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Research Article

Technical efficiency of potato production in mid western terai region of Nepal

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ABSTRACT

A study was done in 2018 to estimate the technical efficiency of potato production in mid western terai region of Nepal.30 households each from Dang, Banke and Bardiya districts were interviewed. Maximum likelihood estimate of the parameter showed the mean technical efficiency of 0.79 which indicated a high scope of increasing the production with the improvement of production technology. The coefficient for the parameter seed, Urea, DAP, MOP and labour were positive contributing for the production of potato. The parameter Compost, pesticides, herbicides and hour of tractor use were negative. The use of these input could be improved for increasing the production of potato. The farm specific variables Education, contact with the extension agent and farm size showed negative coefficient which causes less inefficiency of the farmers in production of potato while the coefficient for Age was estimated to be positive.

Keywords: Efficiency, Inefficiency, Maximum likelihood Estimate, Potato

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INTRODUCTION

Potato is considered as one of the fourth most important crops in the world after rice maize and wheat in terms of area and coverage and second in the production. It is used as a major vegetable crop in terai and mid hills of Nepal. It is one of the important cash crops to address food insecurity and reduce poverty among smallholder farmers in the developing countries like Nepal (Timsina et al, 2013). Nepal is one of the top twenty countries where potato contributes substantially for the human diet (Subedi et al., 2019). Potato is the third most important food crop in the world after rice and wheat in terms of human consumption. More than a billion people worldwide eat potato, and global total crop production exceeds 300 million metric tons. Potato is a critical crop in terms of food security in the face of population growth and increased hunger rates. Potatoes are an excellent, low-fat source of carbohydrates, with one-fourth the calories of bread. They have more protein than maize and nearly twice the calcium. An average serving of potatoes with the skin on provides about 10 percent of the recommended daily intake of fiber (CIP, 2019). Potatoes have 54% more protein per unit area than wheat and 78% higher than rice. Potato is cultivated as a subsistence crop which is the best potential for yield increment and consists of high starch (16.1/100 g), protein (2.1/100 g), vitamin C (17.1 mg/100 g), potassium (443 mg/100 g) and essential amino acids (CIP, 2019). Total area and production of potato is 1,97,037 hectares and 25,86,287 ton respectively (MoAD, 2014). Potato production plays an important role in the economy of Nepal. It accounts for 42.46% in total vegetable cropped area of Nepal providing economic benefits as well as creating employment opportunity for the rural farmers (MoAD, 2012).

Though Potato production in the past years has increased by more than 43%, production of potato in Nepal is still lowest while compared to that the world (MoAD, 2012). Low productivity is still a big challenge. The yield gap is high (5-7 t/ha) depending on the varieties and agro ecological regions. The import of Potato in the Year 2015 is 2,06,621 mt while its export is 405 MT (TEPC, 2016)

The major concern in Nepalese potato farming is limited resources available with the farmers, and inappropriate and inefficient use of these resources leading to chronic inefficiency in potato production. Despite of the release of the number of high yielding varieties of potato, lower productivity is still a challenge. Labor is one of the important factors in potato production where all the farming activities are carried out by labor manually. Nepalese farmers use compost rather than chemical fertilizers for plant nutrients since fertilizer is not available to the farmers in adequate quantity, and the quality is also not certain (Bozoğlu & Vedat ,2007; Donkoh et al.,2013; Nwauwa et al., 2013). It is difficult to increase potato production by increasing the area of land under cultivation due to the limitation of land. But, there is an opportunity to increase production of potato by improving the existing production technology. Technical efficiency deals with the capacity of farm to produce the optimum level of output with a given level of inputs.

