Reprint **ISSN** 1923-7766 (Web Version)

International Journal of Experimental Agriculture

(Int. J. Expt. Agric.)

Volume: 4 **Issue: 2** **March 2014**

Int. J. Expt. Agric. 4(2): 5-11 (March 2014)

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An International Scientific Research Publisher

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ISSN-1923-7766 (Online)
Int. J. Expt. Agric. 4(2):5-11(March 2014)

TECHNICAL EFFICIENCY OF POTATO PRODUCTION IN SOME SELECTED AREAS OF RANGPUR DISTRICT OF BANGLADESH

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Accept for publication on 15 February 2014

ABSTRACT

Sarkar MMA, Yesmin F (2014) Technical efficiency of potato production in some selected areas of Rangpur district of Bangladesh. *Int. J. Expt. Agric.* 4(2), 5-11.

Technical efficiency of potato production in Bangladesh was carried out considering 60 farmers of Rangpur district. The period of the data collection covered from winter and summer season of 2012-2013. The results indicated that the range of technical efficiency varied from 60-99%. The mean efficiency of the potato producers was 88.6% which indicated that they made a production loss of 11.4% due to inefficiency factors. Farmers with 2nd week of December sowing (84.2%) were technically more efficient than the farmers with 1st week of December sowing. So, 2nd week in December sowing have positive impact on achieving higher technical efficiency of potato production. Farmer's with 3rd week of March harvest (85.6%) were technically more efficient than the farmers with 4th week of March harvest. So, harvest date in 3rd week of March have positive impact on increasing technical efficiency of potato producers. In all farms, technical efficiency was much higher (82.4%) for the farmers who use medium high land for potato production than the farmers who did not uses medium high land. So, land type highly influenced technical efficiency of potato production in the study area. Technical efficiency was much higher (86.5%) for the farmers who cultivate potato in sandy loam soil than the farmers who cultivate others type of soil. In all farms technical efficiency was much higher (82.5%) for the farmers who use cardinals variety for potato production than the farmers who used other varieties. So, potato varieties highly influence the technical efficiency of potato production in the study area. On the other hand, the technical efficiency of vegetable-rice-potato cropping pattern was higher than the farmers who did not use cardinals. So, vegetable-rice-potato cropping pattern highly influenced technical efficiency of potato production in the study area. In the study area, the farmers who contacted frequently with Sub Assistant Agriculture Officer are technically more efficient than who contacted less. Therefore, maintaining of optimum sowing and harvesting time, use of medium high land, use of sandy loam soil and maintain vegetable-rice-potato cropping pattern are important factors for obtaining maximum achievable yield.

Key words: *technical efficiency, potato, stochastic frontier production function, cropping pattern, Bangladesh*

INTRODUCTION

Potato (*Solanum tuberosum*) is the third largest food crop in Bangladesh. Its area and production are increasing day by day (BBS 2005). Agriculture is the single most dominant sector of Bangladesh economy. Growth and stability of Bangladesh largely depends on the growth of agriculture. In terms of GDP, Agriculture contributes about 19.29 percent (BBS 2012). The technical efficiency is an important indicator of increased potato production in agriculture in Bangladesh. In order to realize increased production and efficiency, small-scale farmers in developing countries need to efficiently utilize the limited resources accessed for improved food security and farm income generation (Amos 2007). 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 the low level of resource use is a characteristic feature. Lack of resource always adversely affects the agricultural production. The second important characteristic is the inefficient use of resources. Whatever resources available in the country, which are not being properly utilized up to the optimum level. For example, it is very often observed that the labor used in different crops in Bangladesh is significantly more than what is required. This is because of the underemployed family labor and cheap labor. On the other hand, inputs like fertilizer, irrigation and even management is always under used. 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). 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 and allocative) efficiency using existing resources (Rahman 2002). The present study was therefore designed to measure technical efficiency of potato growers. The main function of this technical efficiency research is to understand factors that shift production function upwards (Esparon and Sturgess, 1989). So in order to find out the farm specific technical efficiency and factor affecting inefficiency the study has been under taken. If the farm is technically efficient, then that firm is said to be cost effective (Chukwuji *et al*. 2006).

