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Research Article

Evaluating Technical Efficiency of Small-scale Pineapple (*Ananas comosus*) Production in Bureti District, Kenya

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Abstract: Kenya has been one of the world's leading pineapple producers for many years and is currently ranked 9th internationally. The biggest source of fruit is at Del Monte's farm in Thika, but small-scale growers are also increasing their production for the local market. However, in Bureti District there is a gap between the potential farm yield and the actual yield realized by the pineapple farmers. Thus, this study has examined questions on current farm level efficiency in small-scale pineapple production. A semi-structured and pre-tested questionnaire was used to collect data from small-scale pineapple farmers through face to face interviews. Multi-stage sampling method was employed to get a representative sample of 150 pineapple farmers. The study used stochastic production frontier, to estimate technical efficiencies of pineapple production among small-scale farmers in Bureti district. Results of the study indicated that the average technical efficiency of pineapple production was 0.69. This implies that given the level of technology and inputs, the output could be increased by 30.8% through better use of available resources thus farmers should be trained to enhance their capacity to efficiently use the available resources.

Keywords: Pineapple production, stochastic frontier functions, technical efficiency

INTRODUCTION

Smallholder farmers in Kenya and other comparable regions of Sub-Saharan Africa (SSA), Asia and South and Central America are the poorest category in the world population (Narayan and Gulati, 2002). According to the World Development Report 2008 three out of every four poor people in developing countries live in rural areas and most of them depend directly or indirectly on agriculture for their livelihoods. Thus, any program targeting agriculture especially in the rural areas has the greatest potential to improve farmers' productivity, product quality, incomes and employment.

Kenya has a long history of growing horticultural crops such as pineapples for both domestic and export markets. The ideal tropical and temperate climatic condition makes it favorable for horticulture production and development. The climate is highly varied supporting the growth of a wide range of horticultural crops. Small-scale farmers constitute the bulk of agricultural producers in the country. According to Davis (2006), these farmers derive their livelihood from land holdings of about 5 ha, owning at most 20 heads of livestock, with a mix of commercial and subsistence production; they also have a greater share of family labour in production and the farm is the main source of income.

Kenya has been one of the world's leading pineapple producers for many years and is currently ranked 9^{th} in total production and Del Monte's farm in Thika is the leading producer of pineapples, but small-scale growers are also increasing their production for the local market (USAID (United States Agency for International Development), 2005). In Bureti district pineapples are produced by small-scale farmers for both home consumption and commercial purpose. In 2010, pineapple farmers in the region produced 56,000 tonnes of the crop, earning them more than US$7.2 million with the bulk of the crop sold locally. The area has a production potential of 500,000 tonnes and due to this huge potential, the Kenya government has commissioned the construction of a US$600,000 modern pineapple processing factory in the district (Ministry of Agriculture, 2011).

Despite policy reforms that have been undertaken in recent years, primarily aimed at the liberalization of the agricultural sector from government control, there has been a marked decline in crop productivity (Marinda *et al*., 2006). Estimates of changes in Kenyan smallholders' share of the fresh horticultural export market vary widely. Most researchers seem to agree that shares were as high as 75% in the early 1990s

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(Harris *et al*., 2001). Estimate by Kenya's Horticultural Crops Development Authority (HCDA), places smallholder export market shares at 40% for fruit and 70% for vegetables, implying an overall horticultural share of 55-60%.

Scholars of international management and economic developments have increasingly argued that the competitiveness of emerging market countries often depends on the ability of their firms to upgrade-combine existing resources in new ways to create new, higher value products (Giuliani *et al*., 2005). Yield gaps between potential and farm level yields are evident across ecologies, regions and countries (FAO, 2004).

Despite efforts made by agricultural extension officers in Bureti district to train farmers on better management practices, pineapple production is still low. In fact, farmers only produce 18.6% of the expected optimum level prohibiting them from earning significant returns from their enterprise. Thus, this study aims to establish the current level of technical efficiency of small-scale pineapple production in Bureti district.

