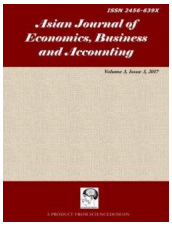

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A Comparative Economic Analysis of Sugarcane Cultivation with and without Intercrops in Selected Areas of Pabna District in Bangladesh

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Authors' contributions

This work was carried out in collaboration between all authors. Author MH designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MB and MRA managed the literature searches, assisted in the analysis and in the preparation of manuscript. Author MHAR managed the analysis and controlled the overall study. All authors read and approved the final manuscript.

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ABSTRACT

The study measures the relative profitability of different farming systems of sugarcane production in Ishwardi Upazila of Pabna district. A total of 60 farmers, out of which 30 with intercropping and 30 without intercropping farm were selected following a stratified random sampling technique. Simple cost and return analysis were performed to examine the profitability of sugarcane production. 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

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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 setts, 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.

Keywords: Sugarcane; intercropping; Benefit Cost Ratio (BCR); Cobb-Douglas function; Pabna District.

1. INTRODUCTION

Sugarcane (*Saccharum officenarum*) is the second most important cash crop and it is cultivated on about 0.16 million hectares of land in Bangladesh. Out of this cultivated area, about 50% is located in the sugar mills zone, and the remaining 50% is grown in the non-mills zone [1]. It is cultivated in the tropical and subtropical regions of the world. This crop supplies raw material for sugar and jaggery production. It is grown in all the districts of Bangladesh, but it concentrates mainly in the greater districts of Rajshahi, Kushtia, Jessore, Rangpur, Dinajpur, Bogra, Pabna, Faridpur, Barisal, Dhaka, and Mymensingh. Sugarcane growing is a profitable farm business [2]. It can play a vital role for the development of the sugar industry as well as the overall economy by increasing the cash income of farmers with the assurance of marketing outlets and thus encourages the farmers to adopt high-value enterprises.

Sugarcane is a long duration crop which occupies the land for 12-14 months from planting to harvesting. During this long period, the growers invest inputs profusely regarding capital and labour; expect a return only in harvesting time. Many of the farmers started to plant cane after harvesting one winter crop which affected in getting better cane yield. To get the benefit of winter crops, a large number of cane growers started early planting, but inter-planted with winter crops randomly [3]. Such random sowing of winter crops did not help them to protect better cane yield. The Sugarcane Research and Training Institute recognized the problem and commenced a research program to assist the small cane growers with appropriate methods of intercropping [4]. Intercropping in sugarcane with various short duration crops like cabbage, potato, mug bean etc. has been proven profitable in comparison to growing sugarcane as sole crop [5]. It is reported that 50 to 80 per cent of rain fed crops are planted as intercrops with sugarcane in many developing countries [6]. The most important advantages of intercropping is additional income received by cane growers from the cane field, thus making sugarcane cultivation economically viable compared to its other competitors and the medium farmers possess the higher benefit-cost ratio [7].

The production of sugarcane is fluctuated from year to year due to the fluctuation of the area under sugarcane cultivation [8]. Sugarcane production depends on the sugarcane area of current year and sugarcane price of previous year [9]. Sugar is produced mainly from sugarcane. About 70% of the world sugar supply is obtained from the sugarcane [1]. There are 15 sugar mills in Bangladesh. Bangladesh is producing 6.8 million metric tons (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 [10]. Presently, on an average 5.79 MMT of sugarcane is being produced in Bangladesh. Out of them, 1.56 MMT sugarcane is used by sugar mills to produce 0.10 MMT of sugar and 3.50 MMT sugarcane are used to produce 0.35 MMT of jaggery and remaining 0.87 MMT are used for seed and chewing purposes [11]. Sugar requirement per capita/day is 29 g and Bangladesh requires 1.0 to 1.2 million tons of sugar per year to meet the demand for domestic consumption [12].

Cost of production and profitability study under the different farming management of sugarcane is important because many people have no idea about the relative profitability of with intercropping and without intercropping farming management practices. The sugarcane production under with intercropping farms can profitable than without intercropping farms. To enhance the productivity of sugarcane in the country, the government should solve the identified problems to increase the income of sugarcane growers. The cost and returns analysis were used to assess the profitability, while multiple linear regression analysis was used in identifying the determinants of profitability [13]. In the case of sugarcane production with inter-crop, tilling and pesticides are positively and significantly, and human labour is significantly but negatively related to sugarcane production. As it 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 [14].