The specific objective of the present study is to estimate the level of technical efficiency of potato production and factors affecting inefficiency in potato farms of Rangpur district of Bangladesh using the stochastic frontier production function.

METHODOLOGY

Selection of the study area

Production economics investigation is generally done by selecting an area where the concerned crop is grown widely. Rangpur district was selected particularly as it is one of the leading potatoes producing areas of

Bangladesh. A preliminary survey was conducted in some villages of Rangpur sadar thana under Rangpur district to gather knowledge about the potato production, productivity and efficiency of the potato growers. After preliminary visit three village's namely Uttor Tumput, Dhakin Tumput and Fatemanogor were selected randomly as the study area.

Period of the study

The period of the data collection covered from winter and summer season of 2012-2013.

Selection of the sample and sampling techniques

A random sampling technique was applied for selecting sample. Through random sampling 60 farmers were selected for the study. Among the 60 farmers, 24 were marginal, 22 were small and 14 were medium. Farm size was arbitrarily classified on the basis of their land where they produce potato and other crops. Farmers having 50 decimal lands were considered as marginal farmers, 51 to 100 decimal as small farmers while those having 101 and above lands as medium farmers. It should be noted that no lands or having less than 50 decimal lands were not included in the present study.

Preparation of survey schedule

In conformity with the objectives of the study, a preliminary survey questionnaire was designed for recording data from the farmers. After pretesting, the questionnaire necessary corrections and modifications were made and then the questionnaire was finalized. The questions were arranged in logical sequences.

Methods of collecting data

The data for the present study were collected from primary and secondary sources. Primary data were collected by the researcher himself through personal interview with the respondents. To attain accuracy and reliability of data, care and caution were taken in data collection. Before interviewing, the aims and objectives of the study were explained to each and every owner of the potato growers.

Processing and analysis of data

Collected data were scrutinized and summarized for the purpose of tabulation. Data were transferred to a master sheet and complied with a view to facilitating classified. Technical efficiency analysis by Frontier 4.1 software. Two types of model namely Cobb-Douglas and translog also applied to measure the technical efficiency.

Technical Efficiency Analysis

A production function was used to examine the effect application of various inputs for producing potato. Among the production function it is generally urged that the Cobb-Douglas production function is more appropriate that in the concept of Agriculture production (Heady and Dillion, 1972). Farrel's (1957) seminar article on efficiency measurement led to the development of several approaches to efficiency and productivity analysis. Among these, the stochastic frontier production (Aigner *et al*. 1977; Meeusen and van den Broeck, 1977) and Data Envelopment Analysis (DEA) (Chames *et al*. 1978) are the two principal methods and for detailed information on efficiency measurement using the stochastic production frontier and DEA, including their strength, weakness, and estimation procedures, as noted by Coelli *et al*. (1998). The stochastic frontier is considered more appropriate than DEA in agricultural applications, especially in developing countries, where the data are likely to be heavily influenced by the measurement errors and the effects of weather conditions, diseases etc.

Empirical Model

Two types of function namely; Cobb-Douglas and translog dominate the technical efficiency literature. In this study, we assume that the Cobb-Douglas is the appropriate form of the frontier production function. The stochastic production function which is used for the potato producers was specified as:

Cobb-Douglas production function model

The stochastic production function which is used for the potato producers was specified as:

$$\ln Y_i = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \beta_3 \ln(X_3) + \beta_4 \ln(X_4) + \beta_5 \ln(X_5) + \beta_6 \ln(X_6) + \beta_7 \ln(X_7) + \beta_8 \ln(X_8) + \beta_9 \ln(X_9)$$

Where,

ln = Natural logarithm
Y = Gross return (Taka/ha)
β_0 = Constant or intercept value
X_1 = Total seed cost (Taka/ha)
X_2 = Pest management cost (Taka/ha)
X_3 = Cost of fertilizer (Taka/ha)
X_4 = Cost of family labor (Taka/ha)
X_5 = Cost of mechanical power (Taka/ha)
X_6 = Land use cost (Taka/ha)
X_7 = Variety dummy 1if HYV, 0 otherwise
X_8 = Extension contact dummy 1 if contacted, 0 otherwise
X_9 = Total return from potato (Taka/ha)