Kericho Country is one of the 47 countries of Kenya (IIBRC, 2012). It is located in the south western region of Kenya, lying in the highlands of The Great Rift-Valley. Kericho Country has six districts and it is a major national producer of tea. Bureti district is one of the districts in Kericho Country and it is ranked the best producer of pineapples in the Country. The districts agro ecological zones make it one of the best agricultural districts in the country. The change in altitude and factors because temperature to vary from 20 to 28 Centigrade and the mean annual rainfall varies from 1400 to 1800 mm, respectively (Kenya Meteorological Services, 2010). The district occupies a total area of 321.10 km^2 and its headquarters is Litein town. The district has a population of 167, 649 (2009 Census). Administratively, the district has three divisions: Roret; Cheborge and Buret.

MATERIALS AND METHODS

Data: A survey of the production practices and household characteristics of small scale pineapple producers was conducted in May 2012 and data for the study relate to pineapple farmers surveyed during production season for the year 2011. Multistage sampling procedure was used in the selection of representative sample. First, Cheborgei and Roret divisions were purposively selected due to their importance as the major pineapple growing divisions among the three divisions in the district. Secondly, 150 farmers were selected at random for interview from both divisions.

Analytical framework: The stochastic frontier production function used in this study was based on one proposed by (Aigner *et al*., 1977) which assumes the presence of technical inefficiency of production. This approach assumes that the stochastic frontier production function contains an error term that consists of two elements: a symmetric and a one-sided component (Battese and Coelli, 1995). It is presented in Eq. (1) as:

$$y_i = f\,(x_i;\, \beta).\, e^{\varepsilon}\; y \geq 0, \tag{1}$$

where,

y_i = The pineapple output in terms of fruits per ha
y_i = Output is a function f (.) the variables in the brackets (.) in this case
x_i = Vectors of inputs
β = The parameters to be estimated
$f\,(x_i; \beta)_i$ = The deterministic part
β = A vector of parameters to be estimated
e^{ε} = Stochastic part of the production ceiling or the frontier
ε = The random error term

The total error term ε in Eq. (1) could be decomposed into two error components (Coelli, 1996) as shown in Eq. (2):

$$\varepsilon = v_i - u_i\, \mu_i\, (\mu_i > 0) \tag{2}$$

where,

v_i = Random variables
u_i = Captures the stochastic effects outside the farmer's control

To measure technical efficiency specification of composite error distribution is necessary as shown in Eq. (3). Modeling and parameterization of the error is explicitly explained in Jondrow *et al*. (1982) and Kumbhakar and Knox (2000).
Therefore:

$$TE = \frac{Y_I}{f(x;\beta).\exp(v)} = \exp\,(-u)\; (u_i \geq o) \tag{3}$$

where,

f(x; β) = Deterministic part
exp (v) = Effect on output of exogenous shocks
exp (-u) = The inefficiency
f(x; β).exp (v) = The stochastic frontier

This defines technical efficiency as the ratio of observed output to maximum feasible output, given the random factors experienced by pineapple farmer exp $\{v_i\}$. Eq. (3) implies that y_i achieves its maximum feasible value of [f $(x_i$;) exp {vi}] if and only if TE = 1 that if there is no inefficiency and, u_i = 0. Therefore farm is considered to be technically efficient $TE_i^t = 1$ and technically inefficient when $0 < TE_i^t < 1$.

The linearised Cobb-Douglas production function of Eq. (1) is specified as in Eq. (4) and uses maximum likelihood estimation to determine technical efficiency following Battese and Coelli (1995):

$$\ln y_{ij} = \beta_0 + \beta_1 \text{lncap} + \beta_2 \text{lnlab} + v_i - u_i, \quad (4)$$

where, ln Y_i is Natural log of total pineapple output and lncap is natural log of capital an (aggregation of asset charges and purchased inputs) and lnlab the natural log of labour (man days per ha).

To determine efficiency effects, the basic null hypothesis test is that a farmer is fully efficient:

H0: y = 0 and the alternative hypothesis is that the farmer is not efficient

H1: y ≠ 0. The statistical test of hypotheses for the parameters of the frontier model will be conducted using generalized Likelihood-Ratio (LR).

