Productivity and Profitability of Sugarcane Production in Northern Bangladesh

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Abstract

Sugarcane is an important industrial and cash crop. It is grown in almost all areas in Bangladesh, but commercial basis sugarcane is produced in Rajshahi, Natore, Pabna, Kustia, Chuadanga, Panchagar, Joypurhat and Thakurgaon districts. Because of available raw materials, most of the sugar mills are located in these areas. By considering the sugarcane production, number of sugar mills and sugar research institutes and the availability of sugarcane related information, we select Lalpur and Ishardi Upazillas under Natore and Pabna districts respectively as our study areas and a total of 90 samples are collected that mainly represent the actual scenery of sugarcane production of North-Bengal Region. 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.

Key Words: Sugarcane Production, Inter-cropping, Productivity and Profitability.

I   Introduction

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 0.15-0.20 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-African's 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.

At present, the condition of the sugar mills in Bangladesh is very gloomy and farmers have faced lots of problems in sugar production. During the span of 1972-73 to 2002-03 national sugar industries incurred losses in 18 seasons and made profit in 13 seasons. Old production techniques and machineries, inefficient manpower and low quality of sugarcane are the fundamental factors that are responsible for low productivity and low profitability of our sugar mills. Due to using low grade local seeds, per acre sugar production in Bangladesh is lower than India, Pakistan or Brazil. Moreover, the workers in the sugar mills are not only inefficient but also shirker and corrupt and the excess manpower is one of the main reasons behind the persistent losses of the sugar mills. In the

field level, the employees of sugar mills take bribes for sanctioning loan and subsidy and at the time of buying sugarcane from farmers through *purzi*. The medium and small farmers, who have no ability to give bribe to the sugar mill workers, sell their sugarcane with low price in private sector. At the same time, if farmers want to sell their sugarcane to sugar mills their production cycle time is pushed forward beyond one year production cycle time. If the production cycle time is more than one year, farmers face losses since they can't grow another crop in the same land.

On the other hand, due to inefficiency, farmers cannot produce sugarcane at their maximum level. It has been observed that the farm where production is low are cultivating in unscientific way, improper preparation land, conventional planting methods, late planting, credit shortage, early and late harvesting, environmental resistance, pests, disease and weeds. There is another serious issue: due to financial crisis, farmers are included to harvest sugarcane very early and marked with produce molasses (gur) which is ultimately made loses for farmers and sometimes sugar mill faces sugarcane shortage in the crashing period. Moreover, land fragmentation or small land size is one of the main barrier to use modern technology like power tiller, tractor, shallow or deep tubewell. Credit facilities and subsidy remain in poor level and most of the case government subsidies don't reach to the farmers' level. Agriculture training or research centers are not available in local area. The role of agriculture extension officer is not satisfactory because the officers do not visit the field area frequently. So, still there is a gap between the maximum level of production and the actual level of production. This study enquires to assess the status of productivity of farms in North Bengal Region of Bangladesh and to identify the factors which could affect the productivity and profitability level of the farmers. 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 measure and compare the profitability of sugarcane production between two districts;

ii) To examine the productivity of different inputs used in sugarcane production;

iii) 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.

From the perspective of the subject matter, this research contributes with an extensive review of issues concerning the methods used to analyze the linkages between the sugarcane production and profitably of farmers. As the issues and methods are complex and multidimensional, only a few research studies have concentrated on sugarcane production in a comprehensive manner. Some studies have done in India as India is one of the largest sugar production country but few works were found where productivity was measured in sugarcane production. In the contest of Bangladesh, sugarcane is not a prime crop and very few works were done in this area. So, there is a huge scope to conduct research in sugarcane production and find out the efficiency level of farmers.

This study focuses on the interaction between agricultural activity and efficient production level within a particular agro-economic zone of a single country context. Most empirical studies have tended to analyze cross-country or group data typically for a sample of both developing and developed countries. This research enriches the productivity measurement literature by providing a specific case study, which analyzes how different factors affect sugarcane production, its implications and what are the dimensions of those implications. Therefore, this research provides a more comprehensive study on this productivity issue and tries to fill the literature gap. Moreover, most of the early research studies on productivity measurement issue were survey type conceptual studies. In some earlier studies, the relationship between inefficiency and agricultural production have been analyzing and established, but as far as our concern, no study did the empirical estimation of such relationship and no such study have been found which have examined the extent of sugarcane production.

