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Research Article

PROFITABILITY AND RESOURCE USE EFFICIENCY OF MUSTARD CULTIVATION

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ABSTRACT

Climatic condition is conducive to cultivate mustard in Bangladesh and there are ample opportunity to improve the present scenario of production, since the demand of oilseeds is high. But economic analysis of production of this crop remains unnoticed most of the time. For assessment of the profitability and resource use efficiency, a field level study was conducted with 100 mustard growers, who were selected purposively and interviewed with pre tested questionnaire from Manikganj district during the period May to August 2019. Applying the Cobb-Douglas production model the results suggested that farmers earned 18577.91 Tk ha^{-1} by producing 1683.75 kg ha^{-1} Mustard with the Benefit Cost Ratio (BCR) 1.28. Land preparation cost, seed, human labour, irrigation and fertilizer had a significant positive effect on the yield of Mustard while insecticides had negative insignificant effect. Farmers were inefficient in case of resource use. Mustard cultivation is profitable in Bangladesh and has the potentiality to minimize import cost of oilseeds. Mustard production can be increased further by ensuring adequate supply of labor at peak period with reasonable wage rate, incentive price of produce for farmers, sufficient drainage system after flood, collateral free and easy access to credit, crop insurance to mustard growers.

Keywords: Cobb-Douglas production function, Oilseeds, Potentiality, Problems, Profitability.

INTRODUCTION

Mustard or rapeseed (*Brassica spp.* L.) is a worldwide cultivated thermo and photosensitive oilseed crop. Asia produces 41.50 % of mustard seed which occupies the first position in terms of percentage share of production followed by the USA (FAOSTAT, 2018). Oilseeds were cultivated in less than 2.20 % of total arable land

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under rice-based cultivation system in Bangladesh, where three fourth of total cultivable land was engaged in rice production in 2015-16 (BBS, 2019).Mustard is the major oilseeds in Bangladesh which exhibits an increase in production from 1994 to 2018 except few fluctuations in the case of total production and area under cultivation (FAO STAT, 2018).

Mustard occupied more than 69.94 % of the total cultivated area of oilseeds followed by sesame, groundnut, and soybean (BBS, 2019). In 2018, the cultivation area was 270023 ha and production of mustard was 311740 MT, which were relatively lower than the previous two years due to severe water logging condition after two spells of flooding. The scenario was far more than the cultivated area (210545 ha) and production (188880 MT) in 2007 (FAO STAT, 2018; BBS, 2019). With the increase in population, the demand for edible oil and oilseeds is in increasing trend (Alam, 2020).

Bangladesh has to import a noticeable amount of edible oil and oilseeds to meet up the existing accelerating demand. The value of imported oilseed and edible oil has increased dramatically from USD 544 million in 2002-03 to USD2371 million in 2018-19 which were 4.99 and 4.23 % of the total value of imports respectively (Bangladesh Bank, 2020). Yield of mustard has increased from 0.75 tha^{-1} in 2001 to 1.15 tha^{-1} in 2019 (MoA, 2007; BBS, 2019). Climate change has affected the production of mustard due to an increase in temperature as it has to be sown from mid-October to mid-November and harvested from late January to mid-February. The sowing time has a great impact on the production of rapeseed or mustard. The production of mustard is prone to decrease in India due to changes in sowing time (Ghosh and Chatterjee, 1988; Boomiraj et al., 2010).

Bangladesh was not in an advantageous position in the case of mustard production (Miah and Rashid, 2015). Very few studies have conducted to analyze the profitability of mustard in Bangladesh. Miah et al. (2015) revealed the reluctance of farmers in following the guidelines provided by BARI for mustard cultivation. Mustard cultivation is profitable and farm size has no adverse influence on yield and profitability though input supply and output demand is primarily determined by the price of mustard (Rahman and Kazal, 2016).

Mustard is cultivated all over Bangladesh and extensively cultivated in 46 districts. A large number of varieties have been developed by researchers to minimize the import cost of oilseeds by increasing the yield. Proper information on the profitability of mustard production is crucial in the formulation of effective and efficient policy regarding the research and development, pricing policy, restructuring marketing system, and prioritizing the cultivation of this nutritious crop. Considering this situation, analysis of profitability, resource use efficiency was focused in this study and problems faced by farmers in mustard cultivation were also identified.

