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ECONOMIC ANALYSIS OF MUNGBEAN (*Vigna radiata*) CULTIVATION IN SOME COASTAL AREAS OF BANGLADESH

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Abstract

The study was conducted in two coastal mungbean growing districts, namely Noakhali and Patuakhali of Bangladesh during the period of 2008-09 with a view to estimating the technical efficiency of mungbean growers. The study revealed that mungbean production was found profitable. The benefit cost ratio (BCR) was 2.22 on full cost basis. The estimated results showed that the average level of technical efficiency among the sample farmers was 89%. This implies that given the existing technology and level of inputs, the output could be increased by 11 percent. Farmer's education and experience had positive significant effect on mungbean production. Fifty nine percent farmers produced outputs to the maximum frontier output level. Farmers in the study area mentioned some constraints like high price of fertilizer, insecticides, severe attack of insects, etc. to the production of mungbean at farm level.

Keywords: Profitability, mungbean, technical efficiency.

Introduction

Pulse crop is important protein source for the majority of the people of Bangladesh. It contains protein about twice as much as cereals. It also contains amino acid lysine, which is generally deficit in food grains (Elias, 1986). Pulse bran is also used as quality feed for animals. Apart from these, the ability to fix nitrogen and addition of organic matter to the soil are important factors in maintaining soil fertility (Senanayake *et al.*, 1987; Zapata *et al.*, 1987). In the existing cropping systems, pulses fit well due to its short duration, low input, minimum care required and drought tolerant nature. Among the food legumes grown, lathyrus, lentil, chickpea, blackgram, and mungbean are the major and they contribute more than 95% to the total pulses production in the country (Rahman, 1998).

Mungbean (*Vigna radiata)* is widely grown in Bangladesh. Mungbean grain contains 19.5% to 28.5% protein (AVRDC, 1988). Major area of mungbean is replaced by cereals (Abedin *et al.,* 1991). Now a days, it is being cultivated after harvesting of Rabi crops (wheat, mustard, lentil, etc.). As mungbean is a short duration crop, it can fit in as a cash crop between major cropping seasons. It is grown three times in a year covering 43,680 ha with an average yield of 0.78 t/ha

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(BBS, 2007). It is shown in Appendix I that area, production and yield were fluctuating since 1995/96 to 2005/06. Area decreased but yield increased, thereby production remained more or less same with wide fluctuation. It provides grain for human consumption and as well as the plant fix nitrogen to the soil. It supplies a substantial amount of nitrogen to the succeeding non-legume crops (i.e., rice) grown in rotation (Sharma and Prasad, 1999). Six varieties of mungbean have been developed by Pulses Research Centre, BARI and disseminated with the package of management technologies to the farmers for cultivation. Therefore, mungbean cultivation is gaining popularity day by day among the farmers. Sustainability of any crop cultivation is mainly depends on its economic aspect but limited study was done on mungbean in this regard. In view of the discussion, the present study was undertaken with the following objectives:

1. to find out the profitability of mungbean production;
2. to measure the technical efficiency of mungbean growers, and
3. to identify the constraints to mungbean production.

Methodology

Multistage sampling technique was followed for this study. The study was conducted in two coastal districts, namely Noakhali and Patuakhali during January to March 2009. Sadar Upazila from Noakhali district and Dumki Upazila from Patuakhali district were purposively selected for the study. List of the farmers were collected with the help of DAE personnel and 100 mungbean farmers taking 50 from each Upazila were randomly selected for interview. The crop season under the study was late *Rabi* (January-May), 2008. Necessary information was collected through survey method with the help of a pre-tested structured interview scheduled by field investigators in collaboration with DAE field staffs under direct supervision of the researchers. Data were collected on input costs, price, yields and other necessary information.

Collected data were edited, summarized, tabulated, and analyzed to fulfill the objectives of the study. Tabular method of analysis using different statistical tools like averages, percentages, and ratios was used in presenting the results of the study. Profitability of mungbean production was examined on the basis of gross margin and benefit cost analysis. The opportunity cost of family supplied labour was taken into consideration in estimating total cost or full cost. In calculating gross margin, all operating costs were considered as variable cost. Efficiency can be measured in two ways, such as technical and allocative. Here we considered only technical efficiency.

Estimation of technical efficiency: Technical efficiency is the ability of a firm to achieve maximum possible output with available resources. The stochastic

Cobb-Douglas production frontier model was used for estimating technical efficiency of mungbean producer in the study areas and the model is given below:

$In\ Y_i = \beta_o + \beta_1\ lnX_{11} + \beta_2\ lnX_{2i} + ... + \beta_0\ ln\ X_{ni} + V_i - U_i$

Where, In represents the natural logarithm; the subscript i represents the i-th farmer in the sample, Y represents the quantity of mungbean harvest in kilogram, X_i represents the variable factors of production, β_i unknown parameters to be estimated, V_1 assumed to be independently and identically distributed (id) random errors, having N (0, σ_v^2) distribution, u are non-negative one sided random variables, called technical inefficiency effects, associated with the technical inefficiency of production of the farmers involved. It is assumed that the inefficiency effects are independently distributed with a half normal distribution (U ~ | N (0, σ_v^2)|).

