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Resource Use Efficiency of Tomato Production under Plastic House in Pokhara Metropolitan City, Nepal

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ABSTRACT

A survey was conducted to assess the technical and allocative efficiency of tomato (*Solanum lycopersicum* L.) production under the plastic house in metropolitan city of Pokhara, Nepal. From the total tomato growers, 80 farmers were selected through multistage sampling. Stochastic frontier approach is applied to the obtained survey data and analyzed to study the technical and allocative efficiency of tomato production. This research is essential for enhancing tomato yields without incurring additional input expenses. Our results find the mean technical efficiency of 78.19%, which shows the great opportunity of improvement of tomato production in Pokhara. Technical efficiency is positively influenced by education level and training availability and negatively affected by farmers' ages. Subsidy has non-significant effect on technical efficiency in the study area. The allocative efficiency ratio of plastic house area, seed, and di-ammonium phosphate shows its underutilization with a score above 1. On the contrary, farmyard manure, urea and muriate of potash application are overutilized with a score of less than 1. The efficiency in tomato production can be improved by optimal allocation of resources, encouraging young farmers in farming, increasing access to education and training to farmers, and change in current subsidy mechanism. Through corrective measures, policies, and practices, an efficient frontier could be achieved by the tomato-growing farmers of the study area, which ultimately will maximize profit without necessarily increasing input level.

Keywords: Allocative efficiency, *Solanum lycopersicum* L., Stochastic production frontier, Technical efficiency.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most cultivated and consumed horticultural commodities in the world. In Nepal, tomato lies in third position among vegetable crops, after cauliflower and cabbage, with 22,566 ha area and 406,434 tons of production (MOALD, 2019). The productivity of tomatoes in Nepal is 18.01 tons/ha (MOALD, 2019), which is way behind the global average productivity of 35.93 tons/ha (FAO, 2019). Terai Region produces more vegetables, but those grown in the hilly region have greater value, as they are produced during the rainy season when prices are higher (USAID/Nepal, 2011). Tomato production peak is from May to September (summer season) in the hill, which is off-season in Terai and thus fetches higher value (Subedi *et al*., 2020).

Pokhara, the largest metropolitan city in the country by area, covers about 400 ha of tomato cultivating land with a production of 6,231 tons and a productivity of 15.58 t/ha (MOALD, 2019). Recently, the government project Prime Minister Agriculture Modernization Project (PMAMP) has recognized Pokhara as a vegetable super-zone with the aim of promotion, expansion, mechanization and commercialization of vegetable production in its area.

Pokhara has potential for tomato cultivation, and that is why there is a huge necessity to know the variation in output for a given technical input factor. Anecdotal

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evidence shows that a number of factors are responsible for the low tomato production at the household level. There has always been a question of how efficiently farmers are utilizing the available resources under the plastic house to produce the maximum output. This study employs stochastic frontier approach to estimate the technical and allocative efficiency of tomato production under plastic house in the metropolitan city.

Previous studies have evaluated the technical efficiency of vegetable production in Nepal, and revealed that there is scope for improvement in the country's vegetable production. Technical efficiency refers to the ability of a farm to produce the maximum amount of output from a given set of inputs, without wasting resources. Shrestha and Huang (2014) studied the resource use efficiency in vegetable production in high hills of eastern Nepal and found the average technical efficiency to be 0.79 under the study area. This indicates that vegetable production could be increased by 21% with the same level of input without any additional cost. A similar study done on production economics and resource use efficiency of tomato production under open field conditions in Kapilvastu, Nepal, reports that all the resources were underutilized in tomato production (Subedi *et al*., 2020). Labor, seed, manures and fertilizers, and other expenses were considered during the research and all the expenses were found to be underutilized in the study area. Weldegiorgis *et al*. (2018) studied resource use efficiency among irrigated tomato producing small holder farmers using Cobb Douglas Stochastic Frontier Analysis. The author discovers degree of education, experience in growing, application of pesticide being positive, and significantly influence technical efficiency. Labor and seed were inefficiently used. A similar study by Najjuma *et al*. (2016) finds the technical efficiency of 65% efficiency for the open field tomato farmers in Kiambu, Kenya, indicating a room of progress of 35% without increase in input. Tabe-Ojong and Molua (2017) studied the technical efficiency of smallholder tomato production in semi-urban farms in Cameroon using semi-structured survey within 80 tomato growing farmers. They found that the farmers were not fully technically efficient with mean technical efficiency score of 0.68. Authors report that education, age and adoption of agronomic practice have a significant influence on technical efficiency of tomato production while nearest distance to extension agent have rather negative influence on technical efficiency. Tabe-Ojong and Molua (2017).

