Bangladesh J. Environ. Sci., Vol. 44, 63-68, 2023 **@ BAED ISSN 1561-9206**

IMPACT OF FLOOD INDUCED SILTATION ON MAIZE PRODUCTION: AN EMPIRICAL EVIDENCE IN GAIBANDHA DISTRICT OF BANGLADESH

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ABSTRACT

The present study was designed to estimate the comparative profitability of silted and non-silted areas of maize production in Gaibandha district of Bangladesh. In total, 60 farmers were randomly selected from the villages of Gaibandha Sadar, Sundarganj, and Fulchori upazilas of Gaibandha district. Both tabular and statistical analyses were applied considering the objectives of the study. Data were collected from selected respondents through the direct interview method using a well-designed, pre-tested structured questionnaire. Gross margin analysis was used to measure farmer's profitability. The study revealed that maize production was a profitable enterprise. Per hectare Gross return, gross margin, and net return were Tk. 318696, Tk. 220607.47, and Tk. 198772.66, respectively, for silted area, whereas, hectare wise gross return, gross margin, and net return for non-silted area were Tk. 265616, Tk. 159245, and Tk. 136585.38, respectively. The benefit cost ratios (BCR) were found to be 2.66 and 2.06 for silted and non-silted areas, respectively, which implies that one taka of investment in maize production generated Tk. 2.66 in silted areas and Tk. 2.06 in non-silted areas. Cobb-Douglas production function analysis indicated that out of seven variables, the effects of labor, cow dung, seed cost, and siltation had a positive and significant impact on the gross return from maize production. In spite of all the constraints, there was a great prospect for maize farming in the study area as a profitable enterprise.

Key words: Maize, Gross margin, BCR

Introduction

Bangladesh has a great chance to maintain this amount of maize flow if maize farming, processing, and marketing are developed in a scientific manner. The optimum soil for growing maize is non-water-logging soil like sandy loam or loamy soil. Due to the growth of the livestock and poultry industries, maize demand has surged in Bangladesh in recent years. Maize is a highly productive and nutritious crop that is used as human food, poultry feed, and livestock fodder (Borase *et al.* 2018). It contains a lot of vitamin B and trace elements (Bojtor *et al.* 2022). Behind rice and wheat, it is the most important cereal crop for reducing food shortages, poultry feed, and malnutrition. Maize surpasses rice in terms of protein, carotene, and oil content. It should be noted that, despite the low protein quality of rice, Bangladesh uses rice to meet more than 80% of its protein needs. It is unquestionable that if rice is substantially substituted in the diet with maize, protein intake will rise. Because of its lower price and greater productivity than rice and wheat, maize is very popular. Therefore, it is crucial to place a strong emphasis on raising maize output. Today, due to global warming, there is flow loss and the formation of islands. Floods were more frequent in the riverine area. Flood-borne silt nourishes the soil with fertility. Floods and rising river waters inundate Bangladesh's low-lying territory every year. Most of the charred areas are flooded every year and accumulate huge amounts of silt. Consequently, this silt makes these areas suitable for cultivating some specific crops. People have little opportunity to survive on those lands. Lands in these areas remain waterlogged from June to October almost every year. After that period, this land remains fallow, and nothing is grown with the exception of natural grasses. This soil is perhaps suitable for the production of maize. The recommendations made for the area will be equally applicable for the Char areas of Bangladesh as a whole. In this way, the livelihood of a large number of Char people could be improved. In this study, an attempt has been made to find out the profitability of maize production in Silted lands. Therefore, this study is facilitated to provide valuable information and may be useful for formulating appropriate policies for widespread cultivation of maize in Bangladeshi Char areas, which could be a lifeline for the Char people. That's why it needs to be knownthe comparative profitability of maize production under non-silted and silted conditions; and factors affecting profitability of maize production in Bangladesh.

Materials and Methods

In order to achieve the objectives, a survey was conducted namely Gaibandha Sadar, Sundarganj, Saghata, and Fulchori Upazila of Gaibnadha district in the period of 2021-2022. These areas are suitable for maize production. The non-silted area had some identical physical characteristics, like topography, soil, and climatic conditions for producing maize; Easy accessibility to the area rather than other silted lands; the farmers were cooperative so that reliable data could be obtained. Therefore, 60 farmers, comprising 30 from char areas and 30 from non-char areas, were chosen randomly for this study. The maize-cultivating farmers were divided into two categories on the basis of siltation. These two categories of respondents are given below: The data were collected through direct interviews conducted during personal visits to the houses of the selected farmers. In order to achieve the objectives of the study and get a meaningful result, collected data were analyzed using the following techniques:

Descriptive statistics: The descriptive statistics technique was used to calculate the sum, average, and percentage of gross return, gross cost, gross margins, net returns, and profitability of maize growers. This technique was also used to describe the socioeconomic condition of the maize growers.