RESULTS AND DISCUSSION

The results of two tailed t-test of continuous socioeconomic characteristics of small scale pineapple farmers are presented in Table 1. These variables include age, household size, farm size, experience in pineapple production and distance to nearest trading centre. Apart from landholdings, farmers in the two divisions were largely homogenous with respect to age, size of household, experience in farming and distance to trading centre.

The average age for the sampled household heads was about 46 years, while an average household had a family of 5.3 persons. The average farming experience for farmers sampled was 8.35 years and the average distance to the nearest trading centre was 4.7 km. Average land owned by farmers in Roret and Cheborgei was 2.67 and 1.87 ha, respectively. Results of chi square showed that land holding was statistically significant at 5% level.

Table 2 shows results of categorical variables including, credit access, marital status, level of formal education, growing other crops, keeping livestock, gender of the head and extension services access. Apart from level of formal education and growing other crops, farmers in the two divisions were largely homogenous with gender of the head, marital status, household size, keeping livestock, credit access and extension services access. From the farmers interviewed; 78.7% were married, 96.7% had access to credit, 83.3% were male headed households, 85.3% grew other crops and only 14.7% had access to extension services.

In terms of education level, majority of farmers were able to access education. The results show that in

Table 1: Summary of continuous socioeconomic characteristics of small-scale pineapple farmers in Bureti district, Kenya

	Mean				
Characteristics	Roret	Cheborge	Overall mean	t-ratio	Sig
Age (years)	46.63(1.5312)	44.96(1.4225)	45.79	0.7970	0.4260
Household size (number)	5.23(0.2050)	5.45(0.2811)	5.34	-6520	0.5160
Farm size (ha)	2.67(0.2659)	1.87(0.1788)	2.27	2.4800**	0.0140
Experience (years)	8.92(0.7826)	7.79(0.6175)	8.35	1.1370	0.2570
Mkt distance (km)	4.69(0.2801)	4.81(0.2326)	4.75	-3.1100	0.7560

* Significant at 10%; ** significant at 5%; *** significant at 1%. Figures in parentheses are standard errors

Table 2: Categorical socioeconomic and institutional characteristics of small-scale pineapple farmers in Bureti District

			Percentages			
Characteristics	Category	Roret	Cheborgei	Overall	Chi sq	Sig
Education	Non	6.7	5.3	6.0	8.5720*	0.0730
	Primary	9.3	26.7	18.0		
	Secondary	45.3	33.3	39.3		
	College	22.7	24.0	23.4		
	University	16.0	10.7	13.3		
Marital status	Married	76.0	81.3	78.7	1.594	0.6610
	Single	4.0	5.3	4.7		
	Divorced	4.0	4.0	4.0		
	Widowed	16.0	9.3	12.7		
Gender	Male	84.0	82.7	83.3	0.048	0.8270
	Female	16.0	17.3	16.7		
Credit access	Yes	98.7	94.7	96.7	1.862	0.1720
	No	1.3	5.3	3.3		
Extension service	Yes	17.3	12.0	14.7	0.8520	0.3560
	No	82.7	88.0	85.3		
Grow other crops	Yes	88	77.3	82.7	2.9780*	0.0840
	No	12	22.7	17.3		
Keep livestock	Yes	84	86.7	85.3	0.2130	0.6440
	No	16	13.3	14.7		

* Significant at 10%; ** significant at 5%; *** significant at 1

Table 3: Estimates for parameters of the stochastic frontier production model for small scale pineapple farmers in Bureti district, Kenya

	Parameter	Ols estimates	Ml estimates
Constant	β_0	-5.5073	-5.5079
		(2.1417)	(1.1138)
Capital	β_1	0.1440	0.1457
		(0.0336)	(0.0330)
Labour	β_2	0.7066	0.6843
		(0.2246)	(0.2149)
sigma-squared	δ^2		0.3268
			(0.0100)
Gamma	γ		0.3877
			(0.0499)
Log likelihood function		-16.8091	-16.8089

Figures in parentheses are standard errors

Table 4: Frequency distribution of technical efficiency of small scale pineapple farmers in Bureti district, Kenya