Using a stochastic frontier model, we empirically estimate the technical efficiency of tomato production under plastic house in Pokhara Metro politan City. We found the mean technical efficiency of 78.19% in the study area. This indicates that the tomato production can be increased by about 22% with the same level of input without additional cost. Technical efficiency is positively influenced by education level and training availability, while negatively by framers' ages. Subsidy is found to have non-significant effect on technical efficiency in the study area. Similarly, our result of allocative efficiency shows that plastic house area, seed, and diammonium phosphate are underutilized while farm yard manure, urea and muriate of potash are overutilized in the study area. Our result is consistent with the literature in developing countries' agriculture practices (see Asante *et al*., 2013; Kadakoğlu and Karlı, 2022; Paudel and Matsuoka, 2009; Shrestha *et al*., 2014, 2015; Tabe-Ojong and Molua, 2017; Xu and Jeffrey, 1998).

This study contributes to our understanding of efficiency of tomato production in three major ways. First, we evaluate the efficiency of tomato production under the plastic house in PMAMP Project Area. This provides an estimate of potential of tomato production in study area without increasing the input cost. Second, this study will also investigate several input variables required for the commercialization and mechanization of tomato production to achieve the desired level of output. Finally, as there is not much fundamental research on the effectiveness of tomato farming,

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particularly in Pokhara, this study will, at the very least, fill a knowledge gap regarding tomato production efficiency in Nepal.

MATERIALS AND METHODS

Theoretical Framework

A production unit is said to be efficient when it can meet its production goal with no wastage. A firm goal of production could be output maximization, cost reduction, or profit maximization. With the beginning of the idea of "no-waste", efficiency measurement comes into action. Efficiency could be in terms of land, labor and/or capital. Allocation of resources is one way of looking into efficiency. The efficient use of technology also leads a production unit toward the attainment of its goal. Therefore, Allocative and Technical Efficiency are two types of efficiency measures. Economic efficiency is the product of both allocative and technical efficiency.

There are two basic methods of measuring efficiency: the classical approach and the frontier approach. The classical approach uses the ratio of output to input for measuring efficiency, which is called partial productivity measure. This classical approach has many shortcomings despite its easiness. Those shortcomings led economists to develop advanced econometric and linear programming methods for analyzing efficiency where more than one input is considered and their technical aspects. This measure is called the frontier measure of efficiency that aims to estimate a frontier representing a fully efficient production unit.

Stochastic Production Frontier (SPF) Analysis and Measurement of Efficiency

The frontier function approach is a method of measuring the productive inefficiency of individual producers. Inefficiency is measured by the deviation from the frontier, which represents the best-practiced technology among all observed firms.

Stochastic Production Frontier (SPF) method of analyzing efficiency is chosen for this study. The justification is that, unlike other methods (for example he Data Envelopment Analysis, DEA), the SPF allows for the sensitivity of data to random shocks by including a conventional random error term in the estimation of the production frontier such that only deviation caused by controllable decisions are attributed to inefficiency (Jaforullah and Premachandra, 2003). Inefficiency is assumed to be composed of two parts, namely, a random error term, which is not in the control of farmers like random shocks and statistical errors, and next is the inefficiency term. The nature of the random error term is that its distribution is normal (0, σ2) while that of the inefficiency term has a truncated normal distribution. The SPF is expressed as follows:

$$Y_i = f(X_i, \beta)e^{v-u} \quad (1)$$

In logarithm terms, the SPF is expressed as

$$lnY_i = lnf(X_i, \beta) + v_i - u_i \quad (2)$$

Where,

*Y*i is the output vector,

*X*i is the input vector,

β is an unknown parameter vector,

v_i is the random error term assumed to be Normally distributed N (0, σ2)

u_i is the inefficiency term independently distributed from v_i .