So, the study is important on the ground that it can provide valuable information about different farming management and its level of profitability to the concerned persons. Therefore, a little effort makes to study the economics of sugarcane production and comparative analysis of different sugarcane farming practices in some selected areas of Pabna district in Bangladesh. The study ascertains the socio-economic profiles of sugarcane farmers. The specific objective of the study is to measure the cost and profitability of adapting sugarcane intercrops over sugarcane mono-cropping pattern and determine the major factors influencing gross returns of sugarcane mono-crop and sugarcane intercrops production. The study also identifies the major problems faced by the farmers in sugarcane production.

2. METHODOLOGY

The study was carried out at Ishwardi Upazila of Pabna district in Bangladesh. Four villages namely, Rejarnogor, Oronkhola, Ista and Umerpur were selected randomly for the study from the Upazila. A total of 60 farmers out of which 30 farmers under with intercropping and 30 farmers under without intercropping farm management practices were selected following stratified random sampling technique. Based on cropping pattern, cultivation of sugarcane is divided into two seasons-*Kharif* and *Rabi*. The *Kharif* season covers from May to September and *Rabi* season covers from October to April. It is generally planted within October to December and harvested after 12-18 months of planting. For this study, 2016-17 was chosen as plantation year. The study mainly based on primary data. The data were gathered from the farmers through a face to face interview using a structured questionnaire. The required data were collected from February to April 2017.

2.1 Analytical Techniques

Both descriptive and statistical techniques were used to analyze the collected data through SPSS programs and MS Excel to get a meaningful result in this study. The descriptive technique was used to calculate the sum, average, and percentage of costs, gross return, net return and profitability of sugarcane. It was also used for analyzing the problems faced by the sugarcane growers. The statistical technique was used to determine the effects of the most important variables to the gross return of sugarcane farm through Cobb-Douglas production function.

2.1.1 Profitability analysis

Profitability analysis of sugarcane cultivation was determined on the basis of net return analysis.

2.1.1.1 Net return analysis

Net return was calculated by deducting all costs from a gross return. The following equation was used to determine the net return of sugarcane cultivation:

$$\Pi = \Sigma P_y.Q_y + \Sigma P_b.Q_b - \Sigma (P_{xi} \times X_i) - TFC \quad (1)$$

Where,

Π = Net return
P_y = Price of main product per unit
Q_y = Total quantity of main product
P_b = Price of byproduct
Q_b = Quantity of byproduct
P_{xi} = Price of i^{th} input per unit used for sugarcane production
X_i = Quantity of the i^{th} input used for sugarcane production
TFC = Total Fixed Cost

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

2.1.1.2 Benefit cost ratio (BCR)

Benefit-cost ratio is a relative measure which is used to compare benefit per unit cost. The BCR was estimated as a ratio of gross returns to gross costs. The formula of BCR (undiscounted) as follows:

Benefit-Cost Ratio= Gross Benefit/ Gross Cost

2.1.1.3 Interest on operating capital (OC)

An interest on operating capital was estimated by using the following formula:

Interest on operating capital =AI × i × t (2)

Where,

AI= Total investment/2
i= Rate of interest per annum
t= Length of crop period in months

2.1.2 Cobb-Douglas production function

To determine the major factors influencing gross returns of sugarcane mono crop and sugarcane inter crops production, the following Cobb-Douglas production function model was used:

$$Y=a\ X_1^{b1}\ X_2^{b2}\ X_3^{b3}\ X_4^{b4}\ X_5^{b5}\ X_6^{b6}\ X_7^{b\,7}{}_{e}U_i \quad (3)$$

Cobb Douglas Production Function was further transformed into the following logarithm form:

$$\ln Y= \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_{7+} U_i \quad (4)$$

Where,

Y = Gross return from sugarcane production (Tk./ha)
a = Constant or intercept value
X_1 = Cost of setts. (Tk./ha)
X_2 = Cost of human labour (Tk./ha)
X_3= Cost of power tiller (Tk./ha)
X_4 = Cost of manures (Tk./ha)
X_5 = Cost of fertilizers (Tk./ha)
X_6 = Cost of insecticides (Tk./ha)
X_7 = Cost of irrigation (Tk./ha)
U_i = Stochastic disturbance term
ln = Natural logarithm
b_1, b_2,.....b_7 = Coefficient of respective variables

3. RESULTS AND DISCUSSION

3.1 Socio-economic Profiles of Sugarcane Farmers

Socioeconomic profiles of sample farmers are important to influence production planning. This study presents a comparative analysis of the socio-economic characteristics of the sugarcane farm owners under with and without intercropping. Socioeconomic profiles of the sample farmers can also control their farm decision making. Finally, this study is to highlight the major socio-economic aspects such as family size and composition, the age of farm owners, level of education, occupation status, a land holding of selected sample farmers etc.

