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An Economic Study of the Oilseed Mustard Variety Binasarisha-4 Production in Some Selected Areas of Bangladesh

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Abstract

Mustard is a leading oil crop in Bangladesh. The study was conducted in four major Binasarisha-4 growing areas of Bangladesh, namely Jashore, Kushtia, Magura and Faridpur district to estimate the socio-economic profile, profitability and technical efficiency of the variety. In total, 160 farmers, 40 from each district were randomly selected as sample size for conducting the study. In the sampled areas data were collected through pre-designed interview schedule from February-March, 2017. Tabular, descriptive statistics and Cobb-Douglas production frontier model were used to fulfill the objectives. In the study, costs and return analysis were done on both cash cost and full cost basis for estimating profitability. The study found that Binasarisha-4 production is profitable. The average net return per hectare was Tk. 29113.30. The net return was highest in Magura (Tk. 33060.19/ha) followed by Kushtia (Tk. 32195.20/ha), Jashore (Tk. 28227.04/ha) and Faridpur (Tk. 22970.78/ha) respectively. Benefit cost ratio was 1.71 and 2.65 on full cost and cash cost basis. The stochastic Cobb-Douglas production frontier model was used for estimating technical efficiency of Binasarisha-4 producer in the study areas. About 61% Binasarisha-4 farmers could achieve 89.5% technical efficiency implying that they could increase Binasarisha-4 productivity through increasing their technical efficiencies in many issues, such as education, income and farming experience. Farmers faced some constraints in cultivating of the variety. Out of them the major constraints were inadequate supply of quality seeds, higher price of fertilizers & insecticides, lack of training, lack of technical know-how, natural calamities, higher charge of irrigation and Infestation of insects.

Keywords: Mustard, Binasarisha-4, Profitability, Technical efficiency, Technical inefficiency, Frontier model, Bangladesh.

INTRODUCTION

Agriculture has played a pivotal role to the sustainable growth and development of the Bangladesh economy. Although, the agriculture sector contributed only 13.82% (at current price) of GDP in 2017-18, its importance in the Bangladesh's socioeconomic development goes well beyond this indicator as 40.6% of the total workforce is employed in agriculture, which includes 59.15% cultivators and 29.85% agricultural labourers [1]. Rapeseed and mustard are popularly called 'Mustard' which is a leading oilseed crop, covering about 80% of the total oilseed area and contributing to more than 60% of the total oilseed production in Bangladesh. It is a cold loving crop which is grown during Rabi season.

Total area under oilseed crops is around 484.21 thousand ha (which is 2.37% of the total area under cultivation) of land and producing about 975 thousand tones [2]. Total area under rape and mustard is around 336.44 thousand ha and producing 363 thousand tones. The country is producing about 0.36 million tons of edible oil from oilseed crops per year as against the total requirement of 1.4 million tons [3]. Rapeseed-mustard (Brassica spp) or mustard is a major oilseed crop in the world which is grown in 53 countries across six continents including India which is the second largest producer after China [4].

Mustard is the principal oil producing crop of Bangladesh yielding 52.2% total oilseed produced from 60.3% of the area converge [5]. The seeds contain 40-44% oil, 25% protein and 6.4% nitrogen [6]. The government of Bangladesh has therefore, provided priority to the agriculture sector to increase the production of oil seeds by giving subsidy to the farmers on different inputs such as fertilizer, irrigation etc. Oil cake, the by product of Mustard, is a nutritious food item for cattle and fish [7]. It is a good organic fertilizer

too. It is an important source of cooking oil in Bangladesh and it meets one third of the edible oil requirement of the country [8]. The production of oilseed is one-third of total oil seed production in Bangladesh. Mostly supply of oil in the market is maintained through import from abroad at the cost of huge amount of foreign exchange [9].