Farmers may be relatively inefficient due to land fragmentation, less experience, illiteracy, etc. Production is complex process where different inputs with different combinations are used. It is a function of farm inputs including land, labour, capital, management practices and other factors. Production not only depends on these resources only but the combinations of

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different inputs have a great contribution in total productivity. The input use level and its combinations are different across farms resulting different yields. Furthermore there is a wide gap in yields of experimental stations and farmer fields indicating the suboptimal use of inputs. Efficient use of inputs can help farmers to get higher production from a given amount of resources. Farmers are expected to operate rationally, maximizing profits while minimizing costs. When farmers are not operating efficiently, it implies either that they are employing more units of input to produce the same level of output, or that they produce less output from the same level of inputs as another, more efficient, farmer. This leads to the increase in the cost of production and thus making the enterprise less profitable. Identification of factors influencing inefficiency can assist .The main objective of the present study is to estimate technical efficiency in potato production in mid western development region, by employing the stochastic production frontier approach and to determine the sources of inefficiency in order to develop policy parameters to improve the existing situation.

MATERIALS AND METHODS

Study area

The study was conducted in Hirmuniya area of Banke, Mainapokhar area of Bardiya and Satbariya of Dang district of Nepal. The reasons for selecting the district was because of its contribution in potato production which accounted for 1,19,765 Metric tons of potato production in 8850 hectares of land with productivity 13 to 15 t/ha. Majority of the farmers in the study found to be semi commercial in nature. The study area is characterized by limited availability of the input. A total of 90 samples, 30 from each district were chosen by using a simple random sampling technique among the potato growers. A well-structured and field pretested comprehensive interviewing schedule was used for collection of detailed information. Survey data had information on socioeconomic characteristics of the farmers and input output quantities along with the prices of the input.

Empirical model

The study adopted stochastic frontier analysis (SFA), version 4.1, developed by Battese and Coelli (1996). One stage procedure was adopted to measure the unknown parameter and for determining farm-specific factors influencing inefficiency in potato production. Battese and Coelli stochastic frontier model is specified as:

$y_i = f(x_i ; \beta) + v_i - u_i$, Where,
y_i is output of the farm-firm in natural logarithm
x_i is a 1x k vector of farm inputs in natural logarithm
β is a k x 1 vector of parameters to be estimated;

Also, while v_i measures the random variation in output (y_i) due to factors outside the control of the farm-firm such as weather and natural disasters, u_i on the other hand measures the factors (within the control of the firm) responsible for that firm's inefficiency such as Age, education, experience, contact with the extension agent . v_i is assumed to be identically and independently distributed. The technical inefficiency effect, u_i, in the stochastic frontier model could be specified in the given equation;

$u_{i,} = Z_i \delta + W_i$, where the random variable, W_i, is defined by the truncation of the normal distribution with zero mean and variance, σ^2.

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The stochastic frontier production function to be estimated in our study is as:

$Ln(Y_i) = \beta_1 ln\ (Seed) + \beta_2 ln(Urea) + \beta_3 ln(DAP) + \beta_4 ln(MOP) + \beta_5 ln(Compost) + \beta_6 ln\ (pesticides\ and\ herbicides) + \beta_7 ln(labour) + \beta_8 ln(tractor\ hour) + v_i - u_i$

Dependent variable yield is the quantity of output produced. Independent variables Seed, Urea, DAP, MOP, compost, pesticides and herbicides are the quantity applied; laour represents average number of labour used per hectare and tractor hour is the average hour of tractor used per hectare. All these variables are converted into log value.

Technical inefficiency was considered as a function of five farm-specific variables such as Age, education level of the head of household, contact with the extension agent, and farm size to analyse the influence of these variables on inefficiency of potato production. The literature indicates that a range of socio-economic determine the efficiency of farms (Seyoum *et al.* (1998); Coelli and Battese (1996); Wilson *et al.* (1998)) and another set of studies concluded farm size, education (Kalirajan & Flinn, (1983); Lingard *et al.* (1983); Shapiro and Muller (1977); Kumbhakar (1994)) is important determinants of efficiency.

$u_i = \delta_0 + \delta_1 Age + \delta_2 Education + \delta_3 Extension\ contact + \delta_4 farm\ size$

Except for the inefficiency effect variables, all the variables are in their natural logarithm. Education is farmers' years of formal education. Farm size is the size of the farmers' plot in hectares. Extension contact was used as a dummy variable. Farmers who were in contact with the extension agents were assigned the value 1 and otherwise 0.

