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Technical efficiency of certified maize seed in Palpa district, Nepal: A stochastic frontier production approach

Mahima Bajracharya[1] and Mahesh Sapkota[2*]

[1]Ministry of Agricultural Development, National Agricultural Research and Development Fund, Singhadurbar plaza, Kathmandu, Nepal
[2]Nepal Agricultural Research Council, Communication, Publication and Documentation Division, Khumaltar, Lalitpur, Nepal
[*]Corresponding author email: sapkotamahes@gmail.com
*ORCID: https://orcid.org/0000-0003-4391-7065

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ABSTRACT

The cereal crop, maize is regarded as staple food mainly in hill areas of Nepal. Seed is one of the vital input which determines the production and yield of any crop. Farmers are found using the required inputs in haphazard way which had increased the cost of production and inefficiency of resources used. The study on seed sector is limited. For such a backdrop, this study was aimed to assess the level of technical efficiency (TE) of certified maize seed production. The total of 164 certified seed producer were interviewed in June, 2016 using simple random sampling technique in Palpa district of Nepal. The result revealed that increase in amount of seed and labor by one percent would increase the yield of certified maize seed by 0.29 and 0.34 percent respectively. The TE was estimated using stochastic production frontier model in Stata software. The average TE was found 70 percent which revealed the scope of increasing TE by 30 percent using the existing available resources. There were about 29 percent farmers who had TE of ≥0.7-0.8 followed by 27.44 percent at ≥0.8-0.9. Government and other stakeholders should prioritize to provide technical knowledge via training and increase the visit of extension worker to increase TE of certified maize seed producer in the district.

Keywords: Certified seed, maize, stochastic frontier, technical efficiency

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INTRODUCTION

Nepal is an agrarian country where about 65.6 percent population is directly involved in agriculture for livelihood, income and employment (CBS, 2012). The share of agriculture sector to national Gross Domestic Product (GDP) is about one-third. Maize is grown in 891,583 hectares (ha) with total production of 2,231,517 tonnes (t) which is considered as second most important crop in Nepal (AICC, 2017). Similarly, in Palpa district, it is grown in 20,210 ha having total production of 42,386 t and yield of 2.1 t/ha respectively (CBS, 2016). Nepali agriculture is dominated by smallholder farmers with subsistence farming system. According to the report FAO (2013), the yield of maize (2.5 t/ha) in Nepal is very low as compared to global scenario (5.52 t/ha). Whereas, the increase in maize production is only because of increase in maize area, not due to increase in yield (ABPSD, 2014). The demand of maize is increasing at geometric ratio due to changing food habit and growing feed industry (IFPRI, 2010). The limited supply of quality seed in Nepal (Pullabhotla et al., 2011) has become major limitation on commercial scale production and better yield. Maize has shown better potential in increasing the yield of smallholder farmers with the adoption of new technology (Kibaara, 2005).

Seed is one of the crucial and inexpensive input which has a major role in contributing crop yield (Langyintuo, 2005). Quality and newly released improved seed contains various traits such as earliness, disease resistant and increased yield potential which governs the yield and value of the commodity in the market (Sentimela, 2006). This helps in the improvement of livelihood of rural people as well as helps in poverty reduction.

Seed production demands high management skills and more labor as compared to grain production (Thomison, 2013). There is limited scope to increase the land size, so need to focus on efficiency of inputs used. Technical efficiency is defined as the ability of a unit to obtain maximal output from a given set of inputs (Farell, 1957). The study on TE provides the pathway in order to increase yield by improving efficiency of existing resources (Kibaara, 2005). Introduction of new technologies would not be meaningful unless the existing resources is used to its full potential. Quality seed alone can contribute to 15-20 percent increment in yield (SQCC, 2013). The demand of quality certified seed is high which requires intensive care and management for its production. This study was aimed to estimate TE of certified maize seed producer to know the existing status of resources used and possible remedial measures to increase TE.

METHODOLOGY

Selection of study area

For this study, the highest maize seed producing district, Palpa was selected. The district is located in Province number five at mid-hill area of western development region. The guidance on technical aspects of seed provided by District Agriculture Development Office (DADO) and Nepal Agricultural Research Council (NARC). DADO had been providing fifty percent subsidy on maize source seed to farmer groups and cooperatives. The experience in certified maize seed

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production was about six years in study site. There were no any research regarding the efficiency of seed production in the district despite of its high share in national maize seed production.

Sampling techniques, sample size and data collection

There were eight farmer groups (FGs) and three cooperatives with total population size of 260 farmers involved in seed production. The list of farmers involved in maize seed production was obtained through DADO office, Palpa. The software Raosoft was used to determine the sample size at 95 percent confidence level and margin of error of 4 percent. The recommended sample size was 182 which represent 70 percent to the total population (http://www.raosoft.com/samplesize.html). The total of 182 random numbers were obtained from Microsoft excel using the formula "randbetween". The respective household was selected for the collection of primary data. There were about 10 percent (n=18) and 90 percent (n=164) foundation and certified seed producer respectively. As there were more number of certified seed producers, this study aimed to estimate the TE of certified seed producer. Primary data was collected in the month June, 2016 using face to face interview method using the pretested interview schedule. Total of four FGDs and few KIIs with officers from DADO, president of farmers' group and cooperatives was conducted to triangulate the data collected during field visit.

