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EFFICIENCY OF CAULIFLOWER CULTIVATION IN A SELECTED AREA OF BANGLADESH

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ABSTRACT
Cauliflower, a pivotal winter crop, is cultivated widely in Bangladesh. This study was conducted to assess the socioeconomic characteristics and to explore the farmers' efficiency of cauliflower production in Gazipur district of Bangladesh by applying the stochastic production frontier approach. Primary data were collected through a field survey of 60 cauliflower farmers from January to March 2023, using a semi-structured interview schedule. The major findings of this study revealed that 95% of the respondents were aged between 30 and 64 years; 48.33% of households had a small family size; and 86.67% of the respondents' primary occupation was agriculture. Cauliflower production was profitable. Per hectare total cost, total return, gross margin, net return, and benefit-cost ratio (BCR) were Tk. 286112, 386250, 138218, 100138, and 1.35, respectively. The mean farmer's technical efficiency was 90%, which implies that the household cultivating the cauliflower can increase revenue by 10% at a given level of resources. Cauliflower farmers complained of a lack of quality seed, the high price of quality seed, natural calamities, and attacks of pests and diseases. Cauliflower is one of the important vegetable crops grown by farmers, mainly to generate household income. The study area has tremendous potential for cauliflower production.
Keywords: *Inefficiency, Profitability Cauliflower Cultivation, Bangladesh*

INTRODUCTION

One of the main drivers of Bangladesh's economy is agriculture, which has made a significant contribution to the country's achievement of macroeconomic goals such as industrialization, labor force employment, a decline in the rate of hunger, and the eradication of poverty. For instance, in Bangladesh, agricultural production accounts for 42.62 percent of all employment and 11.61 percent of GDP (BBS, 2022). The total land area of Bangladesh is 56,977 square miles, or 14.3 million hectares, of which 59.86% is suitable for agricultural use (BBS, 2018). Bangladesh's soil is exceptionally fertile, making it simple to cultivate a wide variety of crops. All around the nation, major crops like rice, potatoes, wheat, sugarcane, jute, oilseed, tea, and a variety of fruits and vegetables are farmed.

Chinese and Indian farmers produced the majority of the world's 25.2 million tons of cauliflower and broccoli, accounting for 73 percent of the total global production. (FAOSTAT, 2016). Among vegetables, cauliflower (Brassica oleracea var. botrytis) is one of the most well-liked vegetables in Bangladesh which is primarily grown in the winter season. The majority of the country's cauliflower is grown in the area near Dhaka, Jessore, Rajshahi, Rangpur, Tangail, and Kustia, where it thrives in a climate with cool daytime temperatures of 21 to 29 °C, ample sunlight, moist soil conditions high in organic matter, and sandy soils. In Bangladesh, the production of vegetables, particularly cauliflower, is rising daily. For instance, whereas the output of cauliflower climbed by 63.09 percent during the same time period, the production of all vegetables increased by 22.73 percent, from 10.52 million metric tons in 2010–11 to 12.912 million metric tons in 2017–18. The annual production of vegetables was 12.912 million metric tons, of which 0.274 million metric tons were cauliflower (BBS, 2019). Cauliflower production thus accounts for a notable portion of Bangladesh's overall vegetable production. More than 40 nations around the world receive fresh horticultural crops from Bangladesh, which are exported in about 100 different varieties. Fresh fruit and vegetable export revenues climbed dramatically from $ 51 million in FY2008-09 to $ 125 million in FY2015-16 (Hortex, 2020). Therefore, through production diversification and market growth, the government of Bangladesh is promoting the production and export of high-value agro-commodities, particularly horticulture crops. The government of Bangladesh has prioritized to increase the production of cauliflower by giving subsidies to the farmers on various inputs such as seeds, fertilizer, irrigation, etc. to achieve self-sufficiency in cauliflower production because of its demand both in the domestic and international markets. The introduction of enhanced variety seed, hybrid seed, chemical fertilizers, insecticides, and simpler irrigation facilities has resulted in a significant increase in agricultural production.