3.1.1 Age distribution of the sugarcane farmers

Age of the respondents is an important factor of involvement in any income generating activity. The selected sugarcane farm owners under with and without intercrops farm management were classified into four categories according to their age. These are 18 to 30 years, 31 to 40 years, 41 to 50 years and 51 years and above. The age group 41 to 50 years was the largest among all age groups (Table 1). About 37 and 40 per cent of the farm owners under with and without intercrops farm management practices belong to this age group, respectively.

Table 1. Distribution of sample farmers according to age group

Age groups	With intercrops		Without intercrops	
	No.	Percent	No.	Percent
18-30	7	23	4	13
31-40	9	30	9	27
41-50	11	37	12	40
51-60	3	10	5	20
Total	30	100	30	100

Source: Authors' calculation based on field survey, 2017

3.1.2 Level of education of sugarcane farmers

Education was considered as the key factor of transforming technology. Education was defined as the ability of an individual age above 6 years to read or write or formal education received up to a certain standard. Education helps individuals to become conscious of their environment and develop rational insight into many matters of life. Farmers' education is expected to play an important role in increasing the production of

farming output. Education also helps farmers to adopt modern technology, and it makes them more capable to manage scarce resources efficiently so that they can earn a higher profit. From the education point of view, all the members are the sample farms are divided into 6 categories. The level of education of the sugarcane farm owners is given in Table 2.

Table 2. Level of education of sugarcane farmers

Level of education	With intercrops		Without intercrops	
	No.	Percent	No.	Percent
Illiterate	12	40	14	47
Primary	6	20	5	17
Secondary	5	17	6	20
S.S.C	3	10	2	7
H.S.C	3	10	3	10
Graduate	1	3	-	-
Total	30	100	30	100

Source: Authors' calculation based on field survey, 2017

It was observed from Table 2 that 40 and 47 per cent of the with intercrops and without intercrops farm owners were illiterate, respectively. Only 3 per cent farmers completed their graduation under with intercrops farm pattern. About 10 and 7 per cent of with and without intercrops farm owners completed their S.S.C level. The percentage of H.S.C passed farm owners were 10 both for the with intercrops and without intercrops farmers respectively.

3.1.3 Occupational status of farmers

Agriculture was the main source of employment for the people of the study area. But many of sugarcane farmers were engaged in various types of occupations. Besides agriculture, some farmers worked in business, some worked in government and some non-government school and some of them were engaged in rural non-farm activities like rickshaw pulling, shop keeping and other wage-related activities.

Table 3. Occupational status of the farmers

Occupation	With intercrops		Without intercrops	
	No.	Percent	No.	Percent
Agriculture	18	60	16	53
Business	6	20	5	17
Service	4	13	6	20
Others	2	7	3	10
Total	30	100	30	100

Source: Authors' calculation based on field survey, 2017

Table 3 shows that, in the case with intercrops farm owners 60 per cent farmers were engaged in agriculture, 20 in business and 13 per cent in service as their main occupation. In the case of without intercrops farm owners, 53 per cent farmers were engaged in agriculture, 17 per cent in business and 20 per cent in service as their main occupation.

3.1.4 Farm size of sugarcane farmers

The land is the most important asset for respondent households. The land was used for producing diversified crops and productive purpose.

Farm size is the amount of land which is operated by a farmer. Farm size is measured by the entire land area operated by the operator [15]. It is computed by adding the area of land owned, rented in and mortgaged in from others and subtracting the area rented out and mortgaged out to others. Thus, the farm size (regarding land area) can be measured by using the following formula:

Farm size = Own land + Rented in land + Mortgaged in land+ Leased in - Rented out land- Mortgaged out land-Leased out

Table 4. Farm size of sugarcane farmers

Land type	With intercrops		Without intercrops	
	Area (ha)	Percent	Area (ha)	Percent
Homestead	0.31	4.42	0.30	3.81
Owned cultivated	2.26	32.19	2.75	34.94
Sugarcane area	1.51	21.51	1.38	17.53
Rented in	1.09	15.53	0.74	9.40
Rented out	0.48	6.83	0.76	9.65
Mortgage in	0.63	8.97	0.34	4.32
Mortgage out	0.29	4.13	0.19	2.41
Leased in	0.32	4.56	0.76	9.65
Leased out	0.13	1.85	0.65	8.25
Total	7.02	100	7.87	100
Farm size	5.75		6.05	

Source: Authors' calculation based on field survey, 2017

Table 4 shows that the average farm size for with intercrops farmers stood 5.75 hectares, while it was 6.05 hectares for without intercropping farmers, respectively.