In Bangladesh with the importance of Mustard cultivation, it is necessary to find out the maximum level of Mustard produced per unit of land using the existing level of resources. Efficient use of resources can provide the farmers to have higher production from the available resources. The situation is particularly critical in a country like Bangladesh where per hectare recommended amount is seldom used in production. However, a few systematic financial investigations on oilseed crops were undertaken either by private or government organizations and were not sufficient to satisfy the demand of extension workers, policy makers, research personnel's and farmers. In this context, this study will help to diagnose the problems and prove our understanding on the interrelated problems of farmer's choice making in producing Mustard. The findings of the study will generate basic financial data on the production practices of Mustard. The present study will provide valuable information to the individual farmers and researcher who will conduct further studies of the similar nature and encourage them in conducting more comprehensive and detailed investigation in this particular field of study.

There are many studies were available on mustard in Bangladesh mainly focusing profitability, socioeconomic, factor affecting the adoption and farmer perceptions. [10] studied profitability, input demand and output supply of mustard, [11] investigated the adoption of BARI mustard technology, [12] studied technological efficiency of mustard production, [13] determined impact of improved technologies on productivity and profitability of rapeseed-mustard production and [14] examined farmers' perception on cultivating mustard. But none of the touch the economic study like socio-economic profile, profitability of Binasarisha-4 and technical efficiency of this variety altogether in the context of Bangladesh at farmers level. Given this backdrop, the present study focuses the socio-economic profile, profitability and technical efficiency of Binasarisha-4 at farmer's level. Keeping this in view the study was undertaken with the following specific objectives;

i. To identify the socio-economic profile of Binasarisha-4 growers;
ii. To estimate the profitability of Binasarisha-4;
iii. To determine the technical efficiency of Binasarisha-4 and
iv. To find out the major constraints to Binasarisha-4 production in Bangladesh.

METHODOLOGY

Selection of the study area, sample size and sampling technique:

This study was conducted in the four districts namely Jashore, Kushtia, Magura and Faridpur in Bangladesh. A total of 160 Binasarisha-4 farmers taking 40 farmers from each districts were randomly selected with the help of Department of Agricultural Extension (DAE) personnel for interview. Field investigators under the direct supervision of the researchers collected field level cross sectional data using pre-tested interview schedule.

Method of data collection and period of study: Data for the present study were collected from sample Binasarisha-4 farmers through face to face interview method using a pre-tested interview schedule. Field level primary data were collected by the researcher with the help of trained enumerators for the period of February-March, 2017.

Analytical techniques: Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. The data were analyzed with the help of suitable statistical measures as frequencies, percentages, mean and standard deviation. Descriptive statistics were used to analyze and compare the socioeconomic characteristics. The total cost is composed of total variable costs (TVC) and total fixed costs (TFC). The gross return (GR) is computed as total mustard output multiplied by the market price of mustard. Profits or gross margin (GM) is defined as GR-TVC, whereas the net return (NR) is defined as GR-TC. Finally, the Benefit Cost Ratio (BCR) is computed as GR/TC [15].

Econometric modeling

Estimation of technical efficiency: The stochastic Cobb-Douglas production frontier model was used for estimating technical efficiency of Binasarisha-4 producer in the study areas. The empirical Cobb-Douglas stochastic frontier production function with double log form can be expressed as:

$$LnY_i = \beta_0 + \beta_1 LnX_{1i} + \beta_2 LnX_{2i}, + \beta_3 LnX_{3i}, + \beta_4 LnX_{4i}, + \beta_5 LnX_{5i}, + \beta_6 LnX_{6i}, + \beta_7 LnX_{7i}, + v_i - u_i \quad (I)$$

Where,
Ln = Natural logarithm,
Y = Yield of Binasarisha-4 (kg/ha)
X_1 = Human labour cost (man-days/ha)
X_2 = Power tiller cost (Tk./ha)
X_3 = Seed cost (kg/ha)
X_4 = Fertilizer cost (kg/ha)
X_5 = Irrigation cost (Tk./ha)
X_6 = Insecticides cost (Tk/ha)

X_7 = Dummy for source of seed

β's and η's are unknown parameters to be estimated

$V_i - u_i$ = error term

V_i are assumed to be independently and identically distributed random errors, having N (0, σ_v^2) distribution.