Since the total cultivable area is declining daily as a result of the increased use of land for non-agricultural activities, the targeted cauliflower production cannot be achieved by increasing the area under cultivation. By improving the technical effectiveness by utilizing current technologies production can be increased. Using the current inputs and available technology, production can be significantly boosted if farmers are determined to be technologically efficient. Another factor contributing to a drop in agricultural output could be ineffective use of currently available technology. There is a large potential to increase agricultural output or profitability by increasing productive (technical and allocative) efficiency utilizing currently available resources, according to a number of studies conducted in various nations.

Although the amount of cauliflower produced has substantially grown, the productivity is still poor because conventional farming methods are still used, as well as a lack of new and high yield variety (HYV). For instance, the production of cauliflower in India is 40 metric tons/ha, compared to Bangladesh's 11.41 metric tons/ha (Reddy, 2019). On the technological effectiveness of cauliflower and vegetable production in Bangladesh and overseas, few empirical investigations have been done. Mitra and Yunus (2018) examined the factors of inefficiency and technical efficiency among the households growing tomatoes in Bangladesh. Hoque et al. (2019) calculated the technical efficiency and sources of inefficiency of the production of bottle gourd and brinjal. These researches revealed that seed, labor, fertilizer and irrigation all had an impact on the technical effectiveness of vegetable production, were not all the same. Inefficiency was also significantly affected by socioeconomic factors as age, education, farm holding size, seedling type, and training service. Additionally, these studies showed that there may be notable efficiency differences among all farm groups and between farm regions. In the short term, it should be possible to improve the performance of the less efficient farms or regions without a significant amount of outside investment. On the other hand, there isn't a single study that evaluates the technological effectiveness of cauliflower production in Bangladesh. Given emphasis on this issue, the aim of this study is to determine the factors that affect cauliflower production as well as to assess its technical efficiency. Finally, the research will identify the causes of inefficiency in cauliflower cultivation.

MATERIALS AND METHODS

A sample of 60 cauliflower farmers were selected randomly from Pubail, Harbaid, and Dirrasrom areas under Gazipur sadar upazila of Gazipur district because the land type and soil type of this area are very fruitful for cauliflower production, and thus many farmers are involved with cultivating cauliflower with other vegetables. Primary data were collected through a field survey using a semi-structured interview schedule in the time period of January to March 2023. Focus group discussions (FGDs) and observation techniques were also used to collect relevant information.

PROFITABILITY ANALYSIS

To determine the profitability of cauliflower farmers, all cost and return item needs to be included. The profit can be calculated using the following formula:

$\Pi = TR - TC$

Where, Π = Profit

TR = Total return

TC = Total cost

TC is the sum of the total cost, whereas the total return can be calculated by multiplying the price by the quantity of output.

$TR = P \times Q$

Where, P = the price of output in Tk.

Q = Quantity of output (kg)

Gross Margin Analysis

The result of cauliflower can be compared with other crops on the basis of gross margin. Gross margin is the difference between total revenue (TR) and total variable costs (TVC). The formula for calculating gross margin is

$GM = TR - TVC$

Where, GM = Gross margin

TR = Total return
TVC = Total variable cost

Net Return Analysis

Net Return is actually the difference between total return (TR) and total cost (TC). The total cost included all costs related to cauliflower production. The equation is as follows:
Net return = total return – total cost of production.

Technical Efficiency Analysis

The estimated result from the model requires technical efficiency analysis. Technical efficiency (TE) analysis using the proper functional form (Cobb-Douglas or Translog) is required to estimate the modeled yield. A stochastic frontier production function (SFP) was used in this instance.

Farrell (1957) was the inventor of the cutting-edge efficiency metric, which reflects actual farm performance and may take into account all pertinent production parameters. Several methods for analyzing efficiency and productivity were developed as a result of Farrell's essay on efficiency measurement. The two main techniques for assessing agricultural efficiency are stochastic frontier analysis (SFA) and data envelopment analysis (DEA). The stochastic frontier is thought to be more significant in developing countries where data are more likely to be severely influenced by measurement mistakes and the impacts of weather, infections, etc.~~,~~ as mentioned by Coelli et al. (1998). Thus, following Aigner *et al*. (1977) and Meeusen and Van den Broeck (1977), the stochastic frontier production with two error terms can be modeled as:

$Y_i=f(X_i,\beta)exp(V_i-U_i)$… (1)

Where, Yj is the production of the i-th farm (i=l. 2, 3 ...n); X_i is a (l×k) vector of functions of input quantities applied by the i-th farm.; P is a (k×l) vector of unknown parameters to be estimated; V_i's are random variables assumed to be independently and identically distributed *(N (0, δ^2))* and independent of U_i*'s* and the U_i*'s* are non-negative random variables, associated with technical inefficiency in production assumed to be independently and identically distributed. The first error component V is intended to capture the effects of random shocks outside the farmer's control, measurement error, and other statistical noise, and the second error component U is intended to capture the effects of technical inefficiency.