To examine the rule of relevant farm specific variables in efficiency, the production inefficiency effect model can be written as follow:

$Ui = \delta_o + \delta_1\ Z_{1i} + \delta_2 Z_{2i} + ... + \delta_n Z_{ni} + W_i$

Where, Z_i represents the farm specific inefficiency variable factors of production, ö unknown parameters to be estimated, W_i unobservable random variables, which are assumed to be independently distributed with a positive half normal distribution.

The empirical Cobb-Douglas stochastic frontier production function with double log form can be expressed as:

$$LnY_i = \beta_0 + \beta_1 LnX_{1i} + \beta_2 LnX_{2i}, + \beta_3 LnX_{3i}, + \beta_4 LnX_{4i}, + \beta_5 LnX_{5i}, + \beta_6 LnX_{6i}, + \beta_7 LnX_{7i}, + \beta_8 LnX_{8i} + v_i - u_i \quad \text{(I)}$$

Where,

Ln = Natural logarithm,

Y = Yield of mungbean of the i-th farm (kg/ha)

X_1 = Human labour used by the i-th farm (man-days/ha)

X_2 = Land preparation cost used by the i-th farm (Tk./ha)

X_3 = Seed cost used by the i-th farm (kg/ha)

X_5 = Urea used by the i-th farm (kg/ha)

X_6 = TSP used by the i-th farm (kg/ha)

X_7 = Insecticides cost used by the i-th farm (Tklha)

X_8 = 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

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

where,

z_1 = Total cultivated land of the i-th farm operator (ha)

z_2 = Age of the i-th farm operator (years)

z_3 = Education of the i-th farm operator (year of schooling)

z_4 = Experience in mungbean farming of the i-th farm operator (year)

z_5 = Family size of the rnungbean growers of i-th farm operator (number)

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

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

$$\text{and } \gamma=\sigma_u^2|\sigma^2 \quad (4)$$

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 (Coelli, 1996) was applied to estimate the parameters of stochastic frontier models using the ML method.

Result and Discussion

Agronomic performance

The farmers prepared their land using 2.64 number of ploughings for mungbean production. More ploughing was done by the farmers of Noakhali (2.90) compared to Patuakhlai (2.39). Average 0.89 laddering was done by the farmers which was more or less same in both the areas (Table 2). Seventy percent farmers used insecticides and it was higher in Patuakhali. In the study area, BARI Mung-2 variety was used by 84% farmers. On the other hand, BARI Mung-5 and BARI Mung-6 were used by 14% and 2 % farmers, respectively. It was observed that 69% farmers completed their sowing within the month of January. Sowing period ranged from 1st week of January to 1st week of February.

Table 1. Agronomic practices of mungbean cultivation of the sample farmers in the study areas.

Activities	Locations		All
	Noakhali	Patuakhali	
Ploughing (average)	2.90	2.39	2.64
Laddering (average)	0.88	0.90	0.89
Weeding (average)	1.16	-	0.58
Insecticide application (%)	60	80	70
Sowing(%):			
Within January	80	58	69
Within February	20	42	31
Weeding number (%):			
One	38	-	38
Two	30	-	30
Three	6	-	6
No weeding	26	-	26
Variety (%):			
BARI Mung-2	90	78	84
BARI Mung-5	10	18	14
BARI Mung-6	-	4	2

All the farmers followed broadcast method of sowing. Weeding in mungbean field was found to be done only by the farmers of Noakhali. Highest 38% farmers weeded their land for one time, while twenty six percent farmers not weeded their land.

Input use pattern

The pattern of input use is presented in Table 3. On an average, mungbean farmers used 72 man-days of human labour per hectare of which 64% were family supplied. The farmers of Noakhali used slightly higher human labour (76 man-days/ha) compared to Patuakhali farmers (68 man-days/ha) might be for increased number of labour used in manuring and weeding. On an average, *25* kg of seed was used per hectare for mungbean cultivation. The farmers used *75%* seed from their own sources.

Table 2. Level of input use per hectare for mungbean cultivation in the study areas.

