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Assessment of profit efficiency among sweet yellow passion fruit farmers in Mbeere south Embu county, Kenya

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Key words: Profit efficiency, Stochastic profit frontier, Sweet yellow passion fruit, Kenya

1 ABSTRACT

The main purposes of this research was to assess the profit efficiency of sweet yellow passion fruit farmers and also determine the socioeconomic and institutional determinants to profit inefficiency of sweet yellow passion farmers located in Mbeere south district, Embu County in Kenya. A stochastic profit frontier approach was adopted. The study used primary data obtained by administering a structured questionnaire to 79 randomly selected sweet yellow passion fruit farmers. The study showed that the profit efficiency levels ranged from 23% to 90% with a mean of 76% implying that an estimated 24% profit loss was being made due to a combination of both technical and allocative inefficiencies. The study also found out that the frequency of farming experience, group membership and access to market information influence profit efficiency significantly. Therefore, it is recommended that extension education investments should be scaled up through producer organizations to improve agricultural productivity and agricultural marketing through proper search and use of marketing information.

2 INTRODUCTION

Agriculture as a sector is the main stay of the Kenyan economy contributing 30% of the GDP and accounts for 80% of employment (HCDA, 2013). The horticulture industry in Kenya has been very successful in the last one and a half decades. This sub-sector has grown to become a major employer and foreign exchange earner(HCDA, 2008). The sub-sector also directly employs over 4 million people; mainly in rural areas with the majority being women and the youth. By positively creating employment, the sector thus help in alleviating poverty, wealth creation and in providing raw materials for agro-based processing industries. It is ranked the second most important foreign exchange earner in Kenya after tourism. According to(HCDA, 2013), the horticulture industry contributes 28% in Kenya shillings (in millions) by value. In 2012, fruits contributed Kshs 61.5 billion accounting for 22% of the domestic value of horticultural produce (HCDA, 2013). The area under fruit cultivation was 167,000ha with a production of 5.2 million tonnes. Although the area under fruit declined by 6% as compared to the previous year, the production and value increased by 46% and 1% respectively due to favourable weather. Further, the report categorizes the main fruits grown in Kenya to be the tropical and temperate fruits. These main crops of importance are; banana (37.6%), mangoes (19.6%), pineapples (12.1%), avocado (9.8%), paw paw (5.4%), oranges (4.6%), watermelon (4.2%) and passion fruit (3.7%). The potential for most fruits remained unexploited

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Passion fruit (*Passiflora edulis*) is widely grown and valued throughout the tropics and subtropics. The different varieties have fruits, which range in colour from purple to yellow-orange, and in size and shape from an egg to a tennis ball. The fruit is eaten as fresh fruit and also made into juice often blended with other juices such as orange,(Committee, 2011). According to(Committee, 2011), Kenya exports around 1000 tonnes of passion fruit per year. There are two main varieties of passion fruit; the purple and the yellow varieties with the yellow being distinguished as *P. edulis f. flavicarpa*. The yellow passion has a yellow rind and larger fruit, more acid flavour, resistant to nematodes and Fusarium wilt and has brown seeds, it if free from most pests and diseases (Committee, 2011). According to Wangungu, (2013), the Kenyan passion fruit has emerged as a high value crop influenced by the establishment of the new Kevian and Valley orchards among others, and the expansion of existing (Delmonte and Coca cola) large scale processors of fruit juice. According to (Carvalho *et al.*, 2011), in order to improve the economic profit of yellow passion fruit cultivation, the development of technologies to increase yield productivity, especially those pertaining to the mineral nutrition, irrigation and fertilization is an essential necessity.(BAOBAB, 2012) points out challenges that smallholder farmers face in the production of passion fruit to be: low volumes of commodities by individual smallholder farmers thus requiring them to form groups to sell in bulk; pressure to sell to middlemen even at lower prices; poor post- harvest handling due to lack of skills and capacity to maintain good post-harvest quality; pests and diseases particularly die back disease that affects passion fruit. Efforts have been mounted to promote the production, marketing and the boosting of smallholder passion fruit farmer income by various stakeholders such as the Kenya Agricultural and Livestock Research Organization (KALRO) and Technoserve. For instance, the World Bank interventions through the Kenyan agricultural productivity and agribusiness project (KAPAP), implemented under the framework of Kenya Government Strategy for Revitalizing Agriculture, has been pursuing a vital role of researching, developing and promoting a new sweet yellow passion fruit that is more tolerant to moisture stress, diseases and pests. These sweet yellow passion fruit varieties are now increasingly being produced by most passion fruit farmers in Embu County. Despite all these efforts, productivity levels of yellow passion fruit remain to be low hence forcing most passion fruit juice processors to import the passion fruit pulp to counter its shortage. It is against this backdrop that this study was conducted to determine the profit efficient levels of the farmers producing sweet yellow passion and therefore its profitability. This information will help in promoting adoption of several sweet yellow passion fruit varieties.