Following Battese and Coelli (1993), the technical inefficiency effects, U_i can be expressed as:

$U_i=Z_i\delta+W_i$… (2)

Where *Wi,* are random variables, defined by the normal distribution with zero mean and variance σ^2, u~~,~~. *Zi* is a vector of farm specific variables associated with technical inefficiency, and δ is a (mxl) vector of unknown parameters to be estimated.

After estimating this model, the potential yield was estimated from the model. The technical efficiency (TE) shows the farms' ability to maximize output with a set of given inputs. The range of TE is 0 to 1. TE = 1 implies that the farm is producing on its production frontier and is said to be technically efficient.

Hence, (1–TE) represents the gap between actual production and optimum attainable production that can be achieved by moving the firm towards the frontier through readjusting inputs (Chaves and Aliber 1993).

Empirical Cobb-Douglas Frontier Production Model

Two types of functions, namely Cobb-Douglas and Translog, dominate the technical efficiency literature. The stochastic production functions for the sample cauliflower farmers were specified as:

$\ln Y = \ln\alpha + b_1\ln X_1 + b_2\ln X_2 + b_3\ln X_3 + b_4\ln X_4 + b_5\ln X_5 + b_6\ln X_6 + b_7\ln X_7 + V_i - U_i$… (3)

Where, Y = yield of cauliflower (kg/ha/season)
α = parameters
b = coefficients
X_1= seed (pc/ha)
X_2 = urea (kg/ha)
X_3 = tsp (kg/ha)
X_4 = mp (kg/ha)
X_5= irrigation (tk/ha)
X_6 = labor (man-days/ha)
i = 1, 2, 3, 4……….
$V_i – U_i$ = disturbance term

Technical Inefficiency Effect Model

The technical inefficiency effect in equation were defined as,

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + W_i \ldots \quad (4)$$

Where, U_i = inefficiency

δ_0 = parameter

Z_1 = age

Z_2 = education of farmers

Z_3 = family size

Z_4 = experience

RESULTS AND DISCUSSION

Age distribution

The study provides an illustration of the cauliflower farmers' age distribution at the time of the study. According to the Bangladesh Bureau of Statistics' working age classification, the study's sample farmers' age groups are divided into three categories (BBS, 2015). These age ranges are: 15 to 29 years of age; 30 to 64 years of age; and 65 years of age and older. Table 1 categorizes cauliflower farmers by age. It demonstrates that 95% of the farmers who were chosen belonged to the age range of 30 to 64. Approximately 0% of farmers were between the ages of 15 and 29, and 5% were above the age of 65.

Table 1: Age distribution of the sample farmers

Age group of the respondents (years)	Number of the respondents	Percentage (%)
15 – 29	0	0
30 – 64	57	95.00
65 and above	3	5
Total	60	100

Source: Field Survey, 2023

Educational Status of Respondents

Education enables a worker to accurately apply information and comprehended manufacturing requirements. Farmers who have received education are also better able to manage their income for household expenses such as food, housing, and other costs. According to the Bangladesh Bureau of Statistics, the respondents' educational status was divided into three levels (BBS, 2015). These are the primary (grades 1 through 8), secondary (grades 9 through 10), and higher secondary levels (above grade 11).

Table 2 shows the level of education held by cauliflower growers in the research area. According to the findings, 13.33% of farmers did not get an institutional education. The highest percentage of farmers among the remainder, 46.67%, completed primary school. Just about 28.33% of farmers.

Table 2: Educational status of the respondents

Education level	Number of the respondents	Percentage (%)
Illiterate	8	13.33
Primary	28	46.67
Secondary	17	28.33
Higher secondary and above	7	11.67
Total	60	100

Source: Field Survey, 2023

Occupational Status of Selected Cauliflower Farmers

One of the most significant socioeconomic traits is occupation. Farmers have been seen to engage in a variety of occupations, including farming, service, business, driving, day labor, etc. The study divides the job of farmer into two categories: the main occupation and the subsidiary occupation.