There is disagreement among econometricians as to the distribution of the inefficiency error term, u_i (Jaforullah and Premachandra, 2003). Earlier investigations have used various distributions including single-parameter half-normal distribution, exponential and truncated normal distribution and two-parameter gamma distribution ((Bravo-Ureta and Rieger, 1990; Jaforullah and Devlin, 2009). In this study, the truncated normal distribution is used in our cross-sectional data.

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Adopting the above to the peculiarities of cross-sectional data, the following model is suggested:

$$lnY_i = lnf(X_i, \beta) + v_i - u_i \quad (3)$$

Where,

Yi is the output vector,

Xi is the input vector,

β is an unknown parameter vector,

v_i is the random error term assumed to be Normally distributed N (0, σ2)

u_i is the inefficiency term independently distributed from v_i.

Empirical Estimation of Technical Efficiency

For our empirical analysis, the Cobb-Douglas frontier production function specifies the technology of the production process. The model is defined as follows:

$$Y = f(seed, land, FYM, urea, DAP, MOP) \quad (4)$$

The operational Cobb-Douglas stochastic frontier function for tomato production will be expressed as:

$$lnYi = \beta_0 + \beta_1 lnLand + \beta_2 lnFYM + \beta_3 lnSeed + \beta_4 lnurea + \beta_5 lnDAP + \beta_6 lnMOP + v_i - u_i \quad (5)$$

Where,

Y is the tomato productivity in tons/ha,

Land is the Total land area where tomato is cultivated in ha,

FYM is the quantity of farm yard manure used in the production process, in Mt/ha,

Seed is the quantity of seed used in the production process, in gram

Urea, DAP and MOP is the quantity of urea, diammonium phosphate, and Murate of potash used in kilogram, respectively.

β_0, β_1, β_2, β_3, β_4, β_5, β_6 are an unknown parameter vector of linear terms,

v_i is the random error term

u_i is the inefficiency term independently distributed from v_i.

The technical efficiency of an individual firm is defined in terms of the ratio of observed output to the corresponding frontier output, conditional on the levels of input used by the firm. Hence, the technical efficiency of the i^{th} firm is expressed as follows:

$$TE_i = \frac{Y_i}{Y^*} = \frac{f(X_i, \beta) + \exp(v_i - u_i)}{f(X_i, \beta) + \exp(v_i)} = \exp(-u_i) \quad (6)$$

For the technical efficiency of firm i, $u_i$is transformed as TR_i= exp (-u_i), which now represents the technical efficiency index.

Socio-Economic Model

The average level of technical inefficiency measured by the mode of truncated normal distribution has been assumed (Dawson *et al*., 1991) to be a function of socio-economic factors as shown in the relationship below:

$$\boldsymbol{u_i = \alpha_0 + \alpha_1 Z_{1i} + \alpha_2 Z_{2i} + \alpha_3 Z_{3i} + \alpha_4 Z_{4i}} \quad (7)$$

Where, Z_1, Z_2, Z_3 and Z_4 are the age of the respondent, years of schooling, access to training, and access to subsidy, respectively. These variables are assumed to influence the technical efficiency of the farmers. α_0 to α_4 are parameters that are estimated using maximum likelihood estimation.

Empirical Estimation of Allocative Efficiency of Tomato Production

Allocative efficiency reflects the ability of a firm to use input in optimal proportions, given their respective prices. A production process is said to have allocative efficiency if it equates the marginal rate of substitution between each pair of inputs with the input price ratio. The requirement for the fulfillment of allocative efficiency is for the Marginal Physical Product (MPP) of all productive resources to be known (Ellis, 1988).