MATERIALS AND METHODS

A total of 100 farmers were selected purposively from Manikganj district which ranked fifth in total annual mustard production as a sample for the present study due to time and money constraint. Primary data were collected from one sub-district (Upazila) of this district. The concentration of mustard growers was another major criterion of selection. Farmers were interviewed from May 2019 to August 2019 with a pre-tested semi-structured questionnaire to get cross-sectional data that were selected randomly with the help of an agricultural extension officer of that Upazila. Microsoft Excel was used to insert collected raw data after a few modifications especially editing and coding to get the desired format for analysis. The analysis was conducted with the help of the statistical software STATA 14 version.

Profitability analysis

Cost and return are the two most dominant terms, which are inevitable in economic analysis. A farm has to calculate profit to know the viability of the intended project. Total variable cost and fixed cost jointly generate total cost (TC) where the cost of land preparation, human labour, seed, fertilizer, insecticides, and water management are considered as variable costs. Interest on operating capital was included in TVC as the operating capital represented the average operating cost over the period because all costs were not incurred at the beginning or at any single point of time; hence, at the rate of 10% per annum interest on operating capital for four months was computed for mustard. Interest on operating capital was calculated by using the following formula:

$$IOC = Alit \quad (1)$$

Where, IOC= Interest on operating capital, i= Rate of interest, AI= Total investment / 3, t = Total period of a cycle

On the other hand, cost of land use was considered as opportunity cost which was calculated based on the use of land per hectare for the cropping period of four months and take into account as fixed cost. Per hectare gross return, Gross margin and Net return or profit were calculated as follows:

Gross Return= (Quantity of the product*Average price of the product) + Value of by-product (2)

Gross margin = Gross return – Variable cost (3)

Net return = Total return – Total production cost (4)

The following profit equation was used to assess the profitability of mustard production at the farm level:

$$\pi = P_r Q_r + P_b Q_b - \sum_{i=1}^{n}(P_{xi} X_i) - TFC \quad (5)$$

Where, π = Profit for producing mustard (Tk. ha^{-1})

P_r= Per unit price of mustard (Tk. kg^{-1})

Q_r= Quantity of mustard (kg ha^{-1}),

P_b= Per unit price of by-products (Tk. kg^{-1})

Q_b= Quantity of by-products (kg ha^{-1})
P_{xi}= Per unit price of the i-th (Variable) inputs (Tk. kg^{-1})
X_i = Quantity of the i-th inputs (kg ha^{-1}), i = 1, 2, 3……..n and TFC = Total fixed cost.

Undiscounted benefit-cost ratio (BCR)

One of the most important criteria for considering the viability of a project and measuring the profitability is BCR which is the average return to each taka spent on production. Undiscounted BCR was estimated as the ratio of total return to the total cost per hectare.

$$\text{BCR} = \frac{\text{Total Return (Gross Return)}}{\text{Total Cost}} \quad (6)$$

Cobb-douglas production function

Cobb-Douglas regression model was used to estimate the production function and find out the factor affecting mustard production in the selected district. To measure the contribution of the most important variables in the production process of mustard, the following type of Cobb-Douglas production function was used in the study.

$$Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} X_6^{\beta_6} e^{U_i} \quad (7)$$

For the present empirical exercise, the Cobb-Douglas production function was converted into the following logarithmic (double log) form:

$$lnY = ln\beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + U_i \quad (8)$$

Where, ln= Natural logarithm, Y= Yield of mustard (kg ha^{-1}), X_1= Amount of Seed (kg ha^{-1})
X_2= Land preparation cost (Tk. ha^{-1}), X_3= Number of labour (Man days ha^{-1})
X_4= Amount of Fertilizer (kg ha^{-1}), X_5= Cost of Irrigation (Tk. ha^{-1})
X_6= Cost of Insecticide (Tk. ha^{-1}), β_0= Constant or intercept term

β_1, β_2, β_3, β_4, β_5, β_6= Coefficients of the respective variables; and U_i= Error term

The explanatory variables for this study were selected considering expectations to be achieved as yield is likely to be influenced by these factors most and previous literatures (Sarker et al., 2010; Dhakal et al., 2015; Khatun et al., 2016; Khatun et al., 2019) provided guidelines in this regard.

