of sugarcane production.

CHAPTER VII
PROBLEM OF SUGARCANE PRODUCTION

7.1 Introduction

The sugarcane growers 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:

Table 7.1. Constraints of sugarcane cultivation

Constraints	Gaibandha (n=60)
1. Technical Constraints (% of farmer response)	
Lack of improved sugarcane variety suitable to climate change	56.7(34)
Lack of clean seed	75.0 (45)
Infestation of disease and pests	75.0 (45)
Lack of irrigation facility	80.0 (48)
Lack of training facility	66.7 (40)
Scarcity of labor	36.7 (22)
Lack of credit facility in pick period	78.3 (47)
Lack of adequate crusher machine	95.0 (57)
2. Marketing Constraints (% of farmer response)	
Low price of sugarcane	91.7 (55)
Lack of transport facility	83.3 (50)
Lack of communication facility	76.7 (46)
Large number of middlemen	61.7 (37)
Outside of sugar mills area	80.0 (48)
3. Social Constraints (% of farmer response)	
Lack of money	91.7 (55)
Thief problems	60.0 (36)
Animal problems	68.3 (41)
Political disorder	25.0 (15)

The farmers of study areas were affected in various problems during sugarcane cultivation. The constraints of sugarcane cultivation in study areas are categorized into three items: Technical constraints, marketing constraints and social constraints. Table 7.1 illustrates that 80% farmer in the study area faced irrigation problem and during post-harvest period

95% farmer faced crusher machine problem. Lack of clean seed (75%), disease and pest problems (75%), lack of training facility (66.7%), lack of credit facility in pick period (78.3%) were major technical problems in the study areas. In case of marketing constraints, 91.7% farmer in study areas supposed that price of sugarcane is low. Lack of transport facility (83.3%), lack of communication facility (76.7%), and large number of middlemen (61.7%), outside of sugar mills area (80%) were the main marketing problems of study areas. Lack of money (91.7%) and animal problems (68.3%) were the major social constraints.

CHAPTER VIII

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

8.1 Summary

Sugarcane is an important cash crop of Bangladesh and played an important role in the up lift of socioeconomic conditions of the growers, rapid growth of sugar industry and contributed in economic development of the country as a whole. Sugarcane is the biggest source of revenue to the government because this crop fetches billions of Taka to the government in the form of duties and taxes. In recent industrial advances sugarcane is not only confined to sugar production, but its bi-products such as alcohol, chipboard, and dozens of others industrial chemical compound can be manufactured during the sugarcane processing. To obtain this main objective, the following specific objectives are set as mentioned below. The following objectives will be formulated keeping in view the importance of farm mechanization and challenges faced by it.

i. To describe the selected socio-economic characteristics of the sugarcane farmers;
ii. To measure the profitability of sugarcane production in the study area;
iii. To examine the productivity of different inputs used in sugarcane production;
iv. To identify the constraints in sugar production and develop the policy initiatives for increasing its production.

The highest proportion 48.9 percent of the sugarcane farmers fell into the 36-50 years age, while 35.8 percent of them fell into the above 50 years age category and 15.4 percent in the 22-35 years age category. The majority (35.4 percent) of the farmers had illiterate compared to 29.8 percent of them having S.S.C level education. About 27.1 percent of the farmers were primary level of education, while 5.7 percent had H.SC level of education. Only 1.4 percent of the farmers were higher level of education. The majority of the 43.2 percent of the sugarcane farmers had "small family" of 2-4 members compared to 35.4 percent of them having "medium family" of 5-7 members. The proportion of "large family" was 21.4 percent. More than half (61.2 percent) of the farmers possessed small farm size compared to 35 percent of them having medium farm size and 3.80 percent of the farmers

having marginal farm size. More than half (53 percent) of the farmers possessed 53 percent 130-250 thousand income compared to 26 percent of them having 251-500 thousand income and 21 percent of the farmers having above 500 thousand income. The highest proportion (63.0%) of the respondents had agriculture and (20%) had business, (11%) had service holder and 6% had others occupation, respectively. The highest proportion 52.4 percent of the sugarcane farmers had 21-30 years' experience, while 33.8 percent of them had 10-20 years' experience category and 13.8 percent had above 30 years' experience. Less than half (49.7 percent) of the farmers possessed marginal land under sugarcane cultivation compared to 46 percent of them having small land and only 4.3 percent medium land under sugarcane cultivation.

To determine the profitability of sugarcane cultivation both the inputs and outputs were valued at market price during the study period. For analytical advantages, the cost item were identified as human labor, sett, urea, TSP, MP, manure, land use cost, and interest on operating capital. Cost and returns were worked out to estimate profitability of sugarcane cultivation. Per hectare total cost, gross return, net return and gross margin were Tk. 113976.5, Tk. 176228.5, Tk. 62252 and Tk. 78924.5 respectively.

In this study, Cobb-Douglas production function model was used to determine the effects of key variable inputs. The most important eleven explanatory variables were included in the model to explain the gross income or return of sugarcane cultivation. Most of the variables in the production function were significant in explaining the gross return except the negative and insignificant effect of pesticides and gypsum. The coefficient with expected sign indicates the selected inputs contributed positively to the gross return. The values of the coefficient of multiple determination of sugarcane production was 0.64 which implied that about 64 percent of the total variation in the gross return could be explained by the included explanatory variables of the model. Production function for sugarcane production exhibits increasing returns to scale (1.307). This means that, if all the variables specified in the model were increased by 1 percent, gross return would also increase by 1.307 percent. The F-value for the sugarcane production was 10.45 which were highly significant at 1 percent level. This study also identified some of the problems and constraints associated with shrimp

farming. These were categorized into technical, marketing, and social problems. The findings revealed that lack of adequate crusher machine, low price of sugarcane, lack of money, lack of transport facility, outside of sugar mills area, lack of irrigation facility, lack of credit facility in pick period, lack of communication facility, infestation of disease and pests, lack of clean seed, animal problems, lack of training facility and large number of middlemen etc were the major obstacle which stand in the way of sugarcane cultivation in the study area.