Method of computation of gross return: Gross return was calculated by multiplying the total volume of production of a product by the average price of that product during the harvesting period. The following algebraic equation was used to calculate the gross return:

$$GR= \sum_{i=1}^{n} Q_m P_m + Q_b.P_b$$

Where, GR = gross return of the maize (Tk. /ha); Q_m= quantity of the main product (kg/ha); P_m= per unit price of the main product (Tk. /kg); Q_b= quantity of by-product (kg/ha); and; P_b= per unit price of by-product (kg/ha).

Method of computation of gross margin: In calculating gross margin, total variable costs are deducted from total return. The algebraic equation for calculating gross margin is follows:

$$\prod_m = \sum_{i=1}^{n} Q_m P_m - \sum_{i=1}^{n} (p_{xi} X_i)$$

Where, $\prod_m$ = Gross margin of maize (Tk. / ha); Q_m= Per ha quantity of maize (kg /ha); P_m= Per unit price of the product (Tk. /kg); P_{xi}=Per unit price of i_{th} variable (Tk. /kg); X_i= per ha quantity of i_{th} variable (kg/ha)

Benefit cost ratio (BCR): The BCR is a relative measure that is used to compare benefit per unit of cost. The BCR was estimated as a ratio of gross returns to gross costs. The formula for calculating BCR (undiscounted) is shown below:

$$BCR=\frac{Gross\ benefit}{Gross\ cost}$$

Cobb-Douglas Production Function Model: A Cobb-Douglas production function model was used to estimate the contribution of key inputs to the production processes of maize (Dillion and Hardaker, 1993), (Haque, 1999). This is a conventional model where the level of production depends on the level of input use. The specification of the Cobb-Douglas production function was as follows:

$$Y_i = a\, X_1^{b1}\, X_2^{b2} X_3^{b3} X_4^{b4}\, X_5^{b5}\, X_6^{b6} X_7^{b7} e^{ui}$$

In the linear form it can be written as follows:

$$LnY_i = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + ui$$

Where, ln = Natural logarithm; Y_i = Gross return (Tk./ha); X_1= Seed cost ; X_2= Human labor cost (Tk./ha); X_3= Power tiller cost (Tk. / ha); $X_{4=}$ Fertilizer cost (Tk./ha), X_5= Irrigation cost (Tk. / ha); X_6=Cow dung cost (Tk. / ha); X_7= Insecticide cost (Tk. / ha); a=Constant or intercept term; b_1, b_2, b_3, b_4, b_5, b_6, b_7= production coefficient of the respective input variable to be estimated; and u_i =error term.

Results and Discussion

Profitability is one of the major criteria for determination of acceptance of a crop production. The production cost, gross return, gross margin, benefit cost ratio, etc. for maize cultivation at silted and non-silted areas are discussed below:

Cost of production: For calculation of cost of production both variable and fixed cost are included. The costs which vary with the level of production is called variable cost. The variable cost includes such as seed, human labor, power tiller, fertilizer, irrigation, etc. These costs are considered variable costs for maize and presented in Table 1.

Table 1. Level of inputs per hector of Maize cultivation in Gaibandha District

Particulars	Area	
	Non-silted	Silted
Human Labor (man-days)	105	102
Family labor (man-days)	13	25
Hired labor (man-days)	92	77
Seed (kg)	25.7	26.2
Cow dung (Kg)	2500	0
Urea (kg)	652	548
TSP (kg)	379	360
Mop (kg)	312	287
Gypsum (kg)	93	89
Zinc (kg)	9.7	8.16
Pesticide (L)	28	30