RESULTS AND DISCUSSION

The descriptive statistics of the variable used in the study is presented in Table 1. The table shows the minimum, maximum and average value of the variable used in the model. The average size of the farm in the study site is 0.27 ha. The seed rate of potato in the study sites was found to be 2094.08 kg/ha with average yield of 16208.77 kg/ha. The average use of Urea, DAP and MOP, compost in the study site was calculated to be 115.96, 201.48 and 71.69 kg/ha and 34373.04 kg/ha respectively. The average quantity of chemical was 11.59 kg/ha. The average number of labour and hours of tractor use was 38 and 3.07 per hectare respectively. The mean schooling year of the respondent is 6.41.

Table 1: Descriptive statistics of variables of potato production

Variables	Minimum	Maximum	Average	Standard deviation
Seed (kg/ha)	750.00	3750.00	2094.08	682.67
Yield (kg/ha)	5400.00	33000.00	16208.77	9453.01
Urea (kg/ha)	30.00	450.00	115.96	82.74
DAP (kg/ha)	30.00	750.00	201.48	184.16
MOP (kg/ha)	30.00	187.50	71.69	47.56
Compost (kg/ha)	3000.00	60000.00	34373.04	15535.78
Qty chemical (kg/ha)	1.09	48.00	11.59	9.10
No of labours	7.00	160.00	38.00	31.64
Hours of tractor	0.50	7.00	3.07	1.45
Age (yrs)	8.59	70.00	43.63	13.29

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Education (no of schooling years)	0.00	16.00	6.41	4.25
Farm Size (ha)	0.07	2.00	0.27	9.04
Extension cont (no)	0.00	1.00	0.37	0.62

ESTIMATION OF THE STOCHASTIC FRONTIER

The results of the Maximum Likelihood Estimation for the cobb douglas production function is presented in Table 2. The sign of all the variables in maximum likelihood estimate is positive except for compost use, chemical pesticide and herbicide and the hour of tractor use. This may be due to the fact that farmers are not using these input as recommended dose. A study done by Abedullah et al., in Pakistan in 2006 also showed the negative coefficients for the use of fertilizer including the compost whereas the study done by Alam et al.,(2012) in Pakistan showed positive coefficient for fertilizers. The Cobb-Douglas production function parameters can be interpreted directly as output elasticities. The parameters of the seed, urea, DAP, MOP, labour are positive and significant at 5% level of significance. A one percent increase in these variables increases the yield of potato by 0.501, 0.155, 0.97, 0.335 and 0.364 % respectively. A study done by shrestha et al., in 2010 in Eastern Hills of Nepal also found positive parameter for these variables. Similar was the case in the study done by Abedullah et al. (2006). It is observed that the MLE estimate of γ is 0.824. This is consistent with the theory that the true γ-value should be greater than zero and less than one. The value of the γ-estimate is significantly different from one, indicating that random shocks are playing a significant role in explaining the variation in potato production, which is expected especially in the case of agriculture where uncertainty is assumed to be the main source of variation. However, it should be noted that 82% of the variation in yield is due to technical inefficiency and only 18% is due to the stochastic random error. The value of the Likelihood ratio rejected the null hypothesis of technical efficiency showing the presence of technical inefficiency. So, in order to investigate the determinants of inefficiency, we estimated the technical inefficiency model.

The coefficient of Age is positive which indicates that the older farmers are more inefficient than the younger ones. The negative estimate for education implies that farmers with greater years of schooling tend to be less inefficient. The coefficient of the parameter extension agent is negative. Consultation with extension workers significantly contributes to improved technical efficiency in potato production and this implies that the extension department should be one of the major targeted variables from the policy point of view in order to improve technical efficiency in potato production. Hence, there is a need to strengthen the role of the extension department in the crop sector and to make its role more effective. Due to a lack of extension services and their effective role, we find that farmers also discuss their crop related problems with input dealers. Abedullah et al. (2006) also found a positive parameter for Age ,negative parameter for Education and negative parameter for Extension contact. Farmers with large farm size are supposed to be less inefficient. The findings of Ogundele and Okoruwa (2004) shows that farm size significantly determines levels of technical efficiency. The results further indicate that increasing the farm size has a positive effect upon the technical efficiency of potato production. This might be because large farmers have much greater access to the input, public services and credit facilities.