From the Cobb-Douglas function presented in Eq. 8, the factor elasticities of land and other capitals are obtained directly from the equation. The estimation process is based on the allocative efficiency rule that states that the slope of the production function (MPP) should be equal to the

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inverse ratio of input price to output price at the point of profit maximization.

$$Y = \delta_0 X_1^{\delta_1} X_2^{\delta_2} X_3^{\delta_3} X_4^{\delta_4} X_5^{\delta_5} X_6^{\delta_6} \epsilon_u \quad (8)$$

Both dependent and explanatory variables were transformed into natural logarithm and the above equation is linearized.

$$lnY = \delta_0 + \delta_1 lnX_1 + \delta_2 lnX_2 + \delta_3 lnX_3 + \delta_4 lnX_4 + \delta_5 lnX_5 + \delta_6 lnX_6 u \quad (9)$$

Where,

Y= Total return from tomato production in Nepalese Rupees (NRs)

X_1, X_2, X_3, X_4, X_5, and X_6 are the total cost of land area, Farm Yard Manure (FYM), seed, urea, (Diammonium Phosphate)DAP, and (Muriate of Potash) MOP used in tomato production in NRs.

δ_0 and ϵ_u are the intercept and error terms respectively.

$\delta_1, \delta_2, \delta_3, \delta_4$ and δ_5 are the regression coefficients to be estimated.

The level of resource use efficiency was calculated using the following formula:

$$r = \frac{MVP}{MFC} \quad (10)$$

Where,

r= Efficiency ratio

MVP= Marginal Value Product; which is the value of an incremental unit of output resulting from the additional unit of inputs.

MFC= Marginal Factor Cost; which is the increase in the cost of inputs due to the purchase of additional units of inputs. This is equal to one since both dependent and explanatory variables are converted to monetary value.

$$MVP = \frac{\delta_i \times \bar{Y}_i}{\bar{X}_i}, \quad (11)$$

Where,

δ_i = Estimated regression coefficient of input $\bar{X}_i$

$\bar{Y}_i$ = Geometric mean value of output.

$\bar{X}_i$ = Geometric mean value of i^{th} resources used

Decision rule:

r= 1; Efficient use of the resource

r> 1; Underutilization of the resource

r< 1; Overutilization of the resource

The relative percentage change in MVP of each resource required to obtain optimal resource allocation, that is, r= 1 or MVP= MFC, is estimated using the following equation:

D= (1–MFC/MVP)×100= (1–1/r)×100,

Where D indicates the absolute value of percentage change in MVP of each resource.

Data and Model Specification

Study Area

Kaski, with Pokhara as the district headquarter, covers an area of 2,017 square km. The district lies in the mid-hilly region of the country with altitudes ranging from 450 m to 8,091 m the highest above sea level. District headquarter, Pokhara, lies at an altitude of about 750 meters above sea level and is the command area under PMAMP Vegetable Superzone. Pokhara is the largest metropolitan city in the country with a total of 33 wards. The research was conducted in 6 wards of the metropolitan city, where tomato is mostly grown under the plastic house. The study area is shown in Figure 1.

Selection of Population and Sample

The tomato growers under the plastic house of the study site were the sampling population. Six major tomato growing wards of the metropolitan city were chosen purposively. The sample farmers were selected randomly from six different wards. In this study, a multi-stage sampling technique was used. The first stage involved the selection of major wards. The second stage involved the random selection of 3 to 5 tomato-producing households from each ward. We selected altogether 80 tomato farmers through this process of sampling. Sample size calculation follows Roscoe's (1975) guidelines.