Efficiency level (%)	Frequency	Percentage	Cumulative (%)
>0≤10	2	1.33	1.33
>10≤20	2	1.33	2.66
>20≤30	4	2.67	5.33
>30≤40	4	2.67	8.00
>40≤50	12	8	16.00
>50≤60	26	17.33	33.33
>60≤70	14	9.33	42.66
>70≤80	30	20	62.66
>80≤90	40	26.67	89.33
>90≤100	16	10.67	100.00
Total	150	100	100
Min		0.0734	
Max		0.9788	
Mean		0.6918	
Std.Dev		0.2008	

Roret division 6.7% of farmers did not go to school, 9.3% of farmers managed to attend primary school, 45.3% of farmers reached secondary level, 22.7% of the farmers attained college education and 16% of the farmers were university graduates. In Cheborgei division 5.3% of farmers did not go to school, 26.7% of farmers managed to attend primary school, 33.3% of farmers reached secondary level, 24% of the farmers attained college education and 10.7% of the farmers were university graduates. Results of chi-square showed that education level was statistically significant at 10% level.

The results presented in Table 2 indicate that 82.7% of the farmers grew other crops from the pineapples, 88% of farmers interviewed grew other crops in Roret while 77.3% of farmers interviewed grew other crops apart from pineapple sin Cheborgei divisions respectively. Results of chi square analysis showed that growing other crops was statistically significant at 10% level.

The Maximum Likelihood (ML) and the Ordinary Least Square (OLS) estimates of the Cobb-Douglas SFPF are presented in Table 3.

The overall significance of the model is shown by the estimated sigma squared (δ^2) 0.3267 was significantly different from zero at 5% level. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. The value of gamma (γ) is 0.39 and is implying that 39% of variation in output is due to inefficiency that is, the technical inefficiency effects are significant at 5% level in the stochastic frontier production function.

All the input coefficients in both models are positive as expected implying that they contribute to increased output and the sum of their input coefficients is 0.84. Using the maximum-likelihood estimates for the parameters of the production frontier (Table 3), the elasticity's of frontier output with respect to capital and labour was estimated to be 0.14 and 0.70, respectively. The results show that the elasticity of mean value of farm output is estimated to be an increasing function of capital and labour. A 10% increase in labour and holding other things constant would increase output by 7.0%. In the same time, a 10% increase in capital would increase output by 1.4%.

The efficiency scores from the SFPF model are presented in Table 4. Technical efficiency ranges from 7.34 to 97.88 with a mean of 69.18%.

The presence of technical inefficiency indicates that there is potential to increase output gains without increasing input use. This implies that if farm households were to be fully efficient they will achieve a cost savings of 30.82%. On the other hand, if the average farm household in the sample was to achieve the TE level of its most efficient counterpart, then the average farm household could realize a 29.32% cost savings (i.e., 1–[69.18/97.88]). A similar calculation for the most technically inefficient farm household reveals cost saving of 92.5% (i.e., 1– [7.34/97.88]).

Table 4 shows that farmers who operated at technicalefficiencylevelrangedbetween80 and 90% were 26.67% of the sampled farmers. Farmers who operated above 50% technical efficiency level were 84% of the sampled population. Furthermore, only 16% of the farmers were operating below5 0% technical efficiency level.

CONCLUSION AND RECOMMENDATIONS

This study has revealed that small scale pineapple farmers are not technically efficient. Technical efficiency scores ranges from 7.34 to 97.88 with a mean of 69.18%. This implies that if farm households were to operate on the frontier, they will achieve a cost savings of 30.82%. On the other hand, if the average farm household in the sample was to achieve the TE level of its most efficient counterpart, then the average farm household could realize a 29.32% cost savings and the most technically inefficient farm household reveals cost saving of 92.5%. This implies that, with available technology, productivity of the small scale farmers could be improved, if key factors that currently constrain overall efficiency are adequately addressed.

Policy strategy aimed at improving technical efficiency in the short run should emphasize on an effective and efficient use of the current technology transfer instruments which enhance capacity of the farmer to efficiently use the physical inputs. Small scale pineapple farmers need to utilize the available technology efficiently to reduce losses or alternatively gain from it by minimizing inputs use while maintaining output levels, holding other things constant.

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