3.2 Cost and Profitability of Sugarcane Cultivation

The costs involved in setts, human labour, power tiller, fertilizer, insecticides, interest on operating capital, land use cost etc. Farmers in the study

area used both purchased and research institution supplied inputs. They used their necessary inputs which were supplied by Bangladesh Sugarcane Research Institute (BSRI). Thus the total production costs consisted of cash and non-cash expenses. In the case of cash expenses, it was easy to estimate the costs of these items on the basis of the market rate. But no cash was paid for the home supplied inputs such as family labour, farm supplied animal labour, manures etc. These input items were valued at the prevailing market rates and sometimes government rates in the areas during the survey period or at the prices at which farmers bought. The output also valued at the farm gate price rate. The total costs per hectare were classified into variable and fixed costs. The fixed cost was estimated for family labour, interest on operating capital and land use cost etc. On the other hand, the variable cost items were hired labour, setts, power tiller, fertilizers, insecticides, irrigation etc. On the return side, the efficiency of sugarcane was measured regarding a gross return, net return and benefit-cost ratio.

3.2.1 Cost of human labor

The human labour largely used input in the production process of sugarcane. Human labours were classified into two groups: hired and family labour. Both hired, and family labourers' were employed in producing sugarcane. Family labour included the farmer himself. The cost of hired labour was calculated as the actual wage paid by the farmers without a meal.

Human labour was required for different operations like land preparation, transplantation, wedding, and earthling up, fertilizer and manure application, insecticides application, harvesting, cleaning, bundling etc. The average wage rate of with and without intercrops farms was Tk. 350 per man-days. The total labour cost per hectare was estimated at Tk. 44688 (hired + family labour) and Tk. 37166 for with intercrops and without intercrops sugarcane farming, respectively (Table 5).

3.2.2 Cost of setts

Sugarcane is vegetative propagated for commercial cultivation. Different kinds of planting materials such as cane setts, settlings and bud chips are used for raising sugarcane crop. Stem cuttings or section of the stalks are called setts or seed pieces. Cost of setts for with and without intercropping varies depending upon the quality and availability of setts. Per hectare costs of setts were calculated at Tk. 6039 and Tk. 5702 for with intercrops and without intercrops sugarcane farming, respectively which constituted 4.76 per cent and 5.17 per cent of the total cost, respectively (Table 5).

3.2.3 Cost of fertilizers

Both with intercropping and without intercropping of sugarcane farms on sugarcane growers used all types of fertilizers available such as Urea, TSP, MoP and gypsum. Table 2 shows that in the case of with intercropping farms per hectare cost of Urea, TSP and MoP were Tk. 14180, Tk. 12800, and Tk. 10400 which were 11.19, 10.11 and 8.21 per cent of the total production cost, respectively. For without intercropping of sugarcane farms, per hectare cost of Urea, TSP and MoP were Tk. 10060, Tk. 11200 and Tk. 9600 which 9.13, 10.16 and 8.71 per cent of the total production cost, respectively (Table 5).

3.2.4 Cost of manures

In the study area, it was observed that farmers used manure from their own supply. Per hectare costs of manure were estimated at Tk. 2500 and Tk. 2250 for with intercropping and without intercropping farming, which was 1.97 and 2.04 per cent of the total production costs, respectively (Table 5).

3.2.5 Cost of insecticides

Both with intercropping and without intercropping of sugarcane farming used insecticide to protect their crops from pest attack. In the study area, per hectare insecticide costs were Tk. 3360 and Tk. 3000 for with intercropping and without intercropping farms which were 2.65 and 2.72 per cent of the total cost, respectively (Table 5).

3.2.6 Cost of power tiller

Table 2 examines that the per hectare average cost of power tiller for land preparation of with intercropping farm was estimated Tk. 3572 and for without intercropping farm was estimated at Tk. 3315, which shared 2.82 and 3.01 per cent of total costs for the respective farms (Table 5).

3.2.7 Cost of irrigation

Irrigation water was very essential for sugarcane cultivation (both with and without intercropping farm). The cost of irrigation water was Tk. 3679

and Tk. 3604 for with intercropping and without intercropping farms which were 2.90 and 3.27 percent of the total cost, respectively (Table 5).

3.2.8 Interest on operating capital (OC)

Interest on operating capital was charged at the rate of 14 per cent per annum and was estimated for the duration of 14 months for both the farms. It was assumed that if the farmers borrowed the money from a bank, they had to pay interest at the same rate. Interest on operating capital for with intercropping and without intercropping farms was Tk. 8132 and Tk. 6933, respectively (Table 5).