Sources of Data

The study used both primary and secondary data. Primary data was obtained directly from respondents (farmers) through

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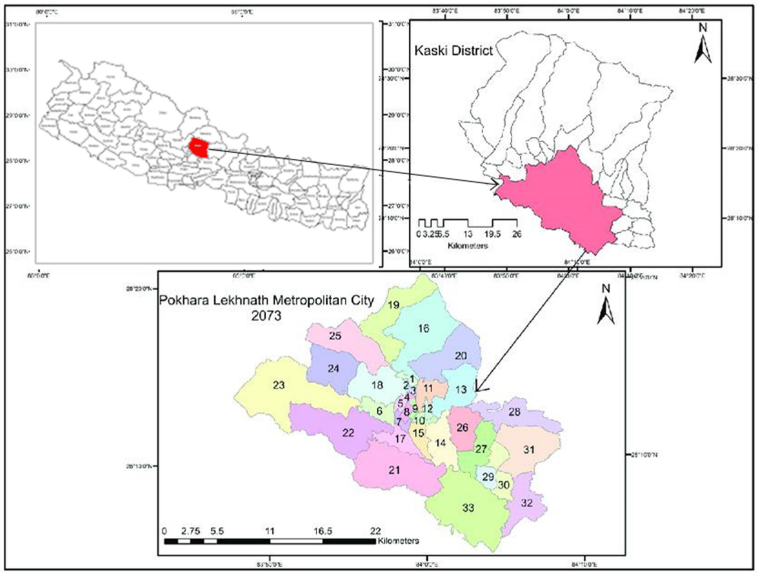

Figure 1. Map of Nepal showing Kaski District (Study area).

face-to-face interviews and telephone interviews while secondary data were obtained from books, journals and records of the Ministry of Agriculture and Livestock Development.

Primary data

The primary data were collected from the tomato growers of the site through face-to-face interviews and key informant surveys. Telephone interview was also used for understanding personal and household characteristics, level and cost of inputs, farm return in terms of tomato output, post-harvest issues, and constraints in tomato production.

Secondary data

The secondary data were collected through publications related to tomato production from different institutes and organizations such as Agriculture Knowledge Center, Central Bureau of Statistics (CBS), Nepal Agriculture Research Council (NARC), and so on.

Survey Design and Data Collection Procedure

Interview Schedule

A set of interview schedules was designed for primary data collection from tomato producers in the study area. With the help of the interview schedule information regarding personal and household characteristics, farm resources, farm production, returns, post-harvest issues, and constraints in tomato production were recorded.

Household Survey and Telephone Interview

The household survey was conducted during March and April of 2021. During this period, some of the accessible farmers were directly reached out while other farmers were surveyed via telephone interview due to the Covid-19 pandemic and lockdown restrictions imposed by the Government of

Nepal. The interview timing was primarily based on the farmer's convenience.

Model Specification

To estimate the stochastic frontier model parameters via the MLE approach, we have to assume specific functional forms for Equation (1). We adopt a Cobb-Douglas specification for the production function with six inputs that were being used by farmers in the study area, namely, seed, farm yard manures, urea, DAP, MOP and land area of the plastic house. A Cobb-Douglas production frontier used to represent the production technology used by tomato farmers in the study area is specified by Equation (5).

Socio-Demographic and Economic Variables

Socio-demographic variables like family size, years of schooling, size of land holdings, age of household head and age of family members were used for descriptive analysis of the study population. Likewise, estimation of costs and returns for tomato production necessitates a proper assessment of the costs of inputs, input services and price of output. Summary statistics of socio-demographic and economic variables is presented in Table 1.

Yield Distribution

The yield distribution in the study area is reported in Table 2. This shows that the majority of the farmers are achieving yield between 10-15 ton ha^{-1}. About 27.5% of the respondents reported a 5-10 ton ha^{-1} yield while 41.25, 30, and 1.25% reported yield within the range of 10-15, 15-20, and above 20 ton ha^{-1}, respectively. The average yield of the study area was found to be 12.823 ton ha^{-1}.