II   Literature Review

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. 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. 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. 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.

III   Methodology

A micro-level study based on the primary cross-section data has been designed to attain the objectives of this study. The methodology concerns mainly itself with the sources of data, selection of study areas, sampling procedure, data collection technique and analytical framework used in this study.

(i) **Study Area and Data**

Secondary data have been collected from various sources such as books, journals, research reports, statistical reports which related to socio-economic characteristics, productivity and efficiency analysis, sugarcane production, agricultural production and policy suggestions. In addition, data about districts, thanas, unions and villages were collected which give precise information for selecting the research areas. It includes cultivable land areas, sugarcane culktivated areas, number of agricultural households, number of sugarcane farming households, research institute, socio-economic characteristics, number of sugar mills and government policies in agricultural sector and sugarcane production.

To conduct the research study, primary data were used and the main sugarcane producing area in north-west Bangladesh, the Natore and Pabna district were selected as the study area. Primary data of this study based on farm level cross-section data of the crop year 2013-2014 and the survey has been conducted October to March of crop year 2013-2014.

Primary data have been collected from selected areas of Northern part of Bangladesh. The rationale behind the selection of this specific region as study area lies in the fact that till around 80% is engaged in farming activities in this region and most of the farmers produce two or three crops in a year. The overall cropping intensity of the region is 175 percent (Wadud 2001). The required number of samples has been collected by using purposive random sampling technique so that target group of farmers can enter in the sample.

Three-stage stratified random sampling has been used. The study area covers two thanas such as Lalpur in Natore district and Ishardi thana in Pabna district. A sample of 90 farmers from two thanas has been chosen for the study. From each thana 45 samples have been collected from at least two villages. To select village area we give priority on those areas where large number of farmers produce sugarcane. Since the study pays attention to productivity and profitability and its determinants in a predominantly sugarcane cultivation area, attempt has been made to choose the villages which has an average level of agricultural performance in their respective sub-regions. This information has been available from thana agriculture offices. The sample is selected in such a way that farmers of each village have representation in the sample.

Following the conventional survey technique, primary data on resource availability and their use, input-output levels, prices of farm produce and inputs and some other relevant information have been ollected by interviewing the farmers personally with the help of suitably designed and pre-tested questionnaire. Secondary data regarding location, climate, soil irrigation, major crop enterprises, population, land utilization pattern, insecticides and fertilizer consumption, have been compiled from district level records and government publications.

(ii)   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.

Profit Function

The activity budget as suggested by Dillon and Hardaker (1980) is employed for deriving the profit equation. The profit equation of the following from is used:

$$f_1 = P_{yi}.Y_i + Pb_i.B_i - \sum_{j=i}^{n} (P_{xji}.X_{ji}) - TFC$$

Where:

$\quad_1 \quad = \quad$ profit per acre from ith output,

$P_{yi} \quad = \quad$ per unit price of ith output,

$Y_i \quad = \quad$ total quantity per acre of ith output,

$P_{bi} \quad = \quad$ per unit price of ith by-product,

$B_i \quad = \quad$ total quantity per acre of ith by-product,

$P_{xji} \quad = \quad$ per unit price of jth input used in producing ith output,

$X_{ji} \quad = \quad$ total quantity of jth input used for the production of per acre

$\qquad\qquad\qquad$ ith output,

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

$i \quad = \quad$ the number of individual crops produced by the farmers,

$j \quad = \quad$ the number of individual inputs used for producing the relevant

product,

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

T = tests were also performed to examine significance of mean difference whenever necessary.

T-tests are also performed to examine significance of mean difference whenever necessary. To test mean difference of profit the 't' statistic as shown below is used

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}}$$

With, $\quad v = \dfrac{\left(\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{\left(\dfrac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \dfrac{\left(\dfrac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$

degrees of freedom.

Where, $\overline{X_1}$, $\overline{X_2}$ are the sample mean profit, S_1 and S_2 are corresponding standard deviations and n_1 and n_2 are sample size. By applying the above formula, the calculated values were compared with tabulated values to test whether the results were statistically significant or not. The model stands as follows Gujarati (2003).