Stochastic production frontier model

There are various methods to estimate TE. This study used stochastic production frontier model to compute TE as this model explicitly accounts for statistical noise. The required inputs in certified maize seed production are described below. Estimation of TE was based on Coelli, Rao, O'Donnell and Battese (2005).

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}X_5^{b_5}$$

Where,

Y = Yield (kg/ha)

X_1 = Foundation seed sown (kg) in ha

X_2 = FYM used (kg) in ha

X_3 = Chemical fertilizer used (kg) in ha

X_4 = Labor used (man-days) in ha

X_5 = Tillage using tractor (hour) in ha

a = Intercept

b_1....b_5 are the elasticity to be estimated.

The stochastic frontier production model was explained by Aigner, Lovell and Schmidt (1977); Meeusem and van den Broeck (1977) as:

$$\text{Ln } q_i = x_i b + v_i - u_i$$

Here v_i was added to capture the statistical noise which arises due to omission of important variables. This model is stochastic frontier production method[1].

[1] Because output values are bound with stochastic variable $x_i b$ and v_i

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Battese (1992) and Raham (2003) applied the stochastic frontier production method to estimate the TE which is followed in this study. The measure of TE (in terms of output) is shown below:

$$TE_i = \frac{q_i}{\exp(x_i'\beta + v_i)} = \frac{\exp(x_i'\beta + v_i - u_i)}{\exp(x_i'\beta + v_i)} = \exp(-u_i)$$

The value of TE lies in between zero and one. TE is estimated by comparing the yield of maize seed with the yield that can be produced at a full efficient level using the existing inputs or resources.

$Y = f(X_i; b_i) + l$

The error term is composite (Chavas, Petrie and Roth, 2005; Rahman, 2003; Sharma and Leung, 2000).

Thus,

$L = v - u$

Where,

Value of 'v' lies between $-\infty$ and $+\infty$ which accounts the effect that are not under the human control and error due to removal of important variables and measurement. Whereas 'u' which value is positive real number accounts for the measurement of technical inefficiency. Thus TE of certified maize seed producer was estimated by the maximum likelihood method.

RESULTS AND DISCUSSION

Socio-economic and demographic characteristics of certified maize seed producer

The descriptive analysis revealed that in an average, the age of household head (HH) was about 57 year with a schooling of five years formal education. The total owned land (0.91 ha) was found higher as compared to average national landholding size (0.68 ha) and farmers allocated only 0.32 ha for certified maize seed. The household size was found greater as compared with national household size (4.88) and Palpa district's average (4.41). Similarly, there were about 73, 52 and 43 percent male headed household, joint family and migrated members respectively. The access to extension service and participation on training was found better with 90 and 68 percent respectively.

Table 1. Description of socio-economic and demographic characteristics

Variables	Mean (±standard deviation)
Age of HH (year)	56.60±14.36
Year of schooling of HH	5.45±4.65
Household size	5.38±2.67
Total owned land (ha)	0.91±0.80
Area under certified seed production (ha)	0.32±0.17
Participation on training (Yes=1)	111 (67.70)
Access to extension service (Yes=1)	147 (89.60)
Gender of HH (Male=1)	119 (72.60)
Family type (Joint=1)	85 (51.80)
Migration (Yes=1)	70 (42.70)

Notes: Figure in parentheses indicate percent. SD is calculated for continuous variable and percent for categorical variable.

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Estimation of technical efficiency

The statistically highly significant value of wald chi-square (54.77) indicates that the model is strong enough to explain the variations on TE. The explanatory variables such as foundation seed, FYM, labor and tillage were statistically significant at either 1, 5 or 10 percent level of significance. The model showed positive influence of all explanatory variables on yield of certified seed production. The result revealed that increase in amount of seed and labor by one percent increases the yield of certified maize seed significantly by 0.29 and 0.34 percent respectively. Similarly, increase in FYM by one percent increases the yield significantly by 0.04 percent 5 percent level of significance. Also, increase in tillage hour by one percent increases the yield by 0.01 percent and was observed statistically significant at 10 percent level.

The estimation of TE resulted in an average of about 70 percent. The minimum and maximum TE was observed to 24 and 92 percent respectively. This stated the scope of increasing TE by 30 percent using the existing resources in the study site. All the concerned governmental organizations and private sectors should focus to increase TE using the existing resources which helps to reduce the cost of production as well as helps to obtain high return from the certified seed production.