8.2 Conclusion and recommendation

Sugarcane cultivation shows the right path to the farmers to uproot the poverty from areas of Bangladesh. Sugarcane farmers are now financially sound and there living standard are changing quickly in recent years. Cost and benefit ratio showed that sugarcane is now one of the leading cash crops in the areas. Intercropping with sugarcane is more profitable than sole sugarcane cultivation. Intercropping with sugarcane should be increased in the study areas. Early plantation (October-November) increases cane yield of sugarcane. Ali, (1986) reported that early planting (October-November) produced 25.35% higher cane yields over late planting (February-March). Among various factors, insect pests inflict considerable losses which are estimated to be around 20% in cane yield and 15% in sugar recovery (Avasthy, 1983). Necessary steps should be taken to control insects and pests in char areas. People are working round the year in sugarcane field and they are earning handsome amount of money every month in the study areas. Disease free clean seed and modern production technology should be disseminated in the study areas. Proper management practice will help sugarcane farmer to earn more profit in the study areas.

Following activities should be done for the improvement of sugarcane cultivation:

i. BSRI released high yielding sugarcane verities should be disseminated in the study areas which can sustain adverse environmental condition.
ii. Disease free clean seed should be provided among the sugarcane farmers so that yield of sugarcane increases in the study areas.
iii. Sugar mill zone area should be extended to the study areas so that farmers can easily supply their sugarcane to the mill authority.

iv. Price of sugarcane is very low. Price of sugarcane should be increased to enhance the interest of the farmers toward sugarcane cultivation.

v. Mortgage free credit facility should be provided to the farmer in the study areas. Credit system of our country is very poor.

vi. Deep shallow tube-well should be introduced to reduce irrigation problem in the study areas.

vii. Intercrop packages which are suitable for study areas should be developed for increasing profitability of sugarcane cultivation.

viii. Training on modern sugarcane production technology should be increased in the study areas.

ix. Integrated pest management (IPM) system should be developed for controlling sugarcane insects and pests in the study areas.

x. Crusher machine should be provided to the sugarcane farmers at installment basis with low interest rate to reduce the oppression of owner of crusher machine.

xi. Transportation and communication system should be developed for better marketing system.

xii. BSRI released various machineries like BSRI developed power crusher, BSRI developed power tiller operated trencher, BSRI developed pedal pump, BSRI developed mini hot water treatment plant, BSRI developed bud chip cutter etc. should be disseminated in the study areas for getting better result.

xiii. Political disorder should be reduced for smooth progress of sugarcane, and

xiv. Awareness among sugarcane farmers should be developed to minimize various social constraints.

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Profitability of sugarcane cultivation in some selected areas of Gaibandha district in Bangladesh

Serial no .....
Name of the respondent'.....
Village .....
Upazila.....

(Please answer to the following questions)

1. **How old are you?** ..... Years

2. What is the level of your education?

i) ..... (Do not know reading and writing)

ii) ..... (Do not know reading and writing, but can sign only)

iii) ..... (Never attended school, but I can little read and write)

iv) (Up to the level of class .... Passed class/ Examination)

3. Including yourself, how many members belong to your family?

Male: ..... members.
Female: ..... members.
Child……members
Total: .....members.

4. Furnish the area of your lands according to use:

Sl. No.	Type of land	Local unit	Hectare
I	Own house		
2	Own land under own cultivation		
3	Land taken from other on borga		
4	Land taken from other on lease		
5	Own land given to others on borga		
6	Own land given to others on lease		
7	Others (Please mention)		
	Total		

5. Please mention your annual income:

Source of income	Amount (maund)	Price (Tk./maund)	Total taka
1. Agricultural sector			
a) Rice			
b) Wheat			

c) Jute			
d) Potato and sweet potato			
e) Pulses			
f) Vegetables			
g) Fruits			
h) Poultry			
i) Cattle			
j) Fishes			
k) Others (Please mention)			
2. Services			
3. Business			
Total			

6. Occupation

What is your occupation?

Agriculture……Service……Business……Others……..

7. Experiences in sugarcane cultivation

How many years you are engaged with sugarcane cultivation?

Ans:…….(years)

8. Land under sugarcane cultivation……hectare.

9. Cost of sugarcane cultivation:

Please mention following information:

a. Total cost per ha

Sl No	Item of cost	Price/kg	Cost /kg (tk)
1.	Human labour cost		
2.	Tractor/ Animal labor cost		
3.	Seed/sett		
4.	Irrigation		
5.	Fertilizer		
	Urea		
	TSP		
	MoP		
	ZnSO4		
	Gypsum		
	Manures (cow dung)		
6.	Pesticide		
	Total		

b. Total return per ha

Sl. No.	Sources of return	Amount of Production kg/ha	Price Kg/taka
1.			

10. Constraints of sugarcane cultivation

a…….
b……
c……
d……
e…….

Thanks you for your co-operation

Date: .....

Signature of the interviewer