RESULTS AND DISCUSSION

Technical Efficiency Estimates

Table 3 shows distribution efficiency

Table 1. Summary statistics of socio-demographic variables. [a]

Variable	Mean	Std Dev	Min	Max
Total land holding (ha)	0.97	1.19	0.0368	5.6
Land under tomato cultivation (ha)	0.15	0.32	0.003	1.5
Household head (age)	48.05	11.03	25	79
Household size	8.125	4.16	3	23
Yield (ton ha^{-1})	12.823	3.661026	5.4	21.23
Seed (g ha^{-1})	396.7405	126.6031	200	694.44
FYM (ton ha^{-1})	15.404	5.837	0.0001	30
Urea (kg ha^{-1})	51.2245	43.10249	0.5	166.67
DAP (kg ha^{-1})	62.21137	45.77165	1	166.67
MOP (kg ha^{-1})	57.53812	40.00196	1	166.67
Cost				
Cost_seed (NRs ha^{-1})	9781.918	22260.42	279.8145	157500
Cost_FYM (NRs ha^{-1})	3702.46	9419.917	1000	57000
Cost_Urea (NRs ha-1)	170.5086	380.8676	25	2430
Cost_DAP (NRs ha^{-1})	285.7073	583.8736	40	3225
Cost_MOP (NRs ha^{-1})	237.383	502.2068	40	3000
Total_cost (NRs ha^{-1})	14177.9769	33147.285	1384.8145	223155

[a] Source: Survey Data (2021).

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Table 2. Yield distribution data.

Variable	Frequency	Percentage
5-10 ton ha^{-1}	22	27.5
10-15 ton ha^{-1}	33	41.25
15-20 ton ha^{-1}	24	30
>20 ton ha^{-1}	1	1.25
Mean	12.823	
Std Dev	3.661026	
Min	5.4	
Max	21.23	

[a] Source: Survey Data (2021).

Table 3. Frequency distribution of technical efficiency estimates.

Efficiency	Technical Efficiency	
Score (%)	Frequency	%
<40	0	0.00
40-50	3	3.75
50-60	3	3.75
60-70	18	22.5
70-80	15	18.75
80-90	27	33.75
> 90	14	17.5
Mean (%)	78.19	
Min (%)	0	
Max (%)	96.54	
Std Dev	12.40	

estimates of tomato producers in the study area.

The study reveals that the technical efficiency indices of tomato farmers range from 44.78 to 96.54%, with a mean of 78.19%. This indicates that tomato production in Pokhara can be increased by 21.81% by improving farming and management practices and without increasing the input resources. Best practicing farmers operate at 96.54% efficiency, while the least practicing farmers operate at about 44.78% level. Variation in the technical efficiency of producers is probably due to differences in managerial decisions and farm characteristics that may affect the ability of the producer to adequately use the existing technology.

Determinants of Efficiency

The main socio-economic factors that were assumed to influence the productive efficiency of farmers and hence were included in the model are the age of the farmer, availability of subsidy, access to training and educational level of farmers. Access to training and subsidy were represented as dummy variables in the model: 1 as having received training or subsidy and 0 otherwise. These variables are regressed on the inefficiency and the regression result is presented in Table 4.

From the MLE results presented in Table 4, subsidy is found to have a non-significant effect on the inefficiency parameter. However, the year of schooling and training has a negative coefficient on the inefficiency parameter and is significant at 10 and 1% level of significance, respectively. It implies that with increased education of household heads and increase exposure to training services, the inefficiency is decreased. Or, put in other words, farmers receiving training services and education are more technically efficient than farmers with less formal education and not receiving training services. This finding of negative coefficient of year of schooling and positive coefficient of age on the inefficiency parameter aligns with the findings of Paudel and Matsuoka (2009). Parlakay *et al*. (2017) finds similar impact of

Table 4. The maximum likelihood estimates of the determinants of efficiency.

Variable	Parameter	MLE		Z-statistics
		Coefficients	Standard error	
Constant	α_0	0.2133556	0.1901087	1.12
Age	α_1	0.0066526**	0.0030847	2.16
Years of schooling	α_2	-0.0568604*	0.0328795	-1.73
Training	α_3	-0.2780351***	0.057576	-4.83
Subsidy	α_4	-0.0511738	0.0503004	-1.02

*** (P< 0.01), ** (P< 0.05) and * (0.1) means significant at 1, 5 and 10% respectively.

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education to technical efficiency of dairy cattle farm in east Mediterranean region of Turkey. Similarly, Table 4 reports that age has a statistically significant positive coefficient on the inefficiency parameter. This implies that young farmers are more technically efficient than aged ones. This might be the case because age might play a role in technology adoption.