3.2.9 Land use cost

Land use cost varied from area to area upon the soil type, topography, location and security of the particular crop field. Land use cost may be calculated using one of the following concepts:

i Interest on the value of land;
ii Valuation of land at its cash lease price per year; and
iii Forgoing income from alternative use.

The second method is the most popular. Therefore, it was used in this study. The average lease values of land per year were estimated at Tk. 17313 per hectare for both the farms (Table 5).

3.2.10 Total cost

Table 5 shows that total cost for with and without intercrops farm Tk. 126663 and Tk. 110143, respectively. On the basis of cash cost estimation, these costs amounted to Tk. 94351 and Tk. 80291, respectively.

3.2.11 Gross return

Per hectare yield of with intercropping farm was found 49300 kg and for without intercropping farms, it was 52000 kg. Price of sugarcane for both farms was Tk. 3.00 per kg in the harvesting period. Regarding the monetary unit, the value of with intercropping and without intercropping farms produced per hectare were Tk. 147900 and Tk. 156000, respectively. Taking the byproduct value into account, the total gross return was Tk. 249416 and Tk. 159204 for with intercropping and without intercropping farms, respectively (Table 6).

3.2.12 Net return

Net return is calculated by subtracting the gross cost from a gross return. Per hectare net returns were Tk. 122752 and Tk. 49060 for with intercropping and without intercropping farms, respectively (Table 5).

3.2.13 Benefit-cost ratio

Benefit-cost ratio (undiscounted) is a relative measure which is used to compare the benefits per unit cost. It helps to analyze the financial efficiency of the farms. Table 5 exhibits that the benefit-cost ratio for with intercropping and without intercropping farms was 1.96 and 1.45, respectively. It indicates that sugarcane production is profitable for both farms in the study area. Under with intercropping farming, farmers harvested extra crop, but without intercropping farms, they harvested sugarcane as a sole crop. Consequently, with intercropping farms, farmers earned a higher level of profit amounted to Tk. 249416 per hectare of sugarcane than the without intercropping farms which accounted for Tk. 159204 per hectare (Table 5).

3.3 Factors Affecting Sugarcane Production

To estimate the effects of various inputs for the production of sugarcane under with intercropping and without intercropping farms, a log-linear form of Cobb-Douglas production function model was chosen. In the analysis, seven independent variables namely, human labour cost, setts cost, and power tiller cost, fertilizer cost, manure cost, insecticides costs and irrigation cost were taken into consideration which is likely to have an impact on production of with intercropping and without intercropping farms.

3.3.1 Functional relationship

Table 7 represents the estimated coefficient and related statistics of Cobb-Douglas production function for intercropping and without intercropping farms. Cobb-Douglas productions function for with intercropping farms as follows:

$$\ln Y=3.542+0.143\ln X_1+0.433\ln X_2+0.057\ln X_3+0.056\ln X_4+0.227\ln X_5-0.072\ln X_6+0.036\ln X_7$$

Cobb-Douglas production function for without intercropping farms was:

$$\ln Y=2.704+0.163\ln X_1+0.113\ln X_2+0.026\ln X_3+0.019\ln X_4+0.236\ln X_5- 0.008\ln X_6+0.237\ln X_7$$

Table 5. Per hectare production cost and returns with and without intercrops of sugarcane cultivation

Items	With intercrops				Without intercrops			
	Quantity (kg/ha)	Price/unit (Tk.)	Total value/ cost (Tk./ha)	Percentage of total cost	Quantity (kg/ha)	Price/unit (Tk./kg)	Total value/cost (Tk./ha)	Percentage of total cost
Cash Cost								
Human labour cost (hired labour)	115.1 man-days	350	40285	31.80	96.60 man-days	350	33810	30.70
Setts cost	2013 kg	3.00	6039	4.76	1900.67 kg	3.00	5702	5.17
Power tiller cost	-	-	3572	2.82	-	-	3315	3.01
Irrigation cost	-	-	3679	2.90	-	-	3604	3.27
Fertilizer Cost								
Urea	709.00 kg	20	14180	11.19	503.00	20 kg	10060	9.13
T.S.P	400.00 kg	32	12800	10.11	350.00	32 kg	11200	10.16
MoP	650.00 kg	16	10400	8.21	600.00	16 kg	9600	8.71
Insecticide	28.00 kg	120	3360	2.65	25.00	120 kg	3000	2.72
Total Cash Cost (A)			94315	74.46			80291	72.90
Non-cash Cost								
Human labor cost (family labor)	-	-	4403	3.47	-	-	3356	3.04
Manure cost	-	-	2500	1.97	-	-	2250	2.04
Interest on operating capital	-	-	8132	6.42	-	-	6933	6.29
land use cost	-	-	17313	13.67	-	-	17313	15.71
Total Non-cash Cost (B)	-	-	32348	25.53	-	-	29852	27.10
Total Cost (A+B)	-	-	126663	100.00	-	-	110143	100.00
Gross return	-	-	249416		-	-	159204	
Net return	-	-	122752		-	-	49060	
BCR	-	-	1.96		-	-	1.45	