The technical inefficiency effects U_i are defined as:

$$U_i = \delta_0+\delta_j Z_i+W_1$$

Where

i = (1, 2, 3, 4, 5, 6)
Z_1 = Age of the farmers
Z_2 = Education of the respondents (Measured in year of schooling)
Z_3 = Farming experience (Measured in year of farming)
Z_4 = Land type dummy (1 if medium high and 0 otherwise)
Z_5 = Soil type dummy (1 if sandy loam soil and 0 otherwise)
Z_6 = Variety dummy (1 if cardinals and 0 otherwise)
Z_7 = Frequency of Extension Contact (1 if contracted and 0 otherwise)

RESULTS AND DISCUSSION

Estimates of Stochastic frontier production function

Efficiency and inefficiency factors of potato production

Maximum likelihood parameter estimates (MLE) of stochastic frontier production function of potato farmers showed that among the selected variables such as hired labor cost, family labor cost, seed cost, interest on operating capital and irrigation cost were significant whereas, mechanical power cost, fertilizer cost, pesticides and insecticides cost, land rent, and cow dung cost were not significant (Table 1). For the inefficiency variables, farm size had significant impact on the return from potato. The positive sign of the coefficient of farm size indicates that it increases the efficiency level in potato cultivation. Education and farming experience of the farmer was significant. Education and farming experience enhance to the efficiency level of potato production in the study area. Age and frequency of extension contact was irresponsive to the efficiency level in potato production.

Table 1. Maximum likelihood estimates of parameter of the stochastic frontier production function and inefficiency model of potato production in the Rangpur district of Bangladesh

Variables	Parameter	Co-efficient	S.E
Constant	β_0	4.22	.665
In Family labor cost	β_1	.133*	.042
In Hired labor cost	β_2	.392*	.041
In Mechanical power cost	β_3	.081^{NS}	.049
In Seed cost	β_4	.172*	.069
In Urea cost	β_5	-.051^{NS}	.115
In TSP cost	β_6	-.057 ^{NS}	.022
In MP cost	β_7	.029 ^{NS}	.097
In pesticides cost	β_8	.011 ^{NS}	.013
In insecticides cost	β_9	.139 ^{NS}	.077
In Irrigation cost	β_{10}	.072*	.033
In Land rent	β_{11}	-.077 ^{NS}	.051
In Interest on operating capital	β_{12}	.108*	.049
In Cow dung cost	β_{13}	-.001 ^{NS}	.004
σ^2	.263		.053
γ	.999		.054
Constant	δ_0	3.05	.999
Age of farmers	δ_1	-.043 ^{NS}	.014
Education of farmers	δ_2	.057*	.029
Farming experience in years	δ_3	.349*	.070
Land type dummy	δ_4	.140 ^{NS}	.64
Soil type dummy	δ_5	.618*	.247
Variety dummy	δ_6	.389 ^{NS}	.240
Frequency of extension contact		-.187 ^{NS}	.197

SE = Standard Error of Mean
*Significant at 5% level of probability
^{NS} Non significant

Farm specific technical efficiency

Descriptive statistics of farm's specific technical efficiency are presented in Table 2. The mean efficiency of the potato producers was 88.57%, which indicates that they were made a production loss of 11.43% due to inefficiency factors. In other words, they were 11.43% apart from the frontier level. There was a wide variation in farm specific technical efficiency levels of potato producers. It ranged from 60 to 99%, with a standard error of mean 1.04% and a variance of 62.78%. The skewness and kurtosis of potato production were –1.10 and 1.02, respectively.

Table 2. Descriptive statistics of farm specific technical efficiencies in potato cultivation in Rangpur district of Bangladesh

Items	Descriptive statistics
Number of farmers	60
Minimum efficiency (%)	60
Maximum efficiency (%)	99
Mean efficiency (%)	88.57
Standard Error of Mean	1.04
Variance	62.78
Skewness	-1.10
Kurtosis	1.02

Showing date and technical efficiency

In case of optimum sowing marginal farmer's efficiency level was comparatively higher in 2nd week of December (78.7%) than 1st week of December (70.8%). Similar picture was found in case of small farms. But in case of medium farm 1st week of December (96.7%) was efficiency than 2nd week of December (85.0%). If we consider all farm size then we also found that farmers 2nd week of December sowing was technically more efficient than the farmers with 1st week of December. So, 2nd week in December sowing have positive impact on achieving higher technical efficiency of potato production.

