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Assessment of Technical Efficiency of Potato Producers in Some Selected Areas of Bangladesh

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ABSTRACT

A study was carried out in three potato growing areas viz. Munshiganj, Bogra and Jessore covering 75 potato growers to measure technical efficiency and economic performance of potato production. Farmers obtained average tuber yield of 24.90 t/ha which was higher than the average yield of Bangladesh (14.90 t/ha) but close to potential yield (25-30 t/ha) of diamant and cardinal varieties. The estimated results showed that gross margin and BCR for potato cultivation were Tk. 174319/ha and 2.40, respectively. The average level of technical efficiency among the sample farmers was 75%. This implies that given the existing technology and level of inputs the output could be increased by 25%. Training on the potato production, extension linkage and quality seed played a significant role in the technical efficiency of the potato production.

Key words: Profitability, technical efficiency, potato producers.

INTRODUCTION

Potato (*Solanum tuberosum*) is the third largest food crop in Bangladesh. Its area and production are increasing day by day (BBS, 2005). In declaring 2008, the international year of the potato, the UN General Assembly seeks to focus world attention on the role of potato in defeating hunger and poverty. Usually farmers follow a different level of production inputs and management depending upon their infrastructural facility and socio-economic condition which ultimately result variability in yields. Potato, a high biomass yielder, utilizes huge quantities of nutrient particularly nitrogen, phosphorus and potassium (Elias *et al.,* 1992). The proper management of fertilizer is fully dependent upon the ability of the manager, his attitude, knowledge, skill and resource condition (Hossain and Islam, 1986). The relative efficiency in agricultural production is an important aspect in developing countries' agriculture (Radam and Latif, 1995). Farm efficiency has long been an area of interest in the investigation of farm operation. Farmers' production performance does not only depend on physical resources and technology available to them, but also on existing farm management conditions. Studies examining farming efficiency in developing countries, the production efficiency levels range 60-82% irrespective of crop types and regions (Rahman, 2003; Coelli *et al.,* 2002; Wang e*t al.,* 1996). The efficient use of resources is an important indicator of increased production in agriculture. Efficient use of inputs can help farmers to get higher production from a given amount of resources. Several studies in other countries have shown that there is significant potential for raising agricultural output or profitability by improving productive (technical

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and allocative) efficiency using existing resources (Rahman, 2002). The present study was, therefore, designed to measure technical efficiency of potato producers.

MATERIALS AND METHODS

Data collection

Based on area and production, the present study was conducted in the potato growing districts of Bangladesh to collect primary data. Among the three districts, high, moderate and low concentrated area was selected for each potato growing areas. Munshiganj was chosen as high concentrated area, Bogra as moderate concentrated area and Jessore as low concentrated area for potato production. Two villages were selected purposively for collecting farm level data from each district. A total of 75 farmers (25 farmers from each district) were selected purposively. Data were collected during April-May 2007. Pre-testing was done before finalizing the interview schedule. Secondary data on area and production related to potato were also used to supplement the information that was collected through field survey.

Empirical model

The Cobb-Douglas production function is used for functional analysis of the data. It is the most widely used model for fitting agricultural production data, because of its mathematical properties, ease of interpretation and computational simplicity (Heady and Dillon, 1969). It is a homogeneous function that provides a scale factor enabling one to measure the return to scale and to interpret the elasticity coefficients with relative ease. It is also relatively easy to estimate because in logarithmic form it is linear and parsimonious (Beattie and Taylor, 1985). Thus, Cobb-Douglas specification provides an adequate representation of the agricultural production technology.

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

$$LnY_i = \beta_0 + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \beta_5 LnX_{5i} + \beta_6 LnX_{6i} + \beta_7 LnX_{7i} + \beta_8 LnX_{8i} + \beta_9 LnX_{9i} + \beta_{10} LnX_{10i} + v_i - u_i$$

Where,

Ln = Natural logarithm,

Y_i = Yield of potato of the i-th farm (kg/ha)

X_{1i} = Human labor used by the i-th farm (man-days/ha)

X_{2i} = Seed used by the i-th farm (kg/ha)

X_{3i} = Nitrogen used by the i-th farm (Tk/ha)

X_{4i} = Phosphorus used by the i-th farm (kg/ha)

X_{5i} = Potassium used by the i-th farm (kg/ha)

X_{6i} = Sulfur used by the i-th farm (kg/ha)

X_{7i} = Cowdung used by the i-th farm (kg/ha)

X_{8i} = Ploughing cost of the i-th farm (Tk/ha)

X_{9i} = Pesticide cost of the i-th farm (Tk/ha)

X_{10i} = Irrigation cost of the i-th farm (Tk/ha)

$v_i - u_i$ = error term

v_i's were assumed to be independently and identically distributed random errors, had N $(0, \sigma_v^2)$ distribution.

