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Research Application Summary

Socio-economic factors affecting technical efficiency of potato production in Kenya

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Abstract

Potato, *Solanum tuberosum* L., is one of the most important staple crops in Kenya. It has high potential for production. However, production does not meet the growing demand. There is need to analyze socio-economic factors affecting the technical efficiency of potato production in Kenya survey was conducted among 105 households using semi-structured questionnaires. Stochastic frontiers regression approach was used to analyze data. The mean technical efficiency index was estimated at 78.9% of efficiency of production and thus inefficiency of 21.1% . This meant that farmers had 21.1% scope of increasing the potato production by using current technology. The inefficiency parameter estimate indicated three socio-economic and institutional factors namely, education level, access to extension services, and access to credit, as having significant effect on technical efficiency.

Key words: Economies of scale, elasticity, *Solanum tuberosum,* stochastic frontier

Résumé

La pomme de terre, Solanum tuberosum L., est l'une des principales cultures de base au Kenya. Il a un fort potentiel de production. Cependant, la production n'est pas en adéquation avec la demande, de plus en plus croissante. Il est nécessaire d'analyser les facteurs socio-économiques influençant l'efficacité technique de la production de pommes de terre au Kenya. Une enquête a été menée auprès de 105 ménages au moyen de questionnaires semi-structurés. L'approche de régression des frontières stochastiques a été utilisée pour analyser les données. L'indice moyen d'efficacité technique a été estimé à 78,9% de l'efficacité de la production et donc une inefficacité de 21,1%. Cela signifie que les agriculteurs ont une portée de 21,1% d'augmentation de la production de pommes de terre en utilisant la technologie actuelle. L'estimation du paramètre d'inefficacité a révélé trois facteurs socio-économiques et institutionnels, y compris le niveau d'éducation, l'accès aux services de vulgarisation et l'accès au crédit, ayant un impact significatif sur l'efficacité technique.

Mots clés : Économies d'échelle, élasticité, *Solanum tuberosum*, frontière stochastique

Introduction

The Government of Kenya recognizes potatoes (S*olanum tuberosum* L.) as one of the most important food crops in the country (GoK, 2007). In 2010, the crop was grown by 500,000 small holder farmers (Nyagaka, 2010) but by 2013 there were more than 800,000 growers (FAO, 2013).The country has high potential for the production and a lot of research and

development efforts have been made to develop high yielding varieties but still yields achieved by small holder farmers are low (Alumira and Obara, 2008). Farmers use different levels of production inputs and management depending on their infrastructural facility and socio economic conditions. In Nyandarua, farmers with more years of experience, and those with higher levels of education are more efficient in production (Nyagaka, 2010). Likewise, those who access extension services and credit facilities have been observed to be more efficient in production. The aim of this study was to establish factors limiting potato production in the study area.

Literature summary

The study is based on the production economic theory which is part of the micro economics that deals with the relationships between the inputs and outputs in production process. Efficiency is attained when the inputs are used optimally. The concept of Technical efficiency is derived from particular interpretation of notion of production frontier which in a classical sense is relationships between the inputs and output used in production process. In estimation methods of efficiency frontier, the production function is the production frontier.

Earlier analysis measures of efficiency were initiated by Farrel (1957) and others. The evaluation of the firms Technical Efficiency levels results from estimation of the frontier production function. There are two approaches in constructing the efficiency frontier: Free Disposal Hull (FDH) and Data Envelopment Analysis (DEA). The DEA was developed by Farrel in 1957 and FDH was developed by Deprins in 1984, however it had limitation. It lacked statistical procedure in testing the hypothesis and does not take measurement of errors and random effects into account. The second approach is parametric based on econometric estimation of production frontier whose functional form is specified in advance. In this approach, the stochastic frontier is most popular because it takes into account the measurements of errors or random effects.

There are many case studies where the stochastic frontier approach were used in establishing Technical efficiency. For example, Iheke (2008) examined the technical effeciency and effect of socio-economics factor of casava farmers in South Eastern Nigeria, employing the stochastic frontier production procedure. On the other hand, Nchare (2007) conducted a study to analyze the factors affecting technical efficiency of Arabica coffee producers in Cameroon and looked at the socio economics factor affecting the efficiency. To carry out this analysis, a translog stochastic production frontier function, in which technical inefficiency effects are specified to be functions of socio-economic variables, is estimated using the maximum-likelihood method. Ajibefun (1996) used the translogarithmic stochastic frontier production function in which inefficiency effects are a function of socio-economic variables, to obtained technical indicators and found positive correlations between the degree of technical inefficiency and the farmer's age, farm size and proportion of hired labour used, and a negative correlation between the degree of technical inefficiency and the producer's experience. There are

many socioeconomic variables that influence the technical efficiency of farmers. Personal characteristics include the farmer's age, level of education and experience. Among other immediate factors are farm size, family size, number of farm workers per hectare, distance between the farm and the nearest city, and the proportion of active household members engaged in non-farm activities. Additional influences are access to credit institutions and to goods supplied by the public sector such as electricity and technical assistance, the use of modern inputs like fertilizer, and the practice of irrigation, soil conservation and crop protection against pests. In fact, the studies reveal that it is possible to increase agricultural production significantly, simply by improving the level of producer technical efficiency without additional investments.