The mean technical efficiency is 79% indicating that further potential exists to improve productive efficiency of the resources allocated to potato production. Shrestha et al.,2010 also

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found the mean technical efficiency of 79% in vegetable farming in Eastern hills of Nepal. The estimated mean technical efficiency is less than that found by Amara, *et al.* (1999) for potato farmers (80.27%) in Quebec, Canada and above than Bakhsh et.al,(2006) for potato (76..0%) in Pakistan. Bravo-Ureta and Pinheiro (1993), Taylor and Shonkwiler (1986) estimated technical inefficiency between 30-34% in the Dominican Republic, Brazilian and Tanzanian agriculture. The value of σ^2 is 0.69 which suggest that the technical inefficiency effects were a momentous component to the total variability of the yield of potato crops.

Table 2. Maximum Likelihood Estimates of the Cobb Douglas Stochastic production Frontier Function

parameters	coefficient	Standard error	t-ratio
Technical efficiency effect			
β_0	0.369	0.123	0.298**
β_1	0.501	0.116	0.430**
β_2	0.155	0.137	0.113**
β_3	0.97	0.946	0.102**
β_4	0.335	0.104	0.320**
β_5	-0.498	0.710	0.701
β_6	-0.141	0.569	-0.248
β_7	0.364	0.132	0.274**
β_8	-0.157	0.828	-0.189
σ^2= .69			
γ=.78			
Mean technical efficiency = 0.79			
Technical inefficiency effect			
δ_1	0.241	0.345	0.698
δ_2	-0.180	0.106	-0.169**
δ_3	-0.222	0.108	0.205**
δ_4	-0.396	0.761	-0.520**

CONCLUSIONS

The study employed the stochastic production frontier approach to estimate technical inefficiency in potato production. It is observed that potato farmers are 79 percent technically efficient, indicating that a substantial potential exists that can be explored by improving resource use efficiency in potato production. The coefficients on compost,chemical pesticides and herbicides and tractor hour used is negative but insignificant implying that these inputs are possibly being over utilized. The MLE results indicate strong evidence that farm size, level of education, extension contact are important factors for improving technical efficiency level for potato production. Future research should focus on determining the optimum use of these inputs for potato production. Such information will facilitate policy managers to strike a balance in resource allocation among agricultural and non-agricultural sectors and even among different crops within the agricultural sector.

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Authors contribution

Basistha Acharya and Tara Sharma did a survey on the project. Jeevan Lamichhane analysed the data and prepared the manuscript.

Conflict of interest

The authors declare that there is no conflicts of interest regarding publication of this manuscript

REFERENCES

Abedullah, B. K., & Ahmad, B.(2016). Technical Efficiency and its Determinants in Potato Production, Evidence from Punjab, Pakistan. *The Lahore Journal of Economics (Winter 2006),11*(2), 1-22.

Abedullah,W., & Hoffman, J.(2000). Efficiency estimation from cob-douglas production function with composed error. *International Economic review*, 18, 435-444.

Amara, N., N. Traoré, R., & Romain, R.(1999). Technical efficiency and farmers' attitudes toward technological innovation: *The case of the potato farmers in Quebec. Canadian Journal of Agricultural Economics, 47*(3), 1-43.

Arif, A., Kobayashi, H., Matsumura, I., & Esham, M. (2011). A comparative economic analysis of crop production between improved and traditional irrigation system: *A case study of a village from Gilgit district in NAs of Pakistan. Journal of Rural innovatuions in Pakistan*, 47, 132-137.

Bozoğlu, M., & Vedat, C. (2007). "Measuring the Technical Efficiency and Exploring the Inefficiency. *Determinants of Vegetable Farms in Samsun Province, Turkey".Agricultural Systems, 94* (3), 649-656.