Source: Field survey, 2022

Different inputs were utilized by farmers to grow maize in the research locations (Table 1).The study revealed that the farmers of the non-silted area used human labor for 105 man-days (where 13 man-days came from family labor and 92 man-days came from hired labor) and 102 man-days (where 25 man-days came from family labor and 77 man-days came from hired labor) in the farmers of the silted area. Besides, Non-silted area farmers used 25.7 kg of seed, while silted area farmers used 26.2 kg per hectare. Moreover, the non-silted farmers used it as cow dung (2500 kg), urea (652 kg), TSP (379 kg), and mop (312 kg). Gypsum 93 kg, and Zinc 9.7 kg while the Silted area farmers used no cow dung, Urea (548 kg), TSP (360 kg), Mop (287 kg), Gypsum (89 kg), and Zinc (8.16 kg) per hectare are required for the cultivation of maize. In the study area found that the total variable cost of the silted and non- silted maize cultivation farmers were Tk.98088.53 and Tk. 106371.1 respectively. The total fixed cost which was included the land rental cost and interest on operating capital were Tk.21834.81and Tk.22659.52 for silted and non-silted farmers for maize cultivation in the study areas. The gross cost was calculated by adding all the costs of variable inputs and fixed inputs. On the basis of gross cost per hectare, production costs of maize in non-silted and silted areas were estimated at Tk. 129030.62 and Tk. 119923.34, respectively, per hectare. The gross cost of non-silted areas was higher than that of silted areas in the study area.

Returns of maize production: Per-hectare gross returns were calculated by multiplying the total amount of product and by-product with their respective farm gate prices. The per-hectare yields of maize in non-silted and silted areas were found 10126 kg and 13008 kg, respectively in the study area. Table 2 showed that in the study area, per-hectare gross returns of maize in silted areas were higher. In terms of monetary units, the value of maize produced in non-silted and silted areas per hectare was Tk. 265616 and Tk. 318696, respectively. It is known that gross margin is the difference between total return and total variable cost. The per-hectare gross margin of the enterprise was obtained by deducting total variable cost from total return. The per-hectare gross margins of non-silted and silted area were estimated at Tk. 159245 and Tk. 220607.47, respectively (Table 2). So, it was impressive from the results that the gross margin of silted area was greater than that of non-silted area. Gross margin can be increased if total returns increase.

The total returns of the silted area are higher than those of the non-silted area.Net return is a useful tool to evaluate the business profitability. It was calculated by deducting the total cost from the total return. The net return from non-silted and silted areas was Tk. 136585.38 and Tk. 198772.66, respectively (Table 2). Net returns from non-silted was very lower than silted area, because cost of production of both areas almost same but per hectare yield from silted area was higher than the non-silted area. So, the per-hectare profitability of silted areas was higher than that of non-silted areas.

Table 2. Per hectare production costs and returns of maize

Items	Value (Tk./ha) for non-silted area	Value (Tk./ha) for silted area
A. Variable cost		
Human labor	31653.1	30733.82
Power tiller	11401.33	11112.64
Irrigation	8335.42	7449.4
Seed	12893.7	13123.67
Urea	10932	9568.94
TSP	9675.33	9055.22
Mop	4992.56	4596.69
Gypsum	1132.05	1068.1
Zinc	1455	1224
Cow dung	3856.23	0
Pesticide	7241.5	7692.7
Miscellaneous cost	2802.88	2463.35
Total variable cost	106371.1	98088.53
B. Fixed cost		
Land rental cost	20,720	20,200
Interest on operating capital cost	1939.52	1634.81
Total fixed cost	22659.52	21834.81
C. Gross cost (A + B)	129030.62	119923.34
D. Gross return	265616	318696
E. Gross margin (D-A)	159245	220607.47
F. Net return (D-C)	136585.38	198772.66
G. Benefit Cost Ratio (D/C) (undiscounted)	2.06	2.66

Source: Field survey, 2022

Benefit cost ratio (BCR) analysis: The benefit cost ratio (BCR) was calculated by dividing gross return by gross cost. It is a measure of the efficiency of resource use. Table 2 shows that the BCR (undiscounted) of non-silted and silted area emerged as 2.06 and 2.66, respectively, implying that Tk. 2.06 and Tk. 2.66 would be earned by investing every Tk. 1.00 in non-silted and silted area by cultivating maize. Table 2 also reveals that BCR 2.66 of silted area production was higher compared to that of non-silted area production, indicating that investment in silted area would be more profitable.

Comparative profitability of maize production: It was found that the per-hectare yield from silted areas was higher than that from non-silted areas. The per-hectare gross cost and gross return in non-silted and silted areas mentioned above are depicted in Table 2. It can be seen from table 2 that per hectare gross cost of non-silted area was higher than that of silted area. Both the gross return and net return of silted area were Tk. 318696 and Tk. 198772.66, respectively, exceeding those of non-silted area, Tk. 265616 and Tk. 159245, respectively. Thus, Benefit cost ratio (BCR) was higher in silted area than that of non-silted. From the above discussion, it was clear that production in silted areas was more profitable than production in non-silted areas.