Table 5 shows the results of the Ordinary Least Squares (OLS) for the Cobb-Douglas stochastic frontier production function. Estimated OLS results obtained from the study revealed that most of the coefficients are statistically significant at either a 1 or 5% level of significance. The overall predictive power of the estimated function is of great importance.

Table 6 reports the results of the maximum likelihood estimates for the Cobb-Douglas stochastic frontier production function.

Coefficients for all the variables, except farm size, have positive magnitude, indicating a positive influence on tomato production. The coefficient of the quantity of seed used has a positive and significant relationship (at 1% level of significance) with tomato output, indicating that tomato output can be increased by 0.28 percent with a percentage increase in the quantity of seed. The estimated coefficient of FYM is significant at 5% level of significance and shows its positive role in increasing output. The output, therefore, can be increased by 0.04 percent with a percentage increase in FYM quantity, holding other inputs constant. The coefficient of urea and DAP is positive and significant at 5 and 10% level of significance, respectively, while the coefficient of MOP is positive but statistically insignificant. The coefficient of farm size is negative, which implies that for a 1 percent increase in farm size, the output will decrease by 0.006 percent. However, this coefficient for farm size is statistically insignificant.

The Wald Chi-square statistics value for the model is 37.83. This significant Wald Chi-square value indicates the presence of inefficiency in tomato production. The coefficient score of Gamma is equal to 0.7141, which indicates the proportion of variation in the model due to technical efficiency. This score indicates 71.41% of the variation in composite error term was due to the inefficiency component.

Allocative Efficiency Estimates

The MLE results presented in Table 5 are used alongside the mean values of the variables included in the model to estimate the allocative efficiencies. Table 6 reports that the level of seed, DAP, and farm area are underutilized factors of tomato production. These variables need to be increased by 2.92, 10.71, and 93.84%, respectively, to achieve allocatively efficient production. However, FYM, urea and MOP are over utilized by 484.61, 350 and 257.14%, respectively.

Table 5. OLS estimates of tomato production using Cobb-Douglas Stochastic frontier production function.

Variable	Parameter	OLS		T-Statistics
		Coefficients	Standard Error	
Constant	β_0	-1.313883	0.4816953	-2.73
ln(Seed)	β_1	0.455412***	0.078288	5.82
ln(Farm size)	β_2	0.0241751	0.0178936	1.35
ln(FYM)	β_3	0.0922364**	0.0216512	4.26
ln(Urea)	β_4	0.0366617**	0.0151679	2.42
ln(DAP)	β_5	0.030189*	0.043191	0.70
ln(MOP)	β_6	0.0263556	0.0470977	0.56
Log Likelihood		11.72		

*** (P< 0.01), ** (P< 0.05) and * (0.1) means significant at 1, 5 and 10% respectively.

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Table 6. The maximum likelihood estimates of the Cobb-Douglas Stochastic Frontier Production Function.

Variable	Parameter	MLE		Z-statistics
		Coefficients	Standard Error	
Constant	β_0	0.5122857	0.4460598	1.15
ln(Seed)	β_1	0.2816122***	0.0645334	4.36
ln(Farm size)	β_2	-0.0068961	0.0130401	-0.53
ln(FYM)	β_3	0.0411423**	0.0182859	2.25
ln(Urea)	β_4	0.0224205*	0.0132421	1.69
ln(DAP)	β_5	0.0241895	0.033115	0.73
ln(MOP)	β_6	0.0190344	0.0349446	0.54
Wald Chi-square		37.83***		
Total Variance	$\sigma^2(=\sigma^2_u+\sigma^2_v)$	0.02838		
Sigma u	σ_u	0.14216		
Sigma v	σ_v	0.09039		
Gamma	$\gamma\ (\sigma^2_u/\sigma^2)$	0.7141		
Lambda	λ	1.572753		
Log Likelihood		37.9439		

*** (P< 0.01), ** (P< 0.05) and * (0.1) means significant at 1, 5 and 10% respectively.

Table 7. Estimation of resource use efficiency using the Cobb-Douglas Production Function.