Resource use efficiency

The resource use efficiency is the ratio of marginal value product (MVP) to the marginal factor cost (MFC) for each input which was estimated as MVP/MFC and tested whether the value is equal to or greater than or less than 1. The marginal productivity of a particular resource represents the addition to gross returns in value terms caused by an additional one unit of that resource, while other inputs are held constant. By multiplying the marginal physical product of inputs (MPP_{xi}) by the per-

unit price of the final product we obtain the MVP. To get the most reliable result, geometric means of all explanatory and explained variables were taken and the most useful estimate of MVP is obtained by this. In this study the MPP and the corresponding values of MVP were obtained as follows:

$$MPP_{xi} \times P_{yi} = MVP \quad (9)$$

$$\text{But, } MPP_{xi} = \beta_i \times (Y_g/X_g) \quad (10)$$

$$\text{So, } MVP = \beta_i \times (Y_g/X_g) \times P_{yi} \quad (11)$$

Where, β_i = regression coefficient per resource,

Y_g= Geometric mean of output (kg ha^{-1})

X_g= Geometric mean of inputs (kg ha^{-1})

P_{yi} = Price of per unit of output (Tk. kg^{-1})

MFC = Price of per unit of input (Tk. kg^{-1})

The values of resource-use efficiency (RUE) 1, < 1 and > 1 indicates optimal utilization, over utilization and under-utilization respectively.

RESULT AND DISCUSSION

Sample characteristics

Most of the sample farmers were middle-aged with a standard deviation of 13.70 which supports Begum et al. (2020). Though a large number of farmers were illiterate in the survey area, the mean educational level was found as approximately 6 years with 4.27 SD. Farmer's lands under mustard cultivation were fragmented and mean land size was 0.30 ha.

Table 1. Summary Statistics

Variables	Mean	SD
Age (Years)	49.99	13.70
Education (Total years of schooling)	6.12	4.27
Land under mustard cultivation (ha)	0.30	0.18

Source: Field survey, 2019.

Estimated costs and returns

The average yield of mustard was 1683.75 kg ha^{-1}, which was similar to the result of Miah and Mondal (2017), Salam and Miah (2013), but higher than the findings of Azam et al. (2013), Rahman and Kazal (2016) and Begum et al. (2020). The per-unit price of mustard was 47.58 Tk. kg^{-1} and a similar price was documented in previous studies (Rahman and Kazal, 2016; Miah and Mondal, 2017). The per-unit cost of mustard seed was 68.80 Tk. and 8.08 kg seed was used by farmers for 1 ha of land which resembled the recommendation of BBS (2019).To cultivate 1 ha of land, 44 man-days labour were required, who had to be engaged in preparing the land, sowing of seed, weeding, watering, providing fertilizers, harvesting, etc. The number of labour was higher than the number reported in the case of onion

production (Anik et al., 2017). None of the respondents used manure in that region. Farmers had to pay 482.70 Tk for hiring one man-day and the cost was in the same track with the findings of Rahman and Kazal (2016). On an average, 250.88, 244.42, and 127.37 kgurea, TSP, and mop respectively were applied for 1 ha of the mustard field; and the price was 16.22, 22.48, and 15.18 Tk. kg^{-1}, respectively. The used amount of fertilizer was far more than the suggested dose of fertilizer (FRG,2018) which were 160, 48, and 120 kg urea, TSP and mop respectively for per hectare in case of a very low level of fertility of the soil. Successive applications of high amount of fertilizer deteriorate the quality of soil and farmers used higher doses than prescribed to get desired amount of yield.