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} = $a \ X_{ij1}^{b1} \ X_{ij2}^{b2} \ X_{ij3}^{b3} \ X_{ij4}^{b5} \ X_{ij5}^{b5} \ X_{ij6}^{b6} \ e^{u_i}$

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

$$lnY_{ij} = lna + b_1 lnX_{ij1} + b_2 lnX_{ij2} + b_3 lnX_{ij3} + b_4 ln X_{ij4} + b_5 lnX_{ij5} + b_6 ln X_{ij6} + u_i$$

Where,

Y_{ij}	=	the per acre output of ith crop on jth area,
X_{ij1}	=	the cost of human labour used per acre for ith crop on jth area
X_{ij2}	=	the value of manures and fertilizers per acre for ith crop on jth area
X_{ij3}	=	the value of seed per acre for ith crop on jth area,
X_{ij4}	=	the cost of irrigation per acre for ith crop on jth area
X_{ij5}	=	the cost of tillage per acre for ith crop on *jth* area,
$Xij6$	=	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

IV   Productivity and Profitability of Sugarcane Production

Profitability measures the amount whereby revenue outweighs the cost. Profit comes out by using some fixed amount of inputs. Productivity of crop agriculture is most often assessed by measures of crop yield. These measures expressed as product per unit of land, labour, fertilizer, seed, insecticide, tillage and irrigation. In order to find out comparative profitability of different cropping patterns, costs and returns of sugarcane and sugarcane with inter-crop have been considered. The profitability is measured based on full cost basis by taking consideration of the opportunity cost of the different inputs.

(i)   Input Cost and Output Value of Sugarcane Production

Although sugarcane needs more than one year for harvesting it is stall a profitable cash crop in Bangladesh. Actually, profit depends on timely harvesting, good market price and weather. Sometimes, farmers produce molasses for more profit or due to uncertainty in timely purchase of sugarcane by sugar mills. Farmers gain more profit if they produce molasses instead of selling sugarcane to the sugar mill and, in this case, sugar mills don't

get sufficient sugarcane in crashing season. In the study area, almost every farmer sells their sugarcane in sugar mills since at present sugar mills give high price and the study area is closely surrounded by several sugar mills (Pabna, Gopalpur and Natore sugar mills). Table 1 shows that per acre inputs cost of sugarcane production is Tk. 42,767.46 where the output value is Tk. 63,887.83 and the net return is Tk. 21,120.37. Though sugarcane is a profitable crop from net returns from sugarcane cultivation is low compared to vegetables, pulses, wheat or maize because it involves more time and huge cost. Per acre yield of sugarcane is also low in Bangladesh compared to India and Brazil. From the field survey, it is found that on an average 18.0 to 28.8 ton sugarcane is produced in the study area on an average which the market price is Tk. 45,000 to Tk. 72,000. If we see the input cost then it is found that almost 50 percent cost is incurred in hiring labour. It means sugarcane is a labour intensive crop in Bangladesh and on an average 90-110 man-days labour is needed for per acre sugarcane production.

Table 1: Per Acre Input Cost and Output Value of Sugarcane Production (in BD Taka)

Input Cost and Output Value Per Acre	Sugarcane	Percentage of Total Cost
Number of Respondent	90	90
1. Labour Cost	21,302.55	49.81%
2. Tillage Cost	3,229.11	7.55%
3. Fertilizer Cost	8,967.46	20.97%
4. Seed Cost	6,047.33	14.14%
5. Irrigation Cost	2,803.00	6.55%
6. Pesticides Cost	418.00	0.98%
7. Total Input Cost	42,767.46	100%
8. Total Value of Production	63,887.83	
9. Profit	21,120.37	
10. Net Returns	49.38%	

Source: Author's Own Calculation

The fertilizer and seed are the second and third largest heads of expenditure for producing sugarcane. From the beginning of land preparation farmers apply huge Urea, Potash, Phosphate, Cow dung and Gypsum for producing sugarcane. On an average, 2.2 to 2.6 ton sugarcane is needed as seed for planting one acre land which cost is around Tk. 6,000. To increase profit margin, farmers have to reduce per acre labour, fertilizer and seed cost. The way to reduce labour cost is to introduce new technology for planting, weeding and

harvesting. To increase per acre yield of sugarcane more scientific research is needed for introducing new varieties.

(ii)   Input Cost and Output Value of Sugarcane with Inter-Crop Production

Multiple cropping, in general, refers to planting two or more crops in the same field in the same period. It involves intensive crop cultivation in terms of effective use of space and time. It plays an important role in promoting the development of agriculture in many countries of the world, especially, in densely populated developing countries with scarce land. In many cases, multiple cropping gives higher total production, and greater resource use efficiency and an increased land productivity by almost 60 percent. It often gives higher cash return and increases total production per unit area than mono-cropping.