Variable	Coefficient	MVP	MFC	R= MVP/MFC	Allocation	D= (1-1/R)×100%
ln(Seed)	0.6498528	1.03	1	1.03	Underused	2.92%
ln(FYM)	-0.26581	-0.26	1	-0.26	Overused	484.61%
ln(Urea)	-0.158402	-0.34	1	-0.34	Overused	350%
ln(DAP)	0.453425	1.12	1	1.12	Underused	10.71%
ln(MOP)	0.11044	0.28	1	0.28	Overused	257.14%
ln(Area)	0.9160286	16.25	1	16.25	Underused	93.84%

CONCLUSIONS

From the findings of the study, it is evident that tomato production in Pokhara can be increased by 21.81% through improved farming and management practices without raising input levels. The study reveals that smaller farms are more efficient than larger ones, suggesting the need for better input management on larger farms. Additionally, there is an underutilization of resources such as seed, diammonium phosphate, and farm area, while farmyard manure, urea, and muriate of potash are overutilized, indicating the need for optimization. To enhance technical efficiency, the Prime Minister Agriculture Modernization Project (PMAMP) should prioritize education and training for young farmers, and the current subsidy mechanism requires restructuring for better effectiveness.

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بهره وری استفاده از منابع درتولید گوجه فرنگی در گلخانه پلاستیکی در شهرستان پوخارا (Pokhara)، نپال

ب. کنوار

چکیده

یک نظرسنجی برای ارزیابی کارایی فنی (technical) و تخصیصی (allocative) تولید گوجه فرنگی (*Solanum lycopersicum* L.) در گلخانه پلاستیکی در کلان شهر پوخارای نپال انجام شد. از کل تولیدکنندگان گوجه فرنگی، ۸۰ کشاورز به روش نمونه گیری چند مرحله ای انتخاب شدند. رویکرد مرزی تصادفی (Stochastic frontier) برای داده‌های بررسی به‌دست‌آمده اعمال شد و برای مطالعه کارایی فنی و تخصیصی تولید گوجه‌فرنگی مورد تجزیه و تحلیل قرار گرفت. این تحقیق برای افزایش عملکرد گوجه فرنگی بدون تحمیل هزینه های اضافی ضروری است. در نتایج ما، میانگین بازده فنی ۷۸.۱۹ درصد بود که فرصت عالی برای بهبود تولید گوجه‌فرنگی در پوخارا را نشان می‌دهد. کارایی فنی به طور مثبت تحت تأثیر سطح تحصیلات و در دسترس بودن آموزش است و سن کشاورزان تأثیر منفی بر آن دارد. تأثیر یارانه بر کارایی فنی در منطقه مورد مطالعه معنی دار نبود. نسبت راندمان تخصیصی مساحت گلخانه های پلاستیکی، بذر و فسفات دی آمونیوم نشان ازکم مصرف کردن آن‌ها داشت و امتیازش را بیشتر از ۱ نشان می داد. در مقابل، کود دامی، اوره و موریات پتاسیم کاربردی با امتیاز کمتر از ۱، نشانگر استفاده بیش از حد آن‌ها بود. بهره وری در تولید گوجه فرنگی را می توان با تخصیص بهینه منابع، تشویق کشاورزان جوان به کشاورزی، افزایش دسترسی به آموزش و آموزش کشاورزان و تغییر مکانیسم فعلی یارانه بهبود بخشید. با اصلاح اقدامات ، سیاست‌ها و فعالیتها، می‌توان به مرز کارآمدی توسط کشاورزان گوجه‌فرنگی منطقه مورد مطالعه دست یافت که در نهایت بدون افزایش سطح نهاده، سود را به حداکثر می‌رساند.

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