The occupational status of the farm households is shown in Table 3. According to the data, agricultural production accounted for roughly 63.33% of farmers' primary employment, and 13.33% of respondents viewed it as their primary source of income.

Table 3: Occupational status of the respondents

Occupation (Main)	Number of the respondents	Percentage (%)	Occupation (Subsidiary)	Number of the respondents	Percentage (%)
Agriculture	38	63.33	Agriculture	8	13.33
Service	4	6.67	Service	2	3.33
Business	14	23.33	Business	3	5.00
Others	4	6.67	Others	4	6.67
			No Subsidiary	43	71.67
Total	60	100	Total	60	100

Source: Field Survey, 2023

Family Size and Dependency Ratio

Families are made up of individuals of all sexes who live together or eat in the same kitchen under the direction of a single person. A family may consist of a, wife, a husband, unmarried sons and daughters, parents, siblings, and other permanently residing family members. 4.53 people make up the average family in Bangladesh (HIES, 2010). Average family size was 4.78 (Table 4).

Table 4: Family size and dependency ratio of the sample households

Family size	Number of the households	Total members	Average family size	Number of earning members	Dependency ratio
Small family (up to 4)	29	108	3.72	31	3.48
Medium family (5 to 6)	26	137	5.27	29	4.72
Large family (above 6)	5	44	8.8	7	6.29
Total	60	287	4.78	67	4.28

Source: Field Survey, 2023

Farm Size of Farmers

Optimal resource usage and productivity may be influenced by farm size and tenure arrangements. According to Yang (1965), the size of a farm is determined by the total amount of land that it uses. It comprised the homestead area as well as the land utilized for farming, pasture, and woods. The total cultivated area of the farmers is used in this study to determine the size of the farms.

In reality, various sizes and structural configurations of farms were discovered in the research region. The farm was divided into three sizes for a better understanding of the distribution of farm sizes: landless, marginal, small, medium, and big farmers. Landless farmers were those who farmed on less than 0.2 ha of land, marginal farmers farmed on 0.21 to 0.50 ha of land, and small farmers farmed on less than 0.01 ha of land.

Table 5: Distribution of the households according to land holding

Farm Category	Land holding (ha)	Number of the households	Average land area (ha)	Percentage (%) of the households
Landless	<.20	14	0.111	23.33
Marginal	.21-.50	28	0.3467	46.67
Small	.51-1.0	13	0.719	21.67
Medium	1.01-2.00	5	1.4085	8.33
Large	>2.00	0	0	0

Source: BBS, 2022; Field Survey, 2023

Land Distribution of the Selected Farmers

A study of the size of the farmer's land cannot be understated because it is a crucial component of production and has a substantial impact on the farmer's revenue. The total amount of all the different types of land the sample farmers owned and had legal rights to was referred to as their land holding. The land distribution of farmers is calculated on an average basis in the current research study.

According to Table 6, farmers in the research region cultivated cauliflower on an average of 0.16 hectares (ha), or 34.6% of the total amount of land used. In the research region, 0.30 acres on average were used for homesteading, other vegetable gardening, rice farming, and ponds.

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Table 6: Land distribution of the households

Land holding	Total land size (ha)	Average land size (ha)	Percentage (%)
Cauliflower cultivated area	9.57	0.16	34.6
Other crops area	18.08	0.30	65.4
Total area	27.65	0.46	100

Source: Field Survey, 2023

Income and Per Person Income Distribution of Farmers

Farmers' expenses are influenced by their revenue. They modified their expenses in accordance with their revenue. The farmers in the study area used their money to pay for things like food, clothing, children's education, medical, and production inputs. They also leased or mortgaged property and used solar power or other forms of energy to generate electricity. Their primary sources of revenue included the cultivation of cauliflower, rice, chickens, fish, shrimp, trees, and vegetables, as well as remittances, services, enterprises, and land leasing, among other things. The average yearly income and income per person for cauliflower farmers are shown in Table 7. The data made it obvious that the average annual income per home in small family groupings (below 4) was Tk. 223965.52, and the average annual income per person was Tk. 60138.89. At