Bravo-Ureta, B., & Pinheiro , A. (1997). Technical, Economics, and Allocative Efficiency in Peasant Farming. *Developing Economies and Dominican Republic, 35*(1), 48-67.

Coelli, T.J. & Battese, G. (1996). Identification of Factors which Influence the Technical Inefficiency of Indian Farmers, *Australian Journal of Agricultural Economics,* 40, 103-128.

CIP. Potato facts, (2019). *Processed. Lima: International Potato Center (CIP)*, 1- 4

Donkoh, S. A., M. Tachega, & Amowine, N.(2013). "Estimating Technical Efficiency of Tomato Production in Northern Ghana". *American Journal of ExperimentalAgriculture, 3* (1), 23-25

Kalirajan, K.P., & Flinn, J.C.(1983). The Measurement of Farm-Specific Technical Efficiency, *Pakistan Journal of Applied Economics*, *2*(2), 167-80.

Kumbhakar, S.C. (1994). Efficiency Estimation in a Profit Maximizing Model Using Flexible Production Function, *Agricultural Economics*, *10*, 143-152.

Lingard, J., Castillo, L.,& Jayasuriya, S. (1983). Comparative Efficiency of Rice Farms in Central Luzon, the Philippines, *Journal of Agricultural Economics*, *34*(2), 163-173.

MoAD (2012). Statistical Information on Nepalese Agriculture. *Agribusiness Promotion and Statistics Division.Ministry of Agriculture.*

MoAD (2014). Statistical Information on Nepalese Agriculture. *Agribusiness Promotion and Statistics Division.Ministry of Agriculture.*

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Nwauwa, L. O. E. (2013). "Determinants of Profit Efficiency of Small-Scale Dry Season Fluted Pumpkin Farmers Under Tropical Conditions: *A Profit FunctionApproach." International Journal of Vegetable Science*, *19* (1), 13-20.

Ogundele, F.O., & Okoruwa, V.O. (2004). "A comparative analysis of technical efficiency between traditional and improved rice variety farmers in Nigeria". *African Journal of Economic Policy*, *11*(1), 91–108.

Seyoum, E.T., Battese, G.E., & Fleming, E.M. (1998). Technical Efficiency and Productivity of Maize Producers in Eastern Ethiopia: *A Study of Farmers Within and Outside the Sasakwa-Glabal 2000 Project*, *Agricultural Economics*, 19, 341-348.

Shapiro, K.H., & Muller, J.(1977). Sources of Technical Efficiency. *The Role of Modernization and Information*, *Economic Development and Cultural Change*, *25*, 293-310.

Shrestha, R.B, Huang, W.C, Pradhan, U. (2010). Resource Use Efficiency in Vegetable Produc tion in the High Hills of Eastern Nepal. *Nepalese Journal of Agricultural Economics*, *2*(3), 79-87.

Subedi, S., Ghimire, Y. N, Gautam, S , Poudel, H. K., & Shrestha, J. (2019). Economics of potato (*Solanum tuberosum* L.) production in terai region of Nepal. *Archives of Agriculture and Environmental Science*, 4(1), 57-62.

Taylor, G.T., & Shonkwiler, J.S. (1986). Alternative Stochastic Specification of the Frontier Production Function in the Analysis of Agricultural Credit Programs and Technical Efficiency, *Journal of Development Economics*, *21*, 149-160.

TEPC. (2016). Export Import Data Bank. Trade and Export Promotion centre. *Ministry of commerce and supplies.Pulchowk*, *Lalitpur*.

Timsina, K.P., Kafle, K., & Sapkota, S. (2013). Economics of potato (*Solanum tuberosum* L.) production in Taplejung district of Nepal. *Agronomy Journal of Nepal*. *2*, 173–81.

Wilson, P., Hadley, D. Ramsden, S., & Kaltsas, I. (1998). Measuring and Explaining Technical Efficiency in Potato. *Journal of Horticultural development*, *4*(1), 67-80.