Study description

The study was carried out in Eldoret East sub county of Uasin Gishu County, Kenya in 2011.The sampling procedure adopted was multi-stage random sampling to select the area of study. The sample size of 105 farmers was obtained by applying systematic sampling and primary data collection was done using semi-structured questionnaires. The data analysis approach used was that of a stochastic frontier function which is specified as:

$$Yi = f(X_i, \alpha) + \varepsilon_i$$

Where:

X_i = vector of inputs by farmer i^{th}

α = vector of unknown parametre to be estimated

ε_i = (V-U) where V= independent random variable assumed to be indepently and identically distributed $N(0,\delta_v{}^u)$ and indepent of U .

while U= random variable that accounts for technical inefficiency and assumed to be independently distributed as truncation of normal mean of μi and variance of

$\alpha^2 = \alpha\, u^2\, (/N(\mu_i\, ;\, \alpha u^2/)^2$.

$\mu_i = A\delta$ in which

A= 1 x e vector of farm characteristics that may cause inefficiency; and

δ = e x 1 vector of unknown parametre to be estimated.

The farm level stochastic frontier that represent maximum output (Q*) can be shown as

$Q^* = f(X_i, \alpha) \exp(v_i)$ where Q* is frontier.

Hence $Q= Q^* \exp(-u)$

The maximum Likelihood (MLE) of parameters of the model and Technical efficiency predicted was obtained using computer programme Frontier 4.1. (Coeli and Battese, 1996). The variance parameters αu^2 and αu^2 are expressed as

$\delta^2 = \delta_v{}^u + \alpha u^2$

$\gamma = \delta u^2 / \delta v^2$

where $0 \leq \gamma \leq 1$

When $\gamma = 1$ it indicates the deviation are due to technical inefficiency

Cobb Douglas Production Function was fitted into the Stochastic Frontier Production Function and estimated. The specified production function was given as:

$LnQ = Ln\alpha_0 x_1 + \alpha_1 Lnx_1 + \alpha_2 Lnx_2 + \alpha_3 Lnx_3 + \alpha_4 Lnx_4 + \alpha_5 Lnx_5 + \varepsilon_i$

where

Q = output of potatoes in kilogram

X_1 = farm size in acres

X_2 =labour in man days

X_3 = capital used, in Kenya shillings

X_4 = fertilizer used, in kilograms

X_5 = quantity of seeds used

A_0- α_5 = parameters to be estimated.

The technical efficiency was then specified as:

$T.E = Õ_0 + Õ_1 Z1 + Õ_2 Z_2 + Õ_3 Z_3 + Õ_4 Z_4 + Õ_5 Z_5 + + Õ_6 Z_6 + Õ_7 Z_7 + + e$

Where

T.E = Technical efficiency

Z_1= Education level

Z_2 = age of farmer

Z_3 = farm size in acres

Z_4= experience of farmer in years

Z_5 = family size

Z_6 = access to extension service

Z_7= access to credit

$Õ_0$ - $Õ_7$ are parameters to be estimated

Research application

The education levels of selected potato farmers for this study ranged from primary, secondary to tertiary level. The variation in education among the selected farmers was significant at 1% level (X^2=51.600, df=2 and P=0.000) .The high proportion of farmers with secondary education level is an indication of fairly high level of literacy among the farmers.

The gap between the farmers who had access to extension services and those who did not was significant at 1% level (X^2=68.810, df=1 and P=0.000). This significant difference in access to extension services among potato farmers may be partly attributed to the differences in their acquaintance with the demand driven extension services offered by the Ministry of Agriculture.

The efficiency indices obtained varied from one farmer to another and ranged from 0.279 to 0.997, with a 0.789 average. These results reveal the presence of technical inefficiencies. The inefficiency effects were specified to be functions of the age, educational level and experience of the farmer, family size, access to extension services, access to credit, and the mono-cropping system. Results also showed that access to credit,

access to extension service, producer's experience and producer's level of education as the main socio-economic variables that significantly affected the technical inefficiency of farmers (p= 0.05) (Table 4).

Table 4. socio economic factors coefficient estimation

Variable	Parameter	Coefficient	Std. Error	T-Ratio
Constant	δ1	0.103	0.422	0.244
Producer's level of education	δ3	-0.047**	0.685	-0.069
Producer's experience	δ4	0.527**	0.602	0.875
Family size	δ5	0.309	0.589	0.525
Access to extension service	δ6	-0.218**	0.409	0.533
Access to credit	δ7	-0.046**	0.375	-0.123
Irish potato varieties planted	δ8	0.672	0.835	0.805
Mono-cropping System	δ9	-0.191	0.359	0.532

**Significance at 5% level
Source: Study Results, 2008

Conclusion

This study has shown that there were technical inefficiencies in potato production in the study area. Socio-economic factors such as farmers' level of education, access to extension, and access to credit were significance at 5% significant level as indicated in the parameters estimated. The results indicated that it is feasible to increase the current level of potato production in the study area.

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