Table 2. Per hectare amount and price of items

Items	Unit	Amount (unit/ha)	SD	Price (Tk./unit)
Yield	Kg	1683.75	190.18	47.58
Seed	Kg	8.08	0.76	68.80
Labour	Man days	43.87	3.72	482.70
Urea	Kg	250.88	9.65	16.22
TSP	Kg	244.42	10.88	22.48
MoP	Kg	127.37	16.10	15.18

USD1 equaled approx. Bangladesh Taka 84 in year 2019
TSP: Triple Super Phosphate
MOP: Murate of Potash

The total production cost of mustard was 66043.05 Tk ha^{-1} which was divided into two major costs and 76.14 % of the total was occupied by variable cost which was estimated 50287.45 Tk ha^{-1}. Begum et al. (2020) presented almost similar results in case of BARI mustard-14 cultivation. This figure was almost double in the finding of Salam and Miah (2013). Increased cost of inputs was responsible for this deviation. The cost of human labour was highest among others in variable cost and it was 21177.08 Tk. ha^{-1} which represented 32.07 % of the total cost followed by the cost of fertilizer which was 11497.23 Tk. ha^{-1} and 17.41 % of the total cost was seized by this item. High wage rate raised the labor cost than previous studies (Salam and Miah, 2013). The total fixed cost was 15755.61 Tk. ha^{-1} and it was 23.86 % of the total cost.

Table 3. Cost and economic returns of mustard cultivation

Items of Cost	Cost (Tk. ha^{-1})	% of Total Cost
Land preparation	7154.57	10.83
Human labour	21177.08	32.07
Seed	555.97	0.84
Urea	4069.03	6.16
TSP	5494.64	8.32
MoP	1933.56	2.93
Cost of Insecticides	768.27	1.16
Cost of Irrigation	7512.15	11.37
A. Total Operating Cost (TOC)	48665.27	73.69
Interest on operating capital @ of 10% for months	1622.17	2.46
B. Total Variable Cost (TVC)	50287.45	76.14
Rental value of land	15755.61	23.86
C. Total Fixed Cost (TFC)	15755.61	23.86
D. Total cost (B+C)	66043.05	100

Profitability of mustard production

The gross return of mustard was 84620.96 Tk ha^{-1} in which the value of yield was 80130.05 Tk ha^{-1}. The gross margin and net return from mustard production were 34333.51 Tk ha^{-1} and 18577.91 Tk ha^{-1} respectively. Net return from the cultivation of Binasarisha-9 variety was 22278.35 Tk ha^{-1} (Sultana et al., 2020). The estimated Benefit-Cost Ratio was 1.28 in this case and it was lower than few previous studies (Azam et al., 2013; Salam and Miah, 2013; Mila et al., 2015; Rahman and Kazal, 2016) which was due to increased production cost. It is possible to earn Tk 1.28 by investing Tk 1 in mustard production.

Table 4. Gross margin and benefit-cost ratio (undiscounted) of mustard production

Items	Cost
Average yield (kg ha^{-1})	1683.75
Value of product (Tk. ha^{-1})	80130.05
Value of product (Tk. ha^{-1})	4490.91
Gross Return (GR) (Tk. ha^{-1})	84620.96
Gross Margin (GR-TVC) (Tk. ha^{-1})	34333.51
Net Return (GR-TC) (Tk. ha^{-1})	18577.91
BCR (undiscounted)(GR/TC)	1.28

Factors affecting the production of mustard

The estimated parameters of the Cobb-Douglas production function are presented in Table 5. All of the coefficients of variables were positive and significant except insecticides which were negative and insignificant. Among explanatory variables seeds and irrigation were significant at 1 %, land preparation and labour were significant at 5 %, and fertilizer was significant at the 10 % level. The findings

support the previous one (Rahman, 2002). According to Tithi and Barmon (2018), mustard yield was affected significantly by farm size, irrigation and seed. Production of mustard can be enhanced up to 0.27 %, 0.33 %, 0.25 %, 0.31 %, and 0.65 % with one percent increase in cost of land preparation, seed, labour, irrigation, and fertilizers respectively. The included explanatory variable could explain 79 % of the variation in mustard production on an average as the calculated value of the coefficient of multiple determination was 0.79. The highly significant value of F indicated the importance of independent variables in explaining the variation of gross return of mustard production. Increasing return to scale of the production function was found from the summation of coefficients. GR can be increased to 1.80% through the increase of the specified variable by 1 %.