Source: Authors' calculation based on field survey, 2017

Table 6. Per hectare gross returns from with and without intercrops

Items	Main product			Value of by-product	Gross return (Tk./ha)
	Quantity (kg/ha)	Price (Tk./kg)	Value (Tk./ha)	Value (Tk.)	
With intercrops	49300	3.00	147900	101516	249416
Without intercrops	52000	3.00	156000	3204	159204

Source: Authors' calculation based on field survey, 2017

3.3.2 Interpretation of input co-efficient

3.3.2.1 Setts cost (X_1)

The coefficient for setts cost were positive and significant at 5 per cent level for with intercropping and without intercropping farm. The coefficient indicates that keeping other factors constant, 1 per cent increase in setts cost would increase the gross return by 0.143 and 0.163 per cent for with intercropping and without intercropping farms, respectively.

3.3.2.2 Human labour cost (X_2)

The regression coefficient of human labour cost for with intercropping farm was 0.433 and significant at 5 per cent level which indicates that considering all other factors constant, one per cent increase in human labour cost would increase gross return by 0.433 per cent. For without intercropping farms, the coefficient of human labour cost was 0.113, which was also significant at 5 per cent level implies that keeping all other factors constant, one per cent increase in labour cost would increase gross return by 0.113 per cent (Table 7).

3.3.2.3 Power tiller cost (X_3)

The coefficient of power tiller costs were positive both for with intercropping and without intercropping farms and significant at 10 per cent level, respectively which indicates that holding other factors constant, 1 per cent increase in power tiller cost would increase the gross return by 0.057 and 0.026 per cent for with intercropping and without intercropping farms production, respectively (Table 7).

3.3.2.4 Manures cost (X_4)

The coefficient of manure cost was 0.056 for with intercropping farms. It implies that a 1 per cent increase in manures cost, keeping other factors constant, would lead to an increase in gross return by 0.056 per cent. For without intercropping farms, the value of the coefficient of manures cost was 0.019 which is statistically insignificant. It indicates that manure cost had no significant impact on the gross return without intercropping farms (Table 7).

3.3.2.5 Fertilizers cost (X_5)

The coefficient of fertilizers cost was positive for with and without intercropping farms. The value of coefficient which indicates that holding other factors constant, 1 per cent increase in fertilizers cost would increase the gross return by 0.227 per cent and for without intercropping farms 1 per cent increase in fertilizer cost would increase the gross return by 0.236 per cent (Table 7).

Table 7. Co-efficient and related statistics of Cobb-Douglas production function for intercrops and without intercrops

Explanatory variables	With intercrops			Without intercrops		
	Estimated coefficient	Standard errors	t-values	Estimated coefficient	Standard errors	t-values
Intercepts	3.542	0.374	6.470	2.704	0.355	5.702
Setts cost (X_1)	0.143**	0.065	2.195	0.163**	0.075	2.160
Human labor cost (X_2)	0.433**	0.151	2.869	0.113**	0.043	2.571
Power tiller cost (X_3)	0.057*	0.223	2.551	0.026*	0.009	2.752*
Manures cost (X_4)	0.056***	0.019	2.821***	0.019	0.065	0.291
Fertilizers cost (X_5)	0.227**	0.070	3.212**	0.236**	0.078	3.010
Insecticides cost (X_6)	- 0.072	0.073	- 0.979	- 0.008	0.009	-0.806
Irrigation cost (X_7)	0.036**	0.016	2.250**	0.237**	0.075	3.148
R^2	0.897			0.751		
Adjusted R^2	0.901			0.762		
F value	13.69***			11.18***		
Returns to Scale	0.88			0.76		

Source: Authors' calculation based on field survey, 2017

*Note: ***Significant at 1% level, **Significant at 5% level and *Significant at 10% level*

3.3.2.6 Insecticides cost (X_6)

The coefficient of insecticides cost 0.072 and 0.008 for with intercropping and without intercropping farms, respectively which was negative and statistically insignificant and also it indicates that insecticides cost had no significant impact on gross return (Table 7).