Table 7: Annual household income and income per person according to the family size

Family size	Number of households	Average income (Tk.)	Number of earning members	Average income/person (Tk.)
Small family(up to 4)	29	223965.52	31	60138.89
Medium family (5 to 6)	26	211192.31	29	40674.07
Large family (above 6)	5	262000	7	29772.73
Total	60	221600	67	46327.53

Source: Field Survey, 2023

Cost and Return of Cauliflower Production

In production, cost plays an important role in the producer's choice-making and continued farming. The costs related to the production of cauliflower are of two types: variable costs and fixed costs. The following subsections illustrate the per-hectare costs of producing cauliflower: There is no doubt that seed is one of the primary and basic items for cauliflower production. All farmers used purchased seed in their fields in the study area. Farmers actually purchased cauliflower seed on a per-piece basis. In the study area, farmers used an average 1.5 kg seed per hectare. The average price of cauliflower seed was Tk. 25000/kg and the average cost was Tk. 37500/ha. Fertilizer is generally used in agricultural land to improve and increase the soil fertility for increased productivity. In this regard, all the farmers in the study area use fertilizers to get higher production. Farmers generally use urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, and boron in the cauliflower-cultivating land. Additionally, farmers frequently use other fertilizers like DAP, zinc, cow dung, etc. The cost of fertilizer incurred at the price that existed in the market was paid by the farmers during the cultivating season.

The average price per kg was Tk. 30 for urea, Tk. 30 for TSP, Tk. 30 for MoP, Tk. 70 for gypsum and Tk. 500 for boron. The average amounts of urea, TSP, MoP, gypsum, and boron used for cauliflower production in the area were 275 kg, 180 kg, 230 kg, 88 kg, and 5 kg per hectare, respectively. On average, the per-hectare costs of urea, TSP, MoP, gypsum, and boron were Tk 8250, Tk 5400, Tk 6900, Tk 6160, and Tk 2500, respectively (Table 8). The average cost of other fertilizers used in the study area is Tk. 1501. Manure is useful for increasing organic matter in the soil to eventually boost vegetable yields. Albeit cauliflower farmers used manure as a fertilizer, most of them rely on other inorganic fertilizers. Not many but some farmers used manure; thus, the average cost of manure used in cauliflower production is Tk. 11,440. In the study area, a power tiller was used instead of animal labor because it is a modern technology with more efficiency and time-saving attributes. A power tiller was used for land preparation. Farmers don't own their own power tillers; therefore, they hire this equipment for land preparation. The average power tiller cost was Tk. 7080/ha (Table 8).

Irrigation is the leading input for vegetable production. The cost for cauliflower growers for irrigation was lower than for other vegetables. The cost of irrigation water was charged at a fixed rate per unit of area. The average irrigation cost for cauliflower production was Tk. 21280/ha in the study area. Marketing cost is one of the major variables for all sorts of vegetables like cauliflower. Actually, marketing costs relate to loading, unloading, and transportation. Transportation costs varied with the distance of the cauliflower field from the local market. In the study area, the average per-hectare cost of marketing was Tk. 23971 Human labor is one of the largest and most important inputs used in the production process of cauliflower. Normally, there were two categories of human labor. i) Hired labor: where the farmer (land owner) hires some laborers to work in his field in exchange for an amount of money ii) Family labor: where the farmer (land owner) himself and his family members work in the cauliflower field. In the study area, both hired and family labour were used mainly for sowing seed and harvesting cauliflower from the field, though many farmers used hired labour for all operations. Total human labour was 207 man-days, and the average wage rate was Tk. 500. So, the total human labour cost was Tk. 103500. Cost of cauliflower production was divided into two types: variable cost and fixed cost. Variable cost consists of the cost incurred for all types of variable inputs. In the study area, the variable inputs for cauliflower production were hired human labor, seed, fertilizer, a power tiller, insecticides, vitamins, marketing costs, etc. The per-hectare average cost of variable inputs in the study area was calculated at Tk. 248032/ha (Table 8).