Table 2. Estimation of TE using stochastic production frontier model

Variables	Coefficients	Standard error	z	P>z
Log Seed (kg)	0.286***	0.111	2.58	0.010
Log FYM (kg)	0.038**	0.019	2.07	0.038
Log fertilizer (kg)	0.009	0.008	1.17	0.241
Log Labor (MD)	0.337***	0.082	4.09	0.000
Log Tillage (hr)	0.013*	0.007	1.7	0.088
Constant	4.715***	0.439	10.74	0.000
Sigma v	0.265	0.042		
Sigma u	0.504	0.076		
$Sigma^2$	0.324	0.062		
Lambda	1.897	0.110		
Observations	164			
Wald Chi2 (5)	54.77			
Prob>Chi2	0.000			
Log likelihood	-81.062			
Mean technical efficiency	0.6996±0.138			
Minimum TE	0.24			
Maximum TE	0.92			

Note: *** , ** and * indicate significant at 1, 5 and 10 percent level of significance respectively.

Oluwatayo, Sekumade and Adesoji (2008) revealed the technical efficiency of 68 percent among maize farmers in rural Nigeria. Chirwa (2007) and Kibaara (2005) found very low technical

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efficiency i.e. 46 and 49 percent among maize farmers and identified the major factor for low efficiency as inappropriate use of fertilizer. Similarly, Abdulai and Eberlin (2001)noted average TE of around 70 percent among maize farmers in Nicaragua using translog stochastic frontier model which was similar to this study.

The technical efficiency scores were categorized in an interval of 10 (figure 1). The majority of the farmers (29.27%) were at TE level of ≥0.7-0.8 followed by 27.44 percent at ≥0.8-0.9, 20.12 percent at ≥0.6-0.7 and so on. The estimation revealed that there were about more than fifty percent farmers having technical efficiency level more than 70 percent.

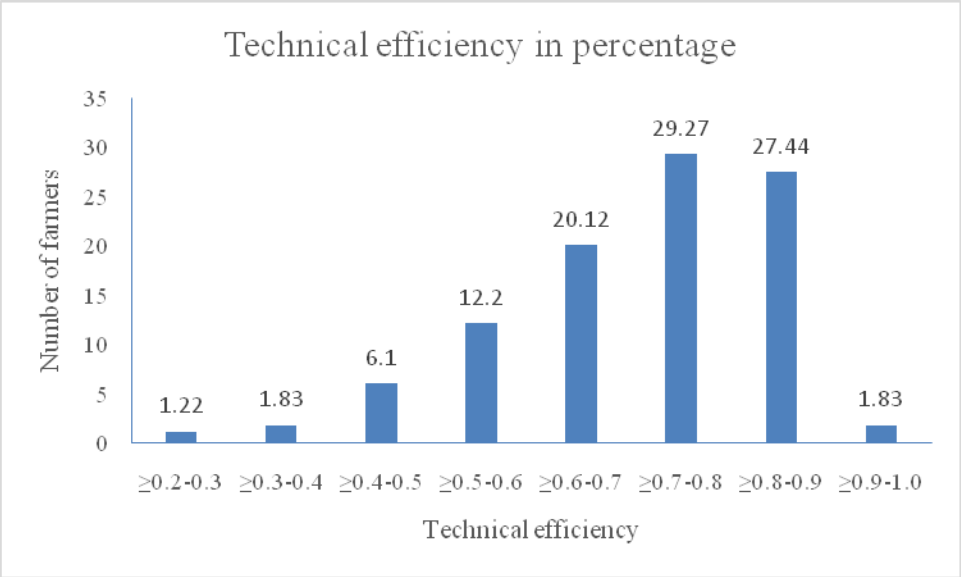

Figure 1: Technical efficiency of certified seed producer

CONCLUSION

The majority of the farmers were at a stage of above 70 percent TE which clarifies that government and other concerned stakeholders should focus to provide technical knowledge on maize seed production and adopt good agriculture practices. Need based training on maize seed production, practice of rouging and frequent visit of extension worker to farmers might help to increase TE. It would be better to deliver programs and activities prioritizing to increase TE rather than discovering new one.

ABBREVIATIONS

DADO: District Agriculture Development Office; **FGD:** Focus Group Discussion; **FYM:** Farm Yard Manure; **ha:** Hectare; **HH: Household head; KII:** Key Informant Interview; **MoAD:** Ministry of Agricultural Development; **t:** tonnes; **NARC:** Nepal Agricultural Research Council; **TE:** Technical efficiency; **VDC:** Village Development Committee

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AUTHORS' CONTRIBUTIONS
M.B. designed whole study procedure, prepared the first draft of this study and reviewed several literatures. Whereas M.S. assisted M.B. in designing the study, collection of field data, analyzed the data, revised the first draft minutely for finalization and drafted the final manuscript to the journal.

CONFLICT OF INTEREST
The authors declare that they have no conflicts of interest.

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