3.3.2.7 Irrigation cost (X_7)

The regression coefficient of irrigation cost was positive for with intercropping and without intercropping farms. The value of coefficient indicates that keeping all other factors constant, 1 per cent increase in irrigation cost would increase gross return by 0.036 per cent for with intercropping farms and would increase gross return by 0.237 per cent for without intercropping farms, respectively (Table 7).

3.3.3 Value of R^2

The coefficients of determination, R^2 of the model were 0.897 and 0.751 for intercropping and without intercropping farms, respectively. For with intercropping farms R^2 of 0.897 indicated that about 89 per cent of variations in gross return from with intercropping farms have been explained by the explanatory variables included in the model. On the other hand, R^2 of 0.751 indicates that about 75 per cent of variations in gross returns from without intercropping farms were explained by the explanatory variables included in the mod2el (Table 7).

3.3.4 F-value

The F-values of the equation derived for with intercropping and without intercropping farms were 13.69 and 11.18 which were significant at 1 per cent level implying that all the explanatory variables were important for explaining the variations in gross returns of with intercropping and without intercropping farms, respectively (Table 7).

3.3.5 Returns to scale (Σbi)

Returns to scale reflect the degree to which a proportional increase in all inputs increases the output. Constant RTS occur when a proportional increase in all inputs results in the same proportional increase in output. Increasing RTS occurs when a proportional increase in all inputs results in a more than proportional increase of the production while decreasing RTS exists when a proportional increase in all inputs produces a decrease in output. The summation of all the regression coefficient of the estimated model gives information about the returns to scale, which is the response of output to a proportionate change in all inputs. The sum of the coefficient of all inputs for with intercropping and without intercropping farms was 0.88 and 0.76 respectively. This implies that production behavior exhibited decreasing returns to scale, in the sense that if all the inputs specified in the production function were increased by 1 per cent, the gross returns would decrease by 0.88 and 0.76 per cent for with intercropping and without intercropping farms, respectively (Table 7).

3.4 Problems of Sugarcane Cultivation

Sugarcane farmers of the study area faced a number of problems. These differed from farmer to farmer. However, farmers were asked about their acute issues in the cultivation of sugarcane, and their statement was classified into four categories as mentioned in Table 8.

3.4.1 Economic problems

Economic problems and constraints are related to financial difficulties. The problems are lack of adequate operating capital, the high price of the input, low product price. The farmers did not have enough money to produce sugarcane due to its long gestation period. It was observed in the study area that most of the farmers were not able to get sufficient capital.

3.4.1.1 Long duration crop

Sugarcane is a year-round crop. As a long duration crop sugarcane creates some problems for the marginal cane growers. Most of the marginal cane growers can earn their livelihood by growing food crops on their small pieces of land. But when their lands are used for sugarcane cultivation, they face problems for food and money in between the time of planting and harvesting. Table 8 shows that 47 and 40 per cent farmer reported about this problem under with intercropping and without intercropping farms, respectively.

3.4.1.2 Lack of capital

Table 8 shows that 67 and 50 per cent farmer reported about this problem under with intercropping and without intercropping farms, respectively.

Table 8. Problems faced by sugarcane cultivation

Categories of problems	With intercrops		Without intercrops	
	No.	Per cent	No.	Per cent
Economic problems				
Long duration crop	14	47	12	40
Lack of capital	20	67	15	50
Technical problems				
Non-availability of tractors	10	33	9	30
Damages by foxes	7	23	6	20
Lack of good quality of setts	24	80	20	66
Inadequate extension services	12	40	8	27
Irregular supply of fertilizer and insecticides	09	30	6	20
Lack of scientific knowledge and technology	14	47	12	40
Problems associated with marketing				
Scarcity of `*purzi'*	27	92	26	87
Impossibility of cash sell	13	43	10	33
Lack of transportation system	11	37	8	27
Corruption in *purzi* distribution	25	86	23	78
Scarcity of labor at harvesting period	29	97	23	80
Incorrect weight and measure	13	43	10	33
Social problems				
Chewing by the villagers	12	40	10	33
Theft of sugarcane from the field	7	23	5	17
Top plant cutting used as fuel	10	33	9	30
Ownership problems	21	70	20	66

Source: Author's calculation based on field survey, 2017

3.4.2 Technical problems

Technical problems are related to production techniques and technology, such as non-availability of tractors/power tiller and certified setts, etc. The technical problems are discussed below:

3.4.2.1 Non availability of tractors

Table 8 showed that 33 and 30 per cent of the sugarcane growers under with intercropping and without intercropping farms reported about non-availability of tractors.