Technical inefficiency effect model

The u's in equation (I) are non-negative random variables, called technical inefficiency effects, assumed that to be independently distributed such that the technical inefficiency effects for the i^{th} farmer, u, are obtained by truncation normal distribution with mean zero and variance σ_u^2, such that

$$u_i = \delta_0 + \delta_1 z_{1i} + \delta_2 z_{2i} + \delta_3 z_{3i}, + \delta_4 z_{4i} + \delta_5 z_{5i}, + W_i \qquad (2)$$

Where,

z_1 = Age (years)

z_2 = Education (year of schooling)

z_3 = Experience (years)

z_4 = Farmers income (Tk/year)

z_5 = Dummy for training

δ's are unknown parameters to be estimated

W_i are unobservable random variable or classical disturbance term, which are assumed to be independently distributed, obtained by truncation of the normal distribution with mean zero and unknown variance σ^2, such that u is non-negative.

The β, η and δ coefficients are unknown parameters to be estimated, together with the variance parameters which are expressed in terms of

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \qquad (3)$$

and $\gamma = \sigma_u^2 | \sigma^2 \qquad (4)$

γ is the ratio of variance of farm specific technical efficiency to the total variance of output and has a value between zero and one.

The estimates for all parameters of the stochastic frontier (I) and inefficiency model (2) were estimated in a single stage by using the Maximum Likelihood (ML) method. The econometric computer software package FRONTIER 4.1 [16]) was applied to estimate the parameters of stochastic frontier models using the ML method.

RESULTS AND DISCUSSION

Socio-economic profile of the Binasarisha-4 farmers

The adoption of new and improved technologies at farm level is mostly dependent on farmers' socio-economic characteristics. Therefore, an attempt was made to identify different socio-economic characteristics that may influence farmers to adopt Binasarisha-4 variety and their management technologies (Table 1).

Age is an important factor that influences farmers' decision to adopt improved technologies. The average age of the Binasarisha-4 farmers was 43.3 years with minimum age of 18 years and the maximum of 80 years. The sample farmers were grouped into five categories based on their level of education. Majority of the Binasarisha-4 farmers (71% of the total farmers) had primary and secondary levels of education. Only 3% Binasarisha-4 farmers' were found to have completed their higher level of education. Nineteen percent of the farmers had basically no education. Length of experience in crop farming is also an important factor that influences farmers' level of adoption for new technologies. The average length of experience of Binasarisha-4 farmers was 23 years. Magura farmers communicated with different extension personnel like Sub-Assistant Agriculture Officer (SAAO), Agriculture Officer, and BINA scientists more frequently than the farmers of other study areas for getting improved Binasarisha-4 technology. The average farm size per household was estimated at 1.41 ha. The highest farm size was found in Kushtia (1.95 ha.) followed by Magura (1.49 ha.), Jashore (1.24 ha.) and Faridpur (0.94 ha.) respectively. The average yearly household income was Tk. 1,45,640. The highest household income was found in Magura (Tk. 1,91,356) followed by Jashore (Tk. 1,52,077), Kushtia (Tk. 1,46,470) and Faridpur (Tk. 74,470) respectively.

Table-1: Socio-economic profile of Binasarisha-4 producers in the study areas

Items	Jashore	Kushtia	Magura	Faridpur	All area
Sample size	40	40	40	40	160
Farmer's age (year)	41.5	44.2	42.6	44.8	43.3
Level of education (%)					
Illiterate	15	21	16	24	19
Primary	42	37	39	36	39
Secondary	33	30	33	34	33
Higher Secondary	6	8	10	5	7
Degree & above	4	4	2	1	3
Farming experience (year)	22.5	24.6	22.5	22.3	23
Communication with extension agents (Score)	14.7	13.5	15.4	8.9	13.1
Farm size (ha.)	1.24	1.95	1.49	0.94	1.41
Household income (Tk/year.)	1,52,077	1,46,470	1,91,356	74,470	1,45,640

Economic profitability of Binasarisha-4 production

Profitability is one of the major criteria for determination of acceptance of a crop. The cost of Binasarisha-4 production, gross return, gross margin, net return and the benefit cost ratio (BCR) for Binasarisha-4 cultivation are being discussed in the following sections.