Type of input	Locations		All
	Noakhali	Patuakhali	
Human labour (man-days)	76	68	72
Own	59	33	46(64)
Hired	17	35	26
Seed(kg/ha):	24	26	25
Own	16	21	18(75)
Purchased	9	5	6
Manures (kg/ha)	978	-	489
Fertilizers (kg/ha):			
Urea	25	26	26
TSP	24	8	16
MP	2	6	4
Insecticides (Tk.)	738	1018	878

Figures in the parentheses indicates the percentage

Farmers of Noakhali district used 978 kg manures/ha, while none of the farmers of Patuakhali district applied manures for mungbean cultivation. Farmers in the study areas also used chemical fertilizers like urea, TSP, and MP at the rate of 26, 16, and 4 kg per hectare, respectively. It was much lower than the recommended doses i.e. urea (40-50) kg/ha, TSP (80-85)kg/ha and MP (30-35) kg/ha (Annoymous, 2006). The Patuakhali farmers used more urea and MP than the Noakhali farmers. Insecticides were used in both areas, but it was more in Patuakhali. None of the farmers in the study areas were found to use irrigation for mungbean production.

Cost of mungbean production

Costs are the expenses in organizing and carrying out the production process. The cost of production included different variable cost items like land preparation, human labour, seed, manure, fertilizer, insecticides, etc. Both cash expenditure and imputed value of family supplied inputs were included in the analysis and are shown in Table 4. It revealed that highest cost was incurred for human labour (54%) followed by land preparation (28%) and seed cost (7%) when family supplied inputs were valued at market rate. The average cost of production in full cost basis was found to be Tk. 20919/ha, which was found slightly higher in Noakhali than Patuakhali due to more cost involvement in manures and fertilizers.

Table 3. Cost of mungbean cultivation by the sample farmers in the study areas.

(Taka per ha)

Cost items	Locations		All area
	Noakhali	Patuakhali	
Land preparation	5662	6072	5867(28)
Own	1215	1107	1161
Hired	4447	4965	4706
Human labour	11362	11077	11220(54)
Own	8800	5361	7081
Hired	2562	5716	4139
Seed	1403	1512	1458(7)
Own	823	1240	1032
Purchased	580	272	426
Manures:	489	-	245(1)
Fertilizers:	1019	608	814(4)
Urea	188	192	190
TSP	786	295	541
MP	45	121	83
Insecticides	738	1018	878(4)
Interest on operating capital (8% for 6 months)	374	503	43 9(2)
Total variable cost:			
Cash cost basis	9346	12579	10963(53)
Full cost basis	21047	20790	20919

Figures in the parentheses are percentage of total cost.

Profitability

Table 5 revealed that the sample farmers received, on an average, 946 kg/ha of mungbean, which was higher than national average of 782 kg/ha (BBS, 2007). Islam *et al.* observed yield 928 kg/ha in 2007. Higher yield (961 kg/ha) was found in Noakhali compared to Patuakhali (930 kg/ha). Higher yield was found in Noakhali may be due to bctter management (i.e. use of manures and weeding their land). The average gross return from mungbean production was found to be Tk. 46423/ha and gross margin was found Tk. 25505/ha on full cost basis. The benefit cost ratio was estimated at 4.34 and 2.22 on cash cost basis and full cost basis, respectively. Total cash cost was found higher in Patuakhali due to high cost of insecticides, hired labour and land preparation cost. As a result, benefit cost ratio was lover in Patuakhali than Noakhali on both cash and full cost basis. The cost of grain was Tk. 11.63 on cash cost basis and Tk. 22.13 on full cost basis. On an average, benefit from per kilogram mungbean production was Tk. 26.97.

Table 4. Profitability of mungbean cultivation in the study areas.

Items	Locations		All
	Noakhali	Patuakhali	
Yield (kg/ha)	961	930	946
Gross return (Tk./ha)	47268	45578	46423
Total cost (Tk./ha):			
Cash cost basis	9346	12579	10963
Full cost basis	21047	20790	20919
Gross margin (Tk./ha)			
Cash cost basis	37922	32999	35461
Full cost basis	26221	24788	25505
Benefit cost ratio:			
Cash cost basis	5.06	3.62	4.34
Full cost basis	2.25	2.19	2.22
Cost of mungbean production (Tk/kg):			
Cash cost basis	9.73	13.53	11.63
Full cost basis	21.90	22.36	22.13
Benefit from mungbean (Tk/kg)	27.29	26.65	26.97

Maximum likelihood estimates of farm specific stochastic frontier production function and inefficiency model

The maximum likelihood esfimates for parameter of the Cobb Douglas Stochastic production function frontier of mungbean is presented in Table 6. Most of the parameters are statistically significant and positive. The empherical result indicated that the co-efficient of TSP was found positive and significant at 1% level, while that of land preparation, seed cost and urea cost were found positive but significant at 10 percent level. In other words, the elasticities of land preparation, seed, urea, and TSP were 0.018, 0.004, 0.002, and 0.004, respectively. It implied that this inputs had a significant and positive impact on mungbean production. The yield of mungbean would increase by 0.018, 0.004, 0.002, and 0.004 percent if farmers apply 1% additional cost for land preparation, seed, urea and TSP, respectively. The estimated coefficient of technical in-efficiency model showed that education and experience had significantly positive effect on the efficiency for mungbean production. It means that technical inefficiency in mungbean production decreases with the increase in farmers education and experience. Coelli and Battese (1996), Sharif and Dhar (1996), Seyoum *et.al.* (1998) observed significant positive correlation with education and experience. The estimated value of variance (σ^2) was significantly different form zero which indicated a good fit and correctness of specified distributional assumption.