3.4.2.2 Damages by foxes

Sugarcane is a good feed for animals like foxes. Twenty-three and twenty per cent of the farmers reported this problem under with intercropping and without intercropping farms, respectively.

3.4.2.3 Lack of good quality of setts

About 80 and 66 per cent of the farmers reported that they did not get certified setts of sugarcane in accordance with their demand under with intercropping and without intercropping farms, respectively.

3.4.2.4 Inadequate extension services

In the study area, about 40 and 27 per cent of the farmers were reported inadequate extension services under with intercropping and without intercropping farms, respectively.

3.4.2.5 Irregular supply of fertilizers and insecticides

Fertilizers and insecticides are essential material inputs for sugarcane cultivation. But in the study area, about 30 and 20 per cent reported irregular supply of fertilizers and insecticides under with intercropping and without intercropping farms, respectively.

3.4.2.6 Lack of scientific knowledge and technology

It was noticed that 47 and 40 per cent farmers were from lack of scientific knowledge and technology.

3.4.3 Marketing problems

Marketing problems include scarcity of *"Purzi". 'Purzi'*(Means an allotment order of mill authority) or cane supply order, lack of transportation facilities, corruption in *"Purzi"* distribution,

scarcity of labour at harvesting period, the impossibility of cash sell and incorrect weight and measures.

3.4.3.1 Scarcity of Purzi

Farmers claimed that they did not get *'Purzi'* in time, even when the sugarcane was fully matured and was about to become dry. About 92 and 87 per cent of the benefited growers suffered from a collection of *`Purzi'* under with intercropping and without intercropping farms, respectively. They further added that the *`Purzj'* was always available to those who were prominent and influential farmers.

3.4.3.2 Impossibility of cash sells

In the study area, about 43 and 33 per cent of the growers were reported that they unable to sell cane in cash under with intercropping and without intercropping farms, respectively.

3.4.3.3 Lack of transportation facility

About 37 and 27 per cent of them faced problems like transportation of sugarcane under with intercropping and without intercropping farms, respectively.

3.4.3.4 Corruption in Purzi distribution

The sugarcane growers were highly dissatisfied with the leaders of *'Purzi'* committee for their selfishness and favour to their relatives. The majority of the farmers complained against them for their unfair means. About 86 and 78 per cent of the sugarcane farmers reported about corruption in' *'Purzi'* distribution for with intercropping and without intercropping farms, respectively. Fictitious cane growers collect *`Purzi'* from them and receive the value of sugarcane with the help of a cashier.

3.4.3.5 Scarcity of labour at harvesting period

Labour scarcity at the harvesting period was a problem mentioned by 97 and 80 per cent of the cane growers with intercropping and without intercropping farms, respectively.

3.4.3.6 Incorrect weight and measure

Table 8 shows that 43 and 33 per cent of the growers reported dishonest staff to deduct some portion of sugarcane from the actual weight under with intercropping and without intercropping farms, respectively.

3.4.4 Social problems

The social factors affecting sugarcane cultivation chewing of cane by villagers and stealing from the field cut the top of the plant and collect dry leaves to use as fuel and ownership problem etc.

3.4.4.1 Chewing by the villagers

Sugarcane is an attractive and tasty crop. People, especially children are generally attracted to it. Chewing of the cane was one of the important social problems reported by 40 and 33 per cent of the cane growers under with intercropping and without intercropping farms, respectively.

3.4.4.2 Stealing of sugarcane from the field

Stealing of sugarcane from the field as a problem reported by the 23 and 17 per cent of the farmers from with intercropping and without intercropping farms, respectively.

3.4.4.3 Top plant cutting and used as fuel

About 33 and 30 per cent of the farmers reported that the villagers cut the top of the plant and collect dry leaves to use as fuel for with intercropping and without intercropping farms, respectively (Table 8).

3.4.4.4 Ownership problem

Ownership is another problem reported by the 70 and 66 per cent of the farmers with intercropping and without intercropping farm, respectively for sugarcane cultivation. Ownership was the key social problem both for with intercropping and without intercropping farmers of sugarcane cultivation.

4. CONCLUSION

Sugarcane cultivation is profitable but sugarcane production under with intercropping farm is more profitable than without intercropping farm. The different cost variables also have a significant impact on sugarcane production for both with intercropping and without intercropping farm management practices. The farmers have faced different problems in producing the sugarcane. The volume of sugarcane production can possibly be increased to a great extent if the related problems can be solved and can play a crucial role in the national economy of Bangladesh. Therefore, the government and policymakers need to take the necessary steps

which can contribute to the development of sugarcane farming.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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