Table 2: Per Acre Input Cost and Output Value of Sugarcane and Inter-Crop Production (in Taka)

Input Cost and Output Value Per Acre	Sugarcane	Percentage of Total Cost
Number of Respondent	54	54
1. Labour Cost	20,786.11	40.83%
2. Tillage Cost	3,318.96	6.52%
3. Fertilizer Cost	8,658.51	17.01%
4. Seed Cost	6,390.00	12.55%
5. Irrigation Cost	2,710.00	5.32%
6. Pesticides Cost	433.33	0.85%
7. Input Cost of Inter-Crop	8,617.22	16.93%
8. Total Cost Sugarcane and Inter-Crop (1+2+3+4+5+6+7)	50,914.14	100%
9. Total Value Sugarcane	65,035.00	**-**
10. Total Valu Inter-Crop	27,283.33	**-**
11. Total Value Sugar and Inter-Crop (9+10)	92,318.33	**-**
12. Profit margin (9-8)	41,404.19	**-**
11. Net Returns(10/8)*100	81.32%	**-**

Source: Author's Own Calculation

Strengthening inter- cropping programme might help obtain a considerable amount of pulses, vegetables, oil seeds, spices and other crops along with sugarcane. In the study area, pulses are very popular for inter-cropping with sugarcane since very little input cost is required for if no additional fertilizer, irrigation and pesticides are required. No adverse effect of inter-cropping on sugarcane yield was found, even in some cases, sugarcane

yield is found to be higher. Yields of inter-crops were higher in paired row. It has been counted that large scale inter- cropping different vegetables with sugarcane in paired row can play a vital role in increasing national production of those crops without involving any extra land.

Table 2 shows that among total cost 16.93 percent input cost expend for inter-crop and here, still labour cost is very high for both sugarcane and inter-crop production. By considering both sugarcane and inter-crop per acre input cost is Tk. 50,914.14 and total output value is Tk. 92,318.33 and the spread is Tk. 41,404.19. It is evident that the same amount of land per acre return is high in multiple cropping.

(iii)   Net Returns of Sugarcane and Sugarcane with Inter-Crop Production

The allocation of farm resources means not only the change in the cropping pattern, but also maximize the net returns of farmers, The farmers is more interested in continuing his farming business and hence, he should be able to realize at least what he spends. The net return of an activity or crop process is determined by deducting the variable cost from the corresponding gross income and then by dividing the resulting value by the variable cost. From Table 3, it is seen that the net return of multiple cropping is greater than mono-crop. In mono-crop (sugarcane) the net return is 49.38 percent meaning that expending Tk. 100, farmers can make profit Tk. 49.38. In the same field and same time if farmers grow multiple crops (sugarcane with inter-crop) then farmers make profit Tk. 81.32. Multiple cropping not only increases farmers profit but also fulfills the food demand and nutrition. Lots of pulse mills and pulse research centers have been built in study area which contributes to meet the national demand and create employment opportunity for the local peoples.

Table 3: Net Returns of Sugarcane and Sugarcane and Inter-Crop Production

Input Cost and Output Value Per Acre (in Tk.)	Sugarcane	Sugarcane and Inter-Crop
Number of Respondent	90	54
1. Total Variable Cost	42767.46	50914.14
2. Total Return	63887.83	92318.33
3. Return Over Variable Cost	63887.83 42767.46	92318.33 50914.14
4. Net Returns	49.38%	81.32%

(iv)   Resource Productivity of Sugarcane Production

The resource productivity of important crops grown in different categories of farms is examined with the help of Cobb-Douglas production function. Hence, Log-Linear regression equation is estimated through ordinary least squares method where the human labour, fertilizers, tillage, irrigation, seed and insecticides are regressed upon yield. Production functions on per acre basis are estimated for sugarcane and multiple crop (sugarcane with inter-crop) production. The estimated regression coefficients are presented in Table 4 and 5. It is observed from the table that the inputs, namely human labour, fertilizers, seed, insecticides, irrigation and tillage are jointly responsible for explaining about 11 to 53 percent variations of the yield of sugarcane and multiple crop production. In the case of log linear Cobb-Douglas type production function, the estimated parameters give the production elasticity of factors included in the model. The elasticity of an input indicates the percentage increase/decrease of the quantity of that input with a specified level of other inputs. The Durbin-Watson (d-statistics) value is reported to show if there is any autocorrelation in the model.