Fixed cost is the sum of the costs of all fixed inputs that are used in cauliflower production. While calculating the land use cost, only the cost for six months of land use was considered because the farmers grow other crops and vegetables on the land during the other half of the year. The average fixed cost was Tk. 25678/ha. It may be noted that the interest on operating capital was calculated by taking into account all the operating costs incurred during the cauliflower production period. Interest on operating capital for cauliflower production was estimated at Tk. 12402 per hectare. Total fixed cost was Tk. 38080. The total cost of production was calculated by adding all types of costs for variable and fixed inputs. The average cost of production for the cauliflower production per hectare was Tk. 286112 (Table 8).

The total return is calculated by multiplying the per hectare (ha) yield by the price of cauliflower that existed in the market. In the study area during the survey period, the price of one kg of cauliflower was Tk. 15. The average per-hectare yield was found to be 25750 kg. The average total return calculated in the study area was Tk. 386250/ha (Table 8).

Table 8: Per hectare/season average cost and return of cauliflower production

Particulars	**Quantity//ha**	**Price per unit (Tk./Unit)**	**Cost/Returns (Tk./ha)**
A. Total Cost of Production			
B. Variable Cost			
Seed	1.5 kg	25000	37500
Urea	275 kg	30	8250
TSP	180 kg	30	5400
MoP	230 kg	30	6900
Gypsum	88 kg	70	6160
Boron	5 kg	500	2500
Manure	-	-	11440
Other Fertilizer			1501
Vitamin	-		3782
Insecticides	-	-	8768
Irrigation			21280
Power tiller	-	-	7080
Hired and family labour	207 man-days	500	103500
Marketing cost			23971
Total variable cost			248032

C. Fixed Cost			
Land use costs			25678
Interest on operating capital (10% of total variable cost for 6 months)			12402
Total fixed cost			38080
Total Cost of Production (B+C)			286112
D. Total return	Kg.25750	Tk. 15	386250
a) Gross Margin (D-B)			138218
b) Net Return (D-A)			100138
c) Undiscounted BCR (D÷A)			1.35

Source: Author's estimation, 2023

Gross margin is the difference between the total return and total variable cost. In the study area, per hectare (ha), the average gross margin was calculated as Tk. 138218 (Table 8).The net return was calculated by subtracting the total cost of production from the total return from production. Net return = total return – total cost of production.

The following table indicates that the per-hectare average net return for cauliflower production in the study area was Tk. 100138 (Table 8). An undiscounted benefit-cost ratio (BCR) is a relative measure used to make comparisons about the benefit per unit of cost. The benefit-cost ratio for the cauliflower production was calculated as the ratio of total return to total cost.

Benefit-cost ratio = total return / total cost of production. In the study area, the undiscounted average benefit-cost ratio for cauliflower was found to be 1.35 (Table 8).

Technical Efficiency Analysis

Technical efficiency refers to the ability of a farm to produce the maximum possible output with a minimum quantity of inputs under a given technology. A technically efficient farm normally runs on its frontier production function. Given the relationship of inputs in a particular production function, the farm is technically efficient if it results in production on its outer bound production function to obtain the maximum possible produce, which is feasible under the current technology (Khan, 2003). This section represents the extent of the efficiency of production for transplanted cauliflower in the research area. Increases in efficiency are based on some socioeconomic and demographic variables. The accuracy of the identification of the impact of different variables depends on the functional form of the production technology (whether Cobb-Douglas or Translog), the nature of the random error component (whether stochastic or deterministic), the distribution of the inefficiency component (whether it is half normal, truncated normal, gamma, or beta), and the nature of the production function (whether primal or dual) (Rahman *et al*. 1999). In order to find the yield gap, the stochastic frontier analysis was done to measure technical efficiency, and then efficient yield was found. For that, both the production inputs and socio-economic characteristics were used in the analysis. The maximum likelihood estimates for parameters of the Cobb-Douglas stochastic production function and the technical inefficiency effect for cauliflower farmers are presented in the Table 9.

Interpretation of ML Estimates of the Stochastic Frontier Production Function

Maximum likelihood estimation begins with writing a mathematical expression known as the likelihood function of the sample data. The likelihood of a set of data is the probability of obtaining that particular set of data, given the chosen probability distribution model. This expression contains the unknown model parameters. The values of these parameters that maximize the sample likelihood are known as the Maximum Likelihood Estimates, or MLEs. The maximum likelihood estimates for parameters of the Cobb-Douglas stochastic frontier production function and technical inefficiency effect model for cauliflower production for all farmers are presented to Table 9.