Production function analysis: A Cobb-Douglas production function model has been chosen to determine the effects of selected inputs on maize production. The production of maize was assumed to be influenced by nine cost items and other factors. The Cobb Douglas production function is used to analyze the data available. The Cobb-Douglas production function has the following characteristics: Seven explanatory variables were taken into consideration for the production function analysis of the farmers' efficiency in maize production. The independent impacts of each of the variables on the gross return for producing maize by each category of farmer are interpreted below: It can be seen from Table 3 that the regression coefficients for seed cost were positive and significant at the 5 percent level for all farmers. The coefficients indicate that an increase in one percent of seed cost, remaining other factors constant, would result in an increase in the gross return of 0.26 percent for farmers.

Table 3. Estimated values of coefficients and related statistics of Cobb-Douglas production function model for maize production for all farmers

Explanatory variables	Values of coefficient	Standard value	t-value
Intercept/constant	7.59	1.31	5.8
Seed cost(X_1)	.26**	.12	2.06
Human labor cost(X_2)	.12**	.05	2.36
Power tiller Cost(X_3)	-.001	.04	-.02
Fertilizer cost(X_4)	.05	.07	.67
Irrigation cost(X_5)	.02	.05	.27
Cow-dung cost(X_6)	.11***	0.03	3.42
Pesticide cost(X_7)	-.03**	.01	-2.17
Dummy(Siltation=1, non-siltation=0)	1.16**	.27	4.30
F-value	40.70	-	-
R2	.84	-	-
Return to scale ($\sum bi$)	1.68	-	-

Note: *** = Significant at 1% level** = Significant at 5% level,* = Significant at 10% level
Source: Author's estimation, 2022

The coefficients of human labor cost of 0.12 indicate that there was a significant relationship between human labor cost and gross return from maize production for farmers. It indicates that a one percent increase in human labor cost, remaining the other factors constant, would result in an increase in the gross return of 0.12% for farmers. So the use of additional human labor is appreciable. The relationship between power tiller cost and gross return was statistically insignificant, but there is a negative relationship between power tiller cost and gross return. The coefficients of fertilizer cost indicate that there is no significant relationship between fertilizer cost and the gross return from maize production for farmers. The coefficients of fertilizer and irrigation cost are not statistically significant, although they have a positive relationship. The magnitudes of the coefficients of cow dung cost for maize production were positive and significant. It indicates that, holding other factors constant, a one percent increase in the cost of cow dung would increase the gross return by 0.11 percent for the maize farmers in the study area. The regression coefficient of pesticide cost for maize production was negative and significant for the farmer at the one percent level of significance, and the coefficient was -0.03. It indicates that, holding other factors constant, a one percent increase in the cost of pesticide would decrease the gross return by 0.03 percent for farmers. The regressionco-efficient of silted conditions for maize production is positive and significant at the 5% level of significance. The coefficient of siltation of 1.16 indicates that a 1% change from non-silted to silted conditions will increase the production of maize by 1.16%. That means silted conditions will increase the production of maize. The coefficients of multiple determinations R^2 of the model were 0.84 for farmers in maize production, indicating that about 84% of variations in gross return from maize production have been explained by the explanatory variables, which were included in the model. The sum of all the regression coefficients or production elasticity's in the estimated model gives information about the returns to scale, that is, the output in response to a proportionate change in all inputs. The sum of all the production coefficients in the equations for maize production was 1.68 (Table 3). These indicate that the production function exhibited increasing returns to scale for the selected farming. Shifting from a non-silted to a silted condition will increase the output significantly. It is evident from the Cobb-Douglas production function model that the key variables included in the model were individually or jointly responsible for variation in the gross returns of maize production.

Conclusion and policy recommendations

The farmers in silted area earned the highest profit from maize production compared to non-silted area farmers. Almost all farmers had no clear idea about the application of inputs at the right time and in the right doses. So, it is necessary to make the farmers aware of the efficient use of resources as follows.

- Improved or hybrid maize production technologies should be available to the farmers through training provided by government and non-government organizations.
- Maize based cropping pattern should be given priority for those areas where maize production is suitable, more particularly in the char lands of Bangladesh

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