The coefficients of partial elasticity of the production of all six inputs (human labour, fertilizers, tillage, irrigation, seed, and insecticides) are less than unity with positive sign implying diminishing marginal productivity of input factors. In other words, by holding the other inputs constant at their geometric mean level, an increasing any of them, the yield would increase at a diminishing rate. The coefficients of partial elasticity of the production of inputs are greater or less than unity with negative sign which indicates that an increase in inputs has negative impacts on total production of crops.

Table 4: Resource Productivity of Sugarcane Production

Variables	Coefficient (b)	Standard Error	t-value	Significance
Constant	13.339	1.393	9.579	.000
Human Labour	-.598	.514	-1.163	.248
Fertilizer	.097***	.049	1.989	.050
Seed	-.185**	.083	-2.236	.028
Tillage (power tiller)	.003	.035	.085	.932
Irrigation	-.038	.031	-1.233	.221
Pesticides	.010*	.004	2.662	.009
Adjusted R^2	.591			
Durbin-Watson (d-	1.89			

statistics)				

Source: Author's Own Calculation
*1% level of Significance   ** 5% level of Significance   *** 10% level of significance

Resources like labour, fertilizer, seed, irrigation etc. play important role for sugarcane production. Some inputs have positive impact where others impact negatively and these may happen due to farmers' inefficiency, lack of education, training and poor quality of inputs. In the production function of sugarcane, human labour is not a significant variable. The b value of human labour shows that one percent increase in the utilization of human labour results to decrease in sugarcane production by 0.598 percent. From the field study, it is seen that farmers expend 50 percent of total inputs cost for hiring human labour and therefore, any excess expenditure on human labour will decrease the output of the farm.

Fertilizer is a significant variable at 10% level, holding other things constant. The elasticity of output with respect to fertilizer is 0.097 means by increasing one percent of the utilization of fertilizer results into an increase in sugarcane output by .097 percent and the probability of occurring the Type I error is 10 percent, so the confidence interval is 90 percent.

The elasticity of sugarcane production with respect to seed is significant with negative sign. Its value reveals that the quantity of output of sugarcane decreases by 0.185 percent due to one percent increase of the use of seeds. It is found from the field survey that farmers use around 2.4 tons sugarcane as seed for planting one acre land which is comparatively very high according to modern tilling method. The rate of eye-budding is very low due to poor soil management and attack of insecticides. Therefore, farmers plant sugarcane more intensively for getting better germination.

Tilling (power tiller) is not a significant variable in sugarcane production but has positive impact on output and the extent of irrigation is insignificant as well as has negative impact on sugarcane production. The coefficient of the variable tillage has expected sign but its impact is insignificant because farmers do not tillage their land in a systematic way. Hence, poor and marginal farmers use less number of tillage compare to prescribe number of tillage due to financial problem. Though sugarcane is a drought tolerant crops

but irrigation is needed in extreme hot weather and it is very much expensive for the farmers. Therefore, most of the farmers in the study area do not use the irrigation in full doses.

Pesticides has turned out to be a highly significant variable in sugarcane production and the elasticity of output with respect to pesticides is .010 indicates due to one percent increase in the cost of pesticides, the output of sugarcane increases by .010 percent. It is significant at 1 percent level, implies that the probability of rejecting the null hypothesis is 1 percent. The value of adjusted-R^2 for sugarcane production is 0.591 indicates that 59 percent of the variations in output of sugarcane are explained by independent variables. The Durbin-Watson statistic is 1.89, which is approximately 2 and this indicate that the data do not suffer from autocorrelation problem.

(v) Resource Productivity of Sugarcane with Inter-Crop Production

In the case of multiple cropping, additional labour and seed are required for inter-cropping with sugarcane. The profit function has shown that the additional cost of inter-cropping has a positive impact on total output. The *b* value of human labour is significant but has negative impact on output. The elasticity of coefficient of output with respect to human labour is -.214 and it is significant at 10 percent level. This implies that if farmers increase the use of human labour by 1 percent, output will decrease by 0.214 percent. Fertilizer and seed have turned out to be an insignificant variable with negative sign. The elasticity's of output with respect to fertilizer and seed are almost identical (fertilize -.050 and seed -.057) in multiple cropping system.