Table 3. Relationship between date of sowing and technical efficiency of potato production in Rangpur district of Bangladesh

Date of sowing	Farm size*			All farm
	Marginal	Small	Medium	
1st week of December	70.84±6.63**	82.97±3.24	96.65±1.01	80.73±3.31
2nd week of December	78.69±4.66	91.42±3.21	85.03±2.73	84.23±2.44
Group Total	75.09±3.94	86.43±2.45	89.18±2.33	82.54±2.03

*Farm size: Marginal (50 decimal), small (51 to 100 decimal), and medium (101 decimal and above)
**Mean ± SE (Standard Error of Mean)

Harvesting date and technical efficiency

Third week of March harvest was efficient harvest date in case of small (87.9%) and medium (92.9%) farmers (Table 4). Opposite picture was found in case of marginal farms. If we consider all farms we found that farmer's with 3rd week of March (85.6%) were technically more efficient than the farmers with 4th week of March. So, harvest date in 3rd week of March have positive impact on increasing technical efficiency of potato producers.

Table 4. Relationship between harvesting date and technical efficiency of potato production in Rangpur district of Bangladesh

Date of Harvesting	Farm size*			All farm
	Marginal	Small	Medium	
3rd week of March	72.23±9.68**	87.86±2.47	92.87±2.04	85.56±2.78
4th week of March	76.23±4.10	79.99±7.61	85.49±3.86	79.08±2.89
Group Total	75.09±3.94	86.43±2.45	89.18±2.33	82.54±2.03

*Farm size: Marginal (50 decimal), small (51 to 100 decimal), and medium (101 decimal and above)
**Mean ± SE (Standard Error of Mean)

Land type and technical efficiency

The technical efficiency of potato production in medium high land was comparatively higher (86.8%) than the other land for small farmers (Table 5). Similar picture was found in case of medium farmers (89.2%). Technical efficiency was 100 percent in medium high land in marginal farm. In all farms technical efficiency was much higher (82.4%) for the farmers who uses medium high land for potato production than the farmers who did not uses medium high land. So, land type highly influenced technical efficiency of potato production in the study area.

Table 5. Relationship between land type and technical efficiency of potato production in Rangpur district of Bangladesh

Land type	Farm size*			All farms
	Marginal	Small	Medium	
Medium high land	75.09±3.94**	86.84±2.67	89.23±2.52	82.44±2.14
Medium land	--	72.30±2.48	88.52±1.94	80.41±2.52
Group Total	75.09±3.94	79.57±2.45	89.18±2.33	81.43±2.03

*Farm size: Marginal (50 decimal), small (51 to 100 decimal), and medium (101 decimal and above)
**Mean ± SE (Standard Error of Mean)

Soil type and technical efficiency

The technical efficiency of potato production in sandy loam soil is comparatively higher (87.4%) than the other soil for small farmers (Table 6). Similar picture was also found in case of medium farms (98.6%). In all farms technical efficiency was much higher (86.5%) for the farmers who uses sandy loam soil for potato production than the farmers who did not uses sandy loam soil.

Table 6. Relationship between soil type and technical efficiency of potato production in Rangpur district of Bangladesh

Soil type	Farm size*			All farm
	Marginal	Small	Medium	
Sandy loam	73.51±4.23**	87.42±3.30	98.55±3.11	86.49±3.47
Loamy	75.74±5.36	86.14±3.05	88.46±2.40	83.02±2.42
Group Total	75.09±3.94	86.43±2.45	89.18±2.33	82.54±2.03

*Farm size: Marginal (50 decimal), small (51 to 100 decimal), and medium (101 decimal and above)
**Mean ± SE (Standard Error of Mean)

Variety used and technical efficiency

The technical efficiency of potato production in Cardinal variety was comparatively higher (73.9%) than the other variety for marginal farmers (Table 7). Similar picture was also found in case of small (86.8%) and medium farmers (89.2%). In all farms technical efficiency was much higher (82.5%) for the farmers who uses cardinals for potato production than the farmers who did not uses cardinals. So, variety highly influenced technical efficiency of potato production in the study area.