Table 5. Estimated value of coefficients of the cobb-Douglas production function

Variables	Coefficients	Standard Error	T-stat	P-value
Intercept (β_0)	-3.59*	2.18	-1.65	0.102
Cost of Land preparation (β_1)	0.27**	0.12	2.38	0.019
Amount of Seed (β_2)	0.33***	0.10	3.25	0.002
Number of Labor (β_3)	0.25**	0.11	2.30	0.023
Cost of Irrigation (β_4)	0.31***	0.20	3.21	0.002
Amount of Fertilizer (β_5)	0.65*	0.36	1.81	0.073
Cost of Insecticides (β_6)	-0.01^{NS}	0.04	-0.28	0.783
R Square	0.7875			
Adjusted R Square	0.7738			
Return to scale	1.80			
F- ratio	57.45 ***			

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. NS: Not significant.

Resources were not optimally utilized in the case of mustard cultivation. Among the three explanatory variables, seed and fertilizers were underutilized where labour was over-utilized. The decision regarding seed and fertilizers supports the decision of Dhaka et al. (2015) but contradicts in case of labor.

Table 6. Estimated resource use efficiency in mustard production

Variables	GM	MVP	MFC	RUE	Comment
Seed	8.05	3239.46	68.8	47.09	Underutilized
Labor	43.71	454.03	482.7	0.94	Over utilized
Fertilizer	622.54	83.79	17.96	4.67	Underutilized

Problems faced by farmers in mustard cultivation

Problems faced by farmers were identified on the basis of performed survey. Labor shortage in peak seasons especially during sowing and harvest seasons was most severe problem to farmers. Labor cost occupies a major part in total production cost. Farmers have to hire labor with high wage rate due to scarce supply. The findings

support Tithi and Barmon (2018). Farmers had to depend on chemical fertilizers only due to unavailability of organic manure. Farmers had to delay the sowing time due to water logging condition which is a common scenario after flood every year in the study area. Water logging condition was major problems to oilseed cultivation (Miah and Mondal, 2017). Most of the farmers don't have their own irrigation machine and they had to depend on rented one which was not available when needed. Shortage of capital and lack of access to institutional credit hampers the production in a large extent which is in the line with the findings of Tithi and Barmon (2018). Detrimental effects of natural disasters reduce the yield of mustard which supports the result of (Miah and Mondal, 2017). High growth of bothua (*Chenopodium album*) weed in mustard field is common. Mostly, broadcast method is applied for sowing seeds in mustard cultivation and to control weed from mustard field is difficult.

Table 7. Problems faced by farmers in mustard production

Problems	% of respondents
Unavailability of labor	89
High wage of labor	85
Low price of final products	78
Delayed sowing season due to water logging condition	76
Unavailability of manure	75
Unavailable irrigation facility	61
Shortage of capital	57
Natural disasters	54
High growth of weed	48

CONCLUSIONS

The study estimates the factors that affect the productivity and level of input use in mustard cultivation. Results reveal significant effects of land preparation cost, labour, seed, irrigation and fertilizer on mustard production. Production can be increased to a great extent through increasing these drivers in the studied region. Increasing returns to scale specifies 1.80 % increase of yield is possible by increasing all the inputs specified in the model by one percent. Though the oilseed sector especially mustard has experienced a slow and steady increase in production, a vast scope is still available to increase the total production. The acceleration of production of oilseeds is a crying need in Bangladesh as the demand for oilseeds and edible oil is higher than the production. To meet domestic demand, a huge amount of foreign currency is spent for importing these products. Mustard cultivation was profitable in the selected region and has a high potentiality to improve the present production scenario. Farmers were not efficient at the use of the available resources which can be focused to increase further production. The yield rate has increased

due to the development of improved varieties. Adoption of these varieties should be ensured to farmers and DAE (Department of Agricultural Extension) officials should come forward to implement this action. Unavailability of labor, the high price of labor, and the low price of final products distracted farmers from mustard production in a rice-based production system. DAM (Department of Agriculture Marketing) should take actions by fixing farm gate price of final produce to ensure incentive price for mustard growers. Sufficient drainage system after flood will encourage farmers in mustard production as appropriate sowing time can be followed. Easy access to credit without any collateral can minimize capital shortage. Initiation of crop insurance can save farmers from huge loss occurred due to natural disaster. By eliminating these hurdle productions can be increased to a great extent as more land coverage is possible in this way.

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