Table 5: Resource Productivity of Sugarcane and Inter-Crop Production

Variables	Coefficient (*b*)	Standard Error	t-value	Significance
Constant	11.068	2.044	5.415	.000
Human Labour	-.214***	.106	-2.016	.050
Fertilizer	-.050	.048	-1.036	.306
Seed	-.057	.071	-.796	.430
Tillage (Power tiller)	.433**	.181	2.392	.021
Irrigation	-.061	.049	-1.262	.213
Pesticides	.010***	.006	1.707	.094
Adjusted R^2	.536			
Durbin-Watson (d-statistics	1.22			

Source: Author's Own Calculation
*1% level of Significance   ** 5% level of Significance   *** 10% level of significance

Tilling (power tiller) is a significant variable at 5 percent level. The *b* value of power tiller shows that one percent increase in the utilization of power tiller results into an increase in sugarcane production by 0.433 percent. In the case of multiple-cropping pesticides is a significant variable and the elasticity of output with respect to pesticides is .010. It is significant at 10 percent level that means the probability of rejecting null hypothesis is 10 percent. The coefficients of determination (R^2) for multiple cropping indicate that 53 percent of the variations in output of sugarcane are explained by independent variables. The value of Durbin-Watson d statistic shows there is no autocorrelation problem in our model.

V   Summary and Policy Recommendation

Many important insights have been found from this study which are necessary for profitable sugarcane cultivation. The present dismal condition of sugar mills and inefficiency of the farmers encourage us to conduct this study. The fact that multiple–cropping is more profitable than mono-cropping indicates that joint cultivation of sugarcane (with pulse etc.) increase the profit margin.

The Costs of fertilizer and pesticides have positive and significant impact on sugarcane production where the cost of seed has negative but significant effect on sugarcane production. Human labour and irrigation have insignificant as well as negative effect on sugarcane production. In case of multiple cropping, a unit increase in human labour results in a decrease in output by 0.214 units. The elasticities of output with respect to cost of tillage and pesticides are 0.433 and .010 respectively implying that if famers increase the use of tillage cost and pesticides cost by 1 % then the production of sugarcane will increase by 0.433% and 0.010% respectively.

In real sense, sugar mills and sugarcane producers in Bangladesh have faced many problems and day by day the condition is getting to worse. It is really unexpected, that our sugar mills unable to make profit since FY 1984-85 to FY 2004-05 except FY 1989-90 and FY 1994-95. Several factors are responsible for the farmers' lack of interest in sugarcane production and the resulting production fall. Old production technique, back dated machineries, unskilled human labour, low quality of sugarcane and molasses production by the farmers instead of selling sugarcane to sugar mills were considered the

basic reasons for chronic losses of sugar mills. The field survey also helps find the problems that the farmer faces during cultivation. It is seen that lack of proper training, use of local variety, inadequate supply of inputs, high price of human labour, extended harvesting period and late payment by the sugar mills were identified as major constraints behind the low profit of the sugarcane producer.

To increase profit margin, per acre yield must rise which necessitalis the invention of high yield variety through extensive research. Inter-cropping can be helpful for enhancing farmers' profit and this is strongly supported by our field survey results. In our perception, government officials as well as the officials from the agricultural extension division should take proper steps to ensure intercropping for all sugarcane producers. As has already been mentioned, because some farmers are interested in multiple-cropping, documented from the field survey to be we think, this fact deserves further research and in addition, modern cultivation method must be introduced. In that pursuit, Bangladesh Sugar Research Institute can take initiative and conduct extensive research. In Bangladesh, sugarcane is a still labour intensive crop and high labour wage swallows up the profit of the farmers. In order to reduce labour cost, new machines and techniques have to be introduced both in planting and harvesting seasons. Poor sugar recovery implies that our sugar mills use old production techniques and back dated machineries Therefore, it is very important to renovate our sugar mills with new production technique and modern equipments.

The authority of Bangladesh Food and Sugar Mills Corporation should take proper steps to reduce the corruption and break the ill motives of the syndicate of sugar importers. To reduce the cost of sugar mills excess man power must be fired. The authorities of sugar mills must take timely decisions so that they can sell unsold sugar and pay the farmers bills in due time.

 Finally, the support from sugar mills as subsidy or loan is very inadequate and farmers claim that agricultural extension officers or block supers visor rarely visit the study area and never give advice for better cultivation. Government should address these issues so that farmers can get an easy access to adequate technical and financial support.

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