Cost of Binasarisha-4 cultivation

The cost of human labour, power tiller, seed, fertilizers, pesticides, and irrigation were taken into consideration, while calculating cost of Binasarisha-4 production. Beside this, interest on operating capital was also considered as the cost of Binasarisha-4 production. Total cost consists of variable cost and fixed cost that covered 64.64% and 35.36% of total cost for Binasarisha-4 production.

From Table 2, the average costs of Binasarisha-4 cultivation were Tk. 41004.09 and Tk. 26503.22 per hectare on full cost and cash cost basis, respectively. The highest production cost was for human labour (44.80%), followed by land use (15.45%), power tiller (13.11%), and irrigation (5.54%). The cost of Binasarisha-4 cultivation was found highest in Kushtia (Tk. 42530.02/ha) followed by that in Faridpur (Tk. 41343.76/ha), Magura (Tk. 40299.72/ha) and Jashore (Tk. 39842.84/ha) respectively.

Table-2: Per hectare cost of Binasarisha-4 production in different locations

Cost Component	Cost of production (Tk/hectare)				All area
	Jashore	Kushtia	Magura	Faridpur	
A. Total Variable Cost	26494.35	27086.21	25250.15	27182.18	26503.22 (64.64)
Hired labour (Man days)	9662.10	10796.32	8636.09	11721.31	10203.96 (24.89)
Power tiller	5427.21	5263.45	5730.42	5081.08	5375.54 (13.11)
Seed	724.40	756.15	706.01	734.41	730.24 (1.78)
Fertilizers	7549.27	7430.96	7564.66	6842.14	7346.76 (2.56)
Urea	1260.12	1031.02	1251.13	1177.02	1179.82 (2.88)
TSP	2029.36	1978.22	2097.11	2075.08	2044.94 (4.99)
MP	1152.14	1329.16	1470.07	1260.91	1303.07 (3.18)
Gypsum	657.32	770.27	696.02	580.56	676.04 (1.65)
Zinc oxide	275.13	236.02	432.2	277.42	305.19 (0.74)
Boric acid	104.02	211.21	338.06	221.04	218.58 (0.53)
Cow dung	2071.18	1875.06	1280.07	1250.01	1619.08 (3.95)
Pesticides	242.21	102.01	335.61	230.06	227.47 (0.55)
Irrigation	2514.12	2410.08	1931.31	2230.13	2271.41 (5.54)
Int. on operating capital	375.04	327.24	346.05	343.15	347.87 (0.85)
B. Total Fixed Cost	13348.52	15443.81	15049.62	14161.68	14500.86 (35.36)
Family labour	7512.28	8642.52	8721.33	7786.34	8165.62 (19.91)
Land use cost	5836.21	6801.29	6328.24	6375.24	6335.25 (15.45)
C. Total Cost (A+B)	39842.84	42530.02	40299.72	41343.76	41004.09 (100.00)

Note: Bracketed figures indicate the percentage of total cost

Return from Binasarisha-4 production

The average return from Binasarisha-4 production in different locations is shown in Table 3. The average yield of Binasarisha-4 was 1623.86 kg/ha. The yield was highest at Magura (1770.25 kg/ha) followed by Kushtia (1678.52 kg/ha), Jashore (1642.03 kg/ha) and Faridpur (1404.66 kg/ha). Most of the farmers in the study areas sold their product just after harvest. The price of Binasarisha-4 was found the highest in Faridpur (Tk. 44.00/kg) and the lowest in Jashore (Tk. 40.00/kg). The total return from Binasarisha-4 production consists of the values of Binasarisha-4 and straw.