Table 5. Maximum likelihood estimates of the stochastic Cobb-Douglas frontier production function and technical inefficiency model for mungbean.

Independent Variables	Parameters	Coefficient	Standard Error	t-ratio
Stochastic frontier				
Constant	β_0	6.64**	0.147	45.07
Ln Human labour (man-days/ha)	β_1	-0.003	0.017	-0.189
Ln Land preparation (Tk!ha)	β_2	0.018*	0.011	1.64
Ln Seed(Tk/ha)	β_3	0.004*	0.002	1.86
Ln Urea (kg/ha)	β_4	0.002*	0.001	1 .76
Ln TSP(kg/ha)	β_5	0.004**	0.001	3.71
Ln Insecticides (Tk./ha)	β_6	-0.001	0.002	-0.97
Dummy for source of seed	β_7	-0.008	0.009	-0.09
Technical inefficiency model				
Constant	δ_0	0.172*	0.021	1.80
Land size	δ_1	0.008	0.021	0.39
Age	δ_2	-0.001	0.003	-0.43
Education	δ_3	0.009**	0.002	-4.46
Experience	δ_4	0.002*	0.001	-1.62
Family size	δ_5	0.001	0.002	0.41
Variance parameters				
Sigma-squared	σ^2	0.007**		5.63
Gamma	γ	0.99**		54.66
Log likelihood function		222.67		

** and * indicate the significant at 1% and 10% level of probability, respectively,

Technical efficiency and it distribution

It is evident from Table 6 that the mean value of technical efficiency was 89% with a range from 82% to 99%. About 41% farmers produced outputs which were very close to the maximum frontier output level (91%–99%).

Table 6: Technical efficiency of mungbean growers in the study areas.

Technical efficiency	No. of farmers	% of total farmers
80%-90%	59	59
91%-99%	41	41
Mean efficiency	89%	
Maximum	99%	
Minimum	82%	

This implies that, on an average, the mungbean growers in the study areas were producing mungbean about 89 percent of potential frontier production levels, given the levels of their inputs and the technology currently being used. This also indicated that there existed an average level of technical inefficiency of 11 percent.

Constraints

Although mungbean was observed a profitable crop in the study area, there are several constraints to its higher production. The constraints are shown in Table 7. Cent percent farmers opined high price of fertilizers as a top ranked problem of mungbean production. Other major constraints were untimely rainfall (69%), incidence of diseases (65%), lack of quality seed (51%), and insect infestation (50%). Besides, lack of capital and lack of suitable land were also opined as the problem of mungbean cultivation.

Table 7. Constraints to mungbean cultivation in the study areas.

Items	Percent farmers' responded			Rank
	Noakhali	Patuakhali	All	
High price of fertilizers	100	100	100	1
Untimely rainfall	72	66	69	2
Incidence of diseases	68	64	65	3
Lack of quality seed	48	54	51	4
Insect infestation	44	56	50	5
Lack of capital	*25*	29	27	6
Lack of suitable land	22	14	18	7
Others*	13	17	15	8

* It means high price of seed and insecticides

Conclusion and Recommendations

The yield performance of mungbean is higher than national average in the study area. The mungbean production in the study areas is profitable. Mungbean farmers received high return on its investment. The estimated technical efficiency for mungbean varies from 82–99%, with an average efficiency 89%. This implies that the output per farm can be increased, on an average, 11% without incurring any additional production cost. The co-efficients of land preparation, seed, urea and TSP were found positive and significant. The coefficients of farmer’s education and experience had significant positive effect on efficiency for mungbean. If modern variety of seed and production technology is available to the farmers, yield and production can be increased which may help to increase their income and nutritional status. The farmers in the study areas require fair price of fertilizers, seed, and insecticides. They also desire to get quality seed, disease and insect tolerant variety for getting higher return from mungbean production.

Appendix 1. Area, production and yield of mungbean in Bangladesh.

Year	Area(ha)	Production(ton)	Yield(kg/ha)
1995/96	54888	32075	584
1996/97	55202	33785	612
1997/98	55004	34405	625
1998/99	55524	33880	610
1999/00	55239	36065	653
2000/0 1	52747	34220	649
2001/02	45538	31095	683
2002/03	44330	29580	667
2003/04	43680	29655	679
2004/05	43725	30000	686
2005/06	43680	34070	780

Source: BBS, 2007

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