Seed (X_1)

The regression coefficients of seed were 0.3316, which implied that, holding other factors constant, a 1 percent increase in the amount of seed would increase the yield of cauliflower by 0.3316 percent (Table 9).

Urea (X_2)

The regression coefficients of urea were 0.02596, which indicated that, other factors remaining the same, if the amount of urea was increased by 1 percent, and then the yield of cauliflower would be increased by 0.02596 percent (Table 9).

Triple Super Phosphate (TSP) (X_3)

The regression coefficients of TSP cost were found to be negative (not significant), which was 0.3267. The result of the analysis indicated that, keeping other factors constant, a 1 percent increase in additional expenditure on TSP would decrease the yield of cauliflower by 0.3267 percent.

Muriate of Potash (MoP) (X_4)

The regression coefficients of MoP were -0.0506 (not significant), which implied that, holding other factors constant, a 1 percent increase in the amount of MoP would decrease the yield of cauliflower by 0.0506 percent (Table 9).

Irrigation (X_5)

The regression coefficients for irrigation cost were found to be negative (not significant), which was 0.10255. The result of the analysis indicated that, keeping other factors constant, a 1 percent increase in additional expenditure on irrigation would increase the yield of cauliflower by 0.10255 percent (Table 9).

Labor (X_6)

The regression coefficients for labor were positive (Table 9). The regression coefficients for labor were 0.0418, which implied that, other factors remaining the same, if the amount of labor was increased by 1 percent, and then the yield of cauliflower would be increased by 0.0418 percent.

Table 9: Maximum Likelihood Estimates for Parameters of the Cobb-Douglas Stochastic Production Function and the Technical Inefficiency Effect for Cauliflower Farmers

Variables	Parameters	Coefficients	Standard Error	p>|z|
Intercept	b_o	3.5294	0.8051	0.000
Seed	b_1	0.33161*	0.1804	0.066
Urea	b_2	0.02596	0.1162	0.823
TSP	b_3	0.32666	0.2144	0.128
MoP	b_4	-0.05063	0.0915	0.580
Irrigation	b_5	0.10255	0.08707	0.239
Labor	b_6	0.0418	0.17537	0.811
Inefficiency Model				
Intercept	δ_0	-4.645652	13.18058	0.724
Age	δ_1	0.1306266	0.2271626	0.565
Education	δ_2	0.1476395	0.24733	0.551
Family size	δ_3	-1.171305	4.04488	0.772
Experiences	δ_4	-0.09308	0.889799	0.917
Mean efficiency	0.908386			
Log likelihood = -13.981237		Prob> chi2 = 0.0000		

** = Significant at* 10%

Source: Author's estimation, 2023

The maximum likelihood estimates for the stochastic frontier production model and the technical inefficiency effect model are shown in the above chart. In the stochastic frontier model, the labor and urea coefficients were statistically significant at the 10% and 5% values, respectively. This suggests that farmers in the study region were efficient with their use of labor and urea, which enabled them to increase the yield of cauliflower. The yield rises by 0.3316%, 0.0418%, 0.3316%, 3266%, and 0.1025%, respectively, with a 1% increase in seed, labor, urea, TSP, and irrigation cost, according to the coefficients of labor, TSP, and urea. The value of MoP, on the other hand, had no significance. Family size and experiences were not numerically significant in the technical inefficiency model. The farmers were producing cauliflower at a rate 9.17% less than frontier output, according to the mean efficiency of 90.83%. Without increasing production expenses, the yield per hectare can be raised by 9.17% on average.

Problems and constraints of cauliflower production

The focus of this chapter is to identify the extent of problems encountered by the cauliflower farmers. Farmers faced a lot of problems producing cauliflower. The problems were social, cultural, financial, and technical. The problems and constraints faced by the farmers were identified according to their opinions.

The major problems and constraints related to cauliflower production are discussed below:

About 28.33% of the cauliflower farmers complained that lack of quality seed was the problem in the selected area. Out of 28.33%, 6.67%, 10%, 5%, and 3.33% were reported as the first, second, third, and fourth problems, respectively (Table 10).