The average gross margin per hectare was found Tk. 43613.34 on variable cost basis. Gross margin was highest in Magura (Tk. 48108.88/ha) followed by Kushtia (Tk. 47638.08/ha), Jashore (Tk. 41574.67/ha) and Faridpur (Tk. 37131.71/ha) respectively. The average net return per hectare was Tk. 29113.30. The net return was highest in Magura (Tk. 33060.19/ha) followed by Kushtia (Tk. 32195.20/ha), Jashore (Tk. 28227.04/ha) and Faridpur (Tk. 22970.78/ha) respectively. Benefit cost ratio was estimated at 1.71 and 2.65 on full cost and variable cost basis implying that the Binasarisha-4 cultivation at farm level was highly profitable.

Table-3: Profitability of Binasarisha-4 cultivation in different location

Particular	Study areas				All area
	Jashore	Kushtia	Magura	Faridpur	
Yield from Binasarisha-4 (Kg/ha.)	1642.03	1678.52	1770.25	1404.66	1623.86
Return from Binasarisha-4 (Tk./ha)	65681.21	71337.33	70810.16	61805.64	67408.59
Return from straw (Tk./ha)	2386.08	3385.15	2547.27	2505.28	2705.95
Gross Return (Tk./ha)	68067.29	74722.48	73357.43	64310.92	70114.53
Total variable cost (Tk./ha)	26492.62	27084.40	25248.55	27179.21	26501.20
Total Cost (Tk./ha)	39840.25	42527.28	40297.24	41340.14	41001.23
Gross Margin (Tk./ha)	41574.67	47638.08	48108.88	37131.71	43613.34
Net Return (Tk./ha)	28227.04	32195.20	33060.19	22970.78	29113.30
Benefit Cost Ratio (BCR)					
BCR on full cost	1.71	1.76	1.82	1.56	1.71
BCR on variable cost	2.57	2.76	2.91	2.37	2.65

Technical efficiency of Binasarisha-4 farmers

Maximum likelihood estimates of the stochastic frontier and technical inefficiency are represented in Table 4. The stochastic frontier model considers the variable inputs as human labour, power tiller, seed, fertilizer, irrigation and insecticides cost and socio-economic variables like age, education, experience and farmers income are considered in the inefficiency model.

In table 4 showed that most of the parameters are statistically significant and positive. The empherical result indicated that the co-efficient of human labour was found positive and significant at 1% level, while that of power tiller, seed, fertilizer and irrigation were found positive but significant at 5, 1, 10 and 5 percent level, respectively. The elasticity of output with respect to human labor, power tiller, seed, fertilizer and irrigation were estimated to be positive values of 0.003, 0.018, 0.004, 0.118 and 0.008, respectively. It showed that these variables had a significant and positive impact on Binasarisha-4 cultivation. Thereby it can be said that if the human labor, power tiller, seed, fertilizer and irrigation are increased by one per cent, per hectare yield of Binasarisha-4 is estimated to increase by 0.003, 0.018, 0.004, 0.118 and 0.008 per cent, respectively. Insecticides cost are statistically insignificant and showed negative relationship with Binasarisha-4 production. The coefficients of dummy variables source of seed positive and significant at 1% level.

The estimated coefficient of technical inefficiency model showed that the coefficient of farmers education, farming experience and farmers income were negative but significant at 1% level which implies that technical inefficiency in mungbean production decreases with the increases in farmers education, farming experience and farmers income [16-18]. Observed significant positive correlation with education and experience. The coefficient of farmer's age and dummy for extension linkage was negative but not significant (Table 4). The estimated value of variance (σ^2) was significantly different from zero which indicated a good file and correctness of specified distributional assumption.