Technical inefficiency effect model

The u_i's in equation were non-negative random variables, assumed to be independently distributed such that the technical inefficiency effect for the i[th] farmer, u_i, were obtained by truncation of normal distribution with mean zero and variance, σ_u^2, such that

$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i} + \delta_8 Z_{8i} + W_i$

Where,

z_{1i} = Ln operated land of the i-th farm operator (ha)

z_{2i} = Age of the i-th farm operator (years)

z_{3i} = Education level of the i-th farm operator (year of schooling)

z_{4i} = Family size of the i-th farm operator (persons/household)

z_{5i} = Experience in potato farming of the i-th farm operator (years)

z_{6i} = Dummy for potato training of the i-th farm operator (1 = yes, 0 = No)

z_{7i} = Dummy for extension linkage of the i-th farm operator (1 = yes, 0 = No)

Z_{8i} = Dummy for seed source (1 = Govt. organization, 0 = otherwise)

W_is were unobservable random variables 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_i 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

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ and

$\gamma = \sigma_u^2 / \sigma^2$

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 and inefficiency effect model was estimated in a single stage by using the Maximum Likelihood (ML) method with the help of computer software package FRONTIER 4.1 (Coelli, 1996).

RESULTS AND DISCUSSION

Agronomic profile

The study revealed that all the farmers used potato variety of Diamant and Cardinal. The average seed rate used by the farmers was 1.98 t/ha while Choudhury *et al.* (2006) suggested 2.20 t/ha seed rate for Munshiganj area. All the farmers apply high dose of nitrogen, phosphorus and potassium than the recommended dose. The average rate used by the farmers was 174, 93, 216 and 58 kg/ha of N, P, K and S, respectively (Table 1) against the recommendation by Hussain *et al.,* (2006) for N (100-115 kg/ha), P (24-30 kg/ha), K (110-125 kg/ha) and S (18-22 kg/ha), respectively. The farmers of Munshiganj applied 3-4 times of higher dose of N, P and K fertilizer than the recommended dose in the potato field (Choudhury *et al.,* 2006). Farmers believed that higher dose of fertilizer would be increased higher yield. But the previous study proved that fertilizer that applied by the farmers also increased the yield but it was not significant nor economically viable (Choudhury *et al.,* 2006). Only 56% of the farmers were found to apply cowdung in the field. Farmers received an average yield of 24.90 t/ha (Table 1) which was higher than the average yield of Bangladesh (14.90 t/ha) (DAE,

2007) but close to the potential yield of potato (Hussain *et al.,* 2006). It was observed from the previous study potato yield varied from 30 to 38 t/ha in different potato growing areas due to different fertilizer management options (Choudhury *et al.,* 2006).

Table 1. Agro-economic profile of potato production in the study areas during 2007

Item	Agronomic profile	Economic performance (Tk.)
A. Variable cost		
Cultivated area of potato (ha)	0.61	-
Variety used	Diamant /Cardinal	-
Sowing period	Last week of November to first week of December	-
Human labor (Man-days/ha)	259	25900 (20.81)
Seed (kg/ha)	1984	49600 (39.85)
Nitrogen (kg/ha)	174	2464 (1.98)
Phosphorus (kg/ha)	93	7922 (6.36)
Potassium (kg/ha)	216	6480 (5.21)
Sulfur (kg/ha)	58	1600 (1.29)
Cowdung (t/ha)	2.78	13900 (11.17)
Ploughing (no.)	2-3	4617 (3.71)
Pesticide (no.)	2-3	1873 (1.50)
Irrigation (no.)	2	973 (0.78)
Interest on operating capital (Tk.)	-	4152 (3.34)
Harvesting period	Last week of February to 1st week of March	-
Tuber yield(t/ha)	24.90	-
Total variable cost	-	119481
B. Fixed cost (Rental value of land)	-	5000 (4.00)
C. Total cost (A + B)	-	124481(100)
Gross return (Tk./ha)	-	298800
Gross margin (Tk./ha)	-	174319
Benefit Cost Ratio (BCR)	-	2.40

Figure in the parenthesis indicate percent of total cost
Note: Interest on operating capital has been calculated @ 12% for 4 month period.
Input price (Tk./kg): Potato seed (tuber) = 25, N = 14, P = 85, K = 30 and CD = 0.50, Potato tuber = 12

Economic performance

Among the variable cost, seed cost incurred the single highest cost followed by human labor cost for potato cultivation. Only seed tuber cost is about 40% of total cost of production in potato cultivation (Anon, 2002). Another study showed that the seed cost was 50-60% of the total variable cost of potato production (Hoque *et al.,* 2006). As potato is labor intensive for seed cutting, planting, mulching, fertilizer application, crop management, harvesting etc. it shared about 21% of the total variable cost (Table 1). Among the different inorganic fertilizers, phosphorus showed higher cost followed by potassium. The gross return, gross margin and BCR were obtained Tk. 298800/ha, Tk. 174319/ha and 2.40, respectively (Table 1). The BCR was close to Hoque *et al.,* (2006) who found BCR for potato cultivation was 2.41 to 2.92 in different treatment of cut size and spacing.