Table 10 reveals that 61.67% of the respondents claimed that attacks of pests and diseases were the major problem in cauliflower production. From this, 61.67%, 11.67%, 25%, 15%, and 10% were reported as the first, second, third, and fourth problems, respectively. Agricultural extension workers and the Upazila Agricultural Officer can help the farmers solve this problem.

The high price of fertilizers was the main problem for the respondents. As a result of high fertilizer costs, the cost of production increased and profitability decreased. Table 10 shows that the highest percentage (76.67%) of the respondents claimed that high fertilizer costs were their biggest problem. Out of 76.67%, 50%, 16.67%, 10%, and 0% were reported as the first, second, third, and fourth problems, respectively. The government should adopt appropriate policies to overcome this problem.

Damage caused by animals was another minor problem in the selected area. Only 8.33% of the respondents claimed high labor demand as the fourth problem (Table 10). Some kinds of birds and some animals are living on damaged cauliflower in the field. This problem was not so acute for the farmers. The high price of quality seed was another problem in the selected area. Table 10 reveals that 76.67% of the respondents claimed that the high price of quality seed was a problem for them. From this, 25%, 25%, 18.33%, and 8.33% complained as the first, second, third, and fourth problems, respectively.

Higher labor demand was another problem in the technology of cauliflower production. Here, higher labor demand means higher human labor demand. Especially in the harvesting period, more human labor was demanded in the selected area.

Table 10 shows, that 69.01% of the respondents claimed that higher human labor demand was another problem in the selected area. Out of this, 69.01%, 20%, and 23.33% were claimed as the third and fourth problems, respectively. This problem could be solved by exchanging their labor with other farmers. The general shortage of human labor was another major problem in cauliflower production. Table 10 reveals that 56.67% of the respondents complained that higher costs in general were a major problem. From this, 56.67%, 23.33%, 16.67%, 8.33%, and 8.33% were claimed as the first, second, third, and fourth problems, respectively.

During the harvesting season, the majority of farmers were forced to sell a sizable amount of their produce in order to fulfill a variety of responsibilities, including household expenses. Yet, due to a plentiful supply at harvest, the price of cauliflower remained low. As a result, farmers were unable to receive a fair price for their goods.

Table 10 shows that the majority of respondents (56.67%) stated the low price of output were their biggest issue. Out of 56.67%, the first, second, third, and fourth difficulties, respectively, were reported to be 33%, 16.67%, 6.67%, and 0%. To solve this issue, the government should implement the necessary policies.

Another significant issue in the manufacture of cauliflower was often higher expenses. Farmers require more operating money for this approach, particularly to purchase.

Table 10: Problems and constraints of cauliflower production as ranked by farmers (Percentages are in parentheses)

Problems/Constraints	Number of times problem was ranked				
	First	Second	Third	Fourth	Total (n = 60)
Lack of quality seed	04	06	05	02	17 (28.33)
Attack of pests and diseases	07	15	09	6	37 (61.67)
High price of quality seed	15	15	11	05	46 (76.67)
Natural calamities	03	11	21	03	38 (63.33)
Low price of output	20	10	04	00	34 (56.67)
Shortage of human labor	14	10	05	05	34 (56.67)
The high price of fertilizers	30	10	6	00	46 (76.67)
Damaged by animals	00	00	02	05	07 (11.67)
High costs in general	03	04	07	06	20 (33.33)
Higher labour demand	06	09	12	14	41 (69.01)

Source: Field Survey, 2023

The aforementioned conversations and the findings in Table 10 suggest that the study area's cauliflower farmers are now dealing with some significant issues with how they are doing their cultivation. These are the main obstacles facing cauliflower farmers in the research area. To improve the production of cauliflower, public and private actions should be implemented to lessen or eliminate these issues.

CONCLUSION

One of the significant vegetable crops farmed by farmers, primarily for the market, is cauliflower. The research locations offer excellent potential for growing cauliflower. The results of this study show that growing cauliflower is quite profitable and will allow the sample farmers in the study locations to have better socioeconomic conditions. Cauliflower is a labor-intensive crop, so growing more of it would boost the economy by generating jobs. Due to a lack of available land, it is challenging to improve cauliflower output in Bangladesh by expanding the area of land under production. Nonetheless, there is a chance to boost cauliflower production by upgrading the current production technique. Farmers are not fully technically efficient, which means there is potential to enhance production by using resources in an efficient way.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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