Table-4: Maximum likelihood estimates of the stochastic Cobb-Douglas frontier production function and technical inefficiency model for Binasarisha-4

Independent variables	Para-meters	Co-efficient	Standard error	T- ratio
Stochastic Frontier model				
Constant	β_0	0.406**	0.451	9.900
Human labour (Man-days ha^{-1})	β_1	0.003***	0.017	0.174
Power tiller (Tk ha^{-1})	β_2	0.018**	0.011	1.647
Seed (Kg ha^{-1})	β_3	0.004***	0.002	1.641
Fertilizer (kg ha^{-1})	β_4	0.118*	0.350	3.370
Irrigation (Tk. ha^{-1})	β_5	0.008**	0.021	0.390
Insecticides (Tk. ha^{-1})	β_6	-0.001	0.002	-0.901
Dummy for source of seed	β_7	0.008***	0.009	0.090
Technical Inefficiency Model				
Constant	δ_0	0.114*	0.380	3.084
Farmers age (Years)	δ_1	-0.001	0.003	-0.430
Farmers education (years of schooling)	δ_2	-0.091***	0.084	-2.721
Farmers experience (years)	δ_3	-0.002***	0.027	-1.205
Farmers income (Tk./year)	δ_4	-0.008***	0.021	0.391
Dummy for extension linkage	δ_5	-0.121	0.397	-0.710
Variance parameters				
Sigma-squared	σ^2	0.111***	0.264	4.050
Gamma	γ	0.713**	0.153	4.691
Log likelihood function	284.62			

Note: ***, ** and * indicate significant at 1% and 5% and 10% level respectively

Technical efficiency and it distribution

In table 5 showed that about 61% farmers produced outputs which were very close to the maximum frontier output level (91%–99%). The mean efficiency of the Binasarisha-4 growers was 89.5%, which indicates that they were made a production loss of 10.5% due to inefficiency factors. In other words, they were 10.5% apart from the frontier level.

Table-5: Technical efficiency of Binasarisha-4 growers in the study areas

Technical efficiency (%)	No. of farmers	% of total farmers
80-90	62	39
91-99	98	61
Mean efficiency	89.5%	
Maximum	99%	
Minimum	80%	

Major constraints to Binasarisha-4 cultivation

Although Binasarisha-4 is opined to be a profitable crop in the study areas, there are several constraints to its higher production. Farmers faced various constraints to Binasarisha-4 cultivation. In table 6, about 95% farmers opined inadequate supply of quality seeds as a top ranked problem of Binasarisha-4 cultivation. Other constraints were higher price of fertilizers & insecticides (44%), lack of training (38%), lack of technical know-how (32%), natural calamities (26%), higher charge of irrigation (10%) and infestation of insects (9%).

Table-6: Major constraints to Binasarisha-4 cultivation in the study areas

Sl. No.	Constraints	% of farmers responded					Rank
		Jashore	Kushtia	Magura	Faridpur	All area	
1.	Inadequate supply of quality seeds	100	98	100	75	95	1
2.	Higher price of fertilizers & insecticides	37	40	55	45	44	2
3.	Lack of training	30	82	8	28	38	3
4.	Lack of technical know-how	30	25	53	15	32	4
5.	Natural calamities	17	13	12	80	26	5
6.	Higher charge of irrigation	10	5	8	20	10	6
7.	Infestation of insects	10	13	8	-	9	7

CONCLUSION

Economic analysis of Binasarisha-4 production reveals that it is a profitable crop to most of the farmers. The estimated technical efficiency for Binasarisha-4 varies from 80–99%, with mean efficiency 89.5%. This implies that the output per farm can be increased, on an average, 10.5% without incurring any additional production cost. They could increase Binasarisha-4 yield by spending more on crop management (Human labour), seed, fertilizers, and irrigation since these inputs had significant and positive impact on yield. About 61% Binasarisha-4 farmers could achieve 89.5% technical efficiency implying that they could increase Binasarisha-4 productivity through increasing their technical efficiencies in many issues, such as education, Income and farming experience. Although mungbean is a profitable crop, its growers faced different constraints, such as inadequate supply of quality seeds, higher price of fertilizers & insecticides, lack of training, lack of technical know-how, natural calamities, higher charge of irrigation and infestation of insects.

Conflict of Interest

Authors have declared that no conflict interests exist.

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