Table 7. Relationship between variety used and technical efficiency of potato production in Rangpur district of Bangladesh

Variety used	Farm size*			All farm
	Marginal	Small	Medium	
Diamonds	69.77±7.06**	84.99±2.86	88.52±1.89	79.39±3.64
Cardinals	73.86±4.67	86.75±2.95	89.23±2.52	82.50±2.34
Group Total	75.09±3.94	86.43±2.45	89.18±2.33	80.94±2.03

*Farm size: Marginal (50 decimal), small (51 to 100 decimal), and medium (101 decimal and above)
**Mean ± SE (Standard Error of Mean)

Cropping pattern and technical efficiency

The technical efficiency of potato production in vegetable-rice-potato cropping pattern was comparatively higher (88.3%) than the other cropping pattern for marginal farmers (Table 8). Similar picture was also found in case of small (86.4%) and medium farmers (89.2%). In all farms technical efficiency was much higher (87.6%) for the farmers who used vegetable-rice-potato for potato production than the farmers who did not uses Cardinal. So, vegetable-rice-potato cropping pattern highly influenced technical efficiency of potato production in the study area.

Table 8. Relationship between cropping pattern and technical efficiency of potato production in Rangpur district of Bangladesh

Cropping pattern	Farm size*			All farm
	Marginal	Small	Medium	
Rice-Potato-Rice	72.44±4.37**	--	--	72.44±4.37
Vegetable-Rice -Potato	88.34±6.39	86.43±2.45	89.18±2.33	87.58±1.66
Group Total	75.09±3.94	86.43±2.45	89.18±2.33	82.54±2.03

*Farm size: Marginal (50 decimal), small (51 to 100 decimal), and medium (101 decimal and above)
**Mean ± SE (Standard Error of Mean)

Contact of Sub Assistant Agriculture Officer and technical efficiency

The farmers who contacted frequently with Sub Assistant Agriculture Officer technically more efficient than who contacted less (Table 9). In all farm category highest technical efficiency (84.1%) was achieved by those farmers who contacted with Sub Assistant Agriculture Officer during the production period. Less technical efficiency (78.9%) was achieved by the farmers who did not contact with Sub Assistant Agriculture Officer during the production period. The trend was similar for different farm category.

Table 9. Relationship between technical efficiency and Contact of Sub Assistant Agriculture Officer according to farm size and study area

Contact of Sub Assistant Agriculture Officer	Farm size*			All farm
	Marginal	Small	Medium	
Yes	75.83±5.47**	89.14±2.20	89.29±2.52	84.12±2.49
No	73.62±4.96	82.51±4.97	87.67±3.65	78.85±3.42
Group Total	75.09±3.94	86.43±2.45	89.18±2.33	82.54±2.03

*Farm size: Marginal (50 decimal), small (51 to 100 decimal), and medium (101 decimal and above)

**Mean ± SE (Standard Error of Mean)

CONCLUSION AND RECOMMENDATION

In order to quantify determinants of inefficiency of potato production some socio-economic variables were included in the stochastic frontier production function. In Rangpur district, farmers with 2nd week of December sowing were technically more efficient than the farmers with 1st week of October. Farmer's with 3rd week of March harvest were technically more efficient than the farmers with 4th week of March. In all farms technical efficiency was much higher for the farmers who use medium high land for potato production than the farmers who did not use medium high land. In all farm categories, technical efficiency was much higher for the farmers who use sandy loam soil for potato production than the farmers who used others type of soil. In all farms technical efficiency was much higher for the farmers who use Cardinal variety followed by other variety. For the inefficiency variables, farm size had significant impact on the return from potato. The positive sign of the coefficient of farm size indicates that it increases the efficiency level in potato cultivation, but age and frequency of extension contact was not significant. Age and frequency of extension contact was irresponsive to the efficiency level in potato cultivation. The average technical efficiency is 88.6% which meant that average inefficiency appeared to be 11.4%. This implies that appropriate training to farmers on potato production, maintaining of optimum sowing and harvesting time, use of medium high land, use of sandy loam soil, maintaining vegetable-rice-potato cropping pattern and ensuring quality seeds can play an important role in minimizing the technical efficiency to a considerable extent.

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