Effect of productivity variables

The empirical results indicated that the co-efficient of seed rate and potassium were positive and significant, while that of nitrogen, cowdung, ploughing cost and irrigation cost were positive but not significant (Table 2). It indicated that seed rate and potassium had significant and positive impacts on potato production. It might be due to lower seed rate and potash loving nature of potato. The coefficient of human labor and phosphorus were found negative and significant. Sulfur and pesticide cost were found also negative but insignificant. Holding other things remaining constant, the yield of potato would be increased by 0.223 and 0.216% as farmers spent 1% additional money for seed and applied 1% additional potassium, respectively. On the other hand, there was negative co-efficient found in human labor, phosphorus, sulfur and pesticide cost. It indicated that there was no need to invest on those items for potato production and if the investment was done on those items, the production would be decreased.

Effect of inefficiency variables

The estimated coefficients showed that training, extension linkage and dummy for seed sources were negative and significant in the inefficiency effect model (Table 2). It indicated that potato production would be increased with the increase of training, extension linkage and good quality seed. There was a positive effect of education, family size and potato farming experience on potato production but not significant. There was negative effect of cultivated potato land area and farmers' age but insignificant.

Table 2. Maximum likelihood estimates of the stochastic Cobb-Douglas frontier production function and technical inefficiency model for potato in the study areas (average)

Independent variables	Para- meters	Co-efficient	Standard error
Stochastic frontier model:			
Constant	β_0	0.792	0.996
Ln Human labor	β_1	-0.031*	0.359
Ln Seed	β_2	0.223*	0.635
Ln Nitrogen	β_3	0.015	0.638
Ln Phosphorus	β_4	-0.084*	0.541
Ln Potassium	β_5	0.216*	0.424
Ln Sulfur	β_6	-0.046	0.051
Ln Cowdung	β_7	0.031	0.194
Ln Ploughing cost	β_8	0.051	0.209
Ln Pesticides cost	β_9	-0.005	0.131
Ln Irrigation cost	β_{10}	0.009	0.282
Technical inefficiency model:			
Constant	δ_0	0.121	1.001
Ln cultivated area of potato	δ_1	0.083	0.834
Farmers age (years)	δ_2	0.011	0.024
Farmers education level (year of schooling)	δ_3	-0.021	0.062
Family size (person/farm)	δ_4	-0.030	0.086
Potato farming experience (years)	δ_5	-0.022	0.028
Dummy for potato training (1 = Yes, 0 = No)	δ_6	-0.269*	0.746
Dummy for Extension linkage (1 = Yes, 0 = No)	δ_7	-0.165*	0.922
Dummy for seed source (1 = Govt. org., 0 = others)	δ_8	-0.115*	0.981
Variance parameters:			
Sigma-squared	σ^2	0.075	0.046
Gamma	γ	0.968	0.480
Log likelihood function		25.806	

* indicate significant at 5% level of probability

Farm specific technical efficiency

It is revealed that farm-specific technical efficiencies varied from 46 to 97% with a mean of 75±14%. Maximum farmers were in the group of 71 to 80 followed by 81-90% efficiency group. Lower efficiency was in few farmers (Fig. 1).

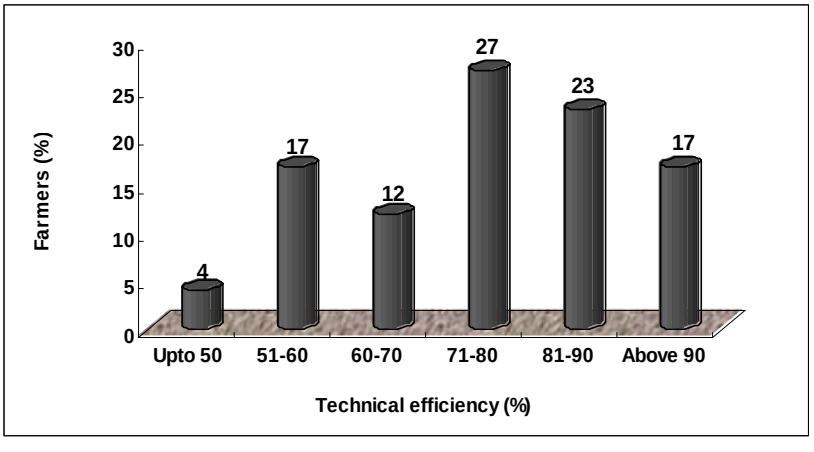

Fig. 1. Frequency distribution of technical efficiency of potato producers in the study areas

CONCLUSION

The average technical efficiency is 75% which meant that the average inefficiency appeared to be 25%. This implies that appropriate training to farmers on potato production and ensuring quality seed can play an important role in minimizing the technical inefficiency to a considerable extent.

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