3 THEORETICAL FRAMEWORK

The theoretical framework is based on the stochastic profit frontier approach in the examination of smallholder farmers' profit efficiency of sweet yellow passion fruit.
(Kolawale, 2006), defined profit efficiency as profit gained from operating on the profit frontier while taking into consideration farm-specific prices and other factors. The technique that was applied for this study, included stochastic frontier profit function which is in line with (Nmadu & Garba, 2013), (Ojo, O, S., Yisa., & H., 2009)and (Oguniyi, 2008) who adopted Battesse and Coelli's model to postulate a profit function that is assumed to behave in a manner consistent with the stochastic concept. According to (Nmadu & Garba, 2013), the model commences by considering a stochastic profit function with a multiplicative disturbance term of the form:

$$\Pi = f(Pi, Zik\beta i)ei(Ei) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where;

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Π = normalized profit defined as gross revenue less variable cost divided by output price,
Pi= normalized price of variable inputs by the farm divided by output price,
Zi= level of kth fixed factor on the farm,
βi= Vectors of parameters, ei= error term used,
Ei= stochastic disturbance term consisting of two independent elements v and μ.

Where;

$$Ei = Vi+\mu i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Vi' is assumed to be independent and identically distributed random errors having normal N (0, σ^2) distribution independent of the μi while the μi is the one-sided disturbance form used to represent profit inefficiency and is assumed to be non-negative truncation of the half normal distribution N (μ, $\sigma^2\mu$).
According to (Nmadu & Garba, 2013), the model can be used to estimate the individual profit efficiency of the respondents as well as the determinants of profit efficiency. The frontier of the farm is given by combining equation 1 and 2 as presented in equation 3:

$$\Pi = f(Pi, Zik, \beta)\ e^{(\mu+v)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The profit efficiency of an individual farmer is defined as the ratio of predicted actual profit to the predicted maximum profit for a best practical passion fruit farmer and this is represented in equation (4).

$$\text{Profit efficiency } (E\Pi) = \frac{\pi}{\pi^{max}} = \frac{\exp[\pi(p,z)\exp(\ln V)\exp(\ln\mu)\theta}{\exp[\pi(p,z)]\exp(\ln V)\theta} \quad \ldots 4)$$

Where π= predicted actual profit, π^{max} = predicted maximum profit. The profit function can be estimated by the maximum likelihood technique given the density function of μi and Vi. The profit efficiency E(π) takes the value between 0 and 1. Therefore if μi=0, that is lying on the frontier, the farmer has potential maximum profit given the price he faces and the level of fixed factors of production, while if μi>0, the farmer is inefficient and operates on lower profit as a result of inefficiency.
Following (Nmadu & Garba, 2013), (Coelli, Rao., O'Donnell, & Battese, 2005) and (Ojo *et al.*, 2009), the stochastic frontier function with behavioural inefficiency components was used to estimate all parameters together in one step maximum likelihood estimation procedure. The explicit Cobb-Douglas functional form for the yellow passion fruit producers in the study area was therefore specified explicitly as presented below in equation (5):

$$Ln\pi = \beta o + \beta_1 \ln Zli + \beta_2 \ln P_{1i} + \beta_3 \ln P_{2i} + \beta_4 \ln P_{3i} + \beta_5 \ln P_{4i} + \beta_6 \ln P_{4i} + (Vi+\mu i) \quad \ldots\ldots\ldots..(5)$$

Where
π= normalized profit function computed as the total revenue less variable cost per output price,
Zi= farm size (ha),
P_1= normalized price of fertilizer (Kshs),
P_{2i}= normalized price of labour (Ksh per man day of labour),
P_{3i} =normalized price of seedling (Kshs per seedling),
P_{4i}= normalized price of agrochemical (Kshs per litre of agro-chemical),
P_{5i}= normalized price of irrigation (cost of irrigation per day), βo=Intercept/constant, β_1-β_6= parameters to be estimated,
μi= non-negative (Zero mean and constant variance) random variable called profit inefficiency effect associated with the profit efficiency of the ith farmers. μij's are the profit inefficiency effects, which are assumed independent of Vijs such that μij's are the non-negative truncation (at zero) of the normal distribution with mean μi and Variance (σ^2V). Where μi is defined by the following equation (6):

$$\mu i = \delta_0 + \delta_1 G_{1i} + \delta_2 G_{2i} + \delta_3 G_{3i} + \delta_4 G_{4i} + \delta_5 G_{5i} + \delta_6 G_{6i} + \delta_7 G_{7i} + \delta_8 G_{8i} + \delta_9 G_{9i} + \delta_{10} G_{10i} + \delta_{11} G_{11i} + \delta_{12} G_{12i} \quad (6)$$

Where
μi= profit inefficiency of the ith farmer,

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G_{1i} = age of the ith farmer in years,
G_{2i} = level of eduation of the ith farmer (years spent in school),
G_{3i} = farming experience of the ith SWY passion fruit farmer in years,
G_{4i} = household size of the ith farmer,
G_{5i} = extension contact and use (number of meeting during production),
G_{6i} = Sex (1 for male, 0 for female),
G_{7i} = credit status of the ith farmer(1 for access, 0 for otherwise),
G_{8i} = Status of membership of a group or cooperative society of the ith farmer (1 for membership,0 for otherwise) $\delta_9 G_{9i}$ = Trust on trader price, $\delta_{10} G_{10i}$ = Access to market information, $\delta_{11} G_{11i}$ = Access to off- sweet yellow passion farm income, $\delta_{12} G_{12i}$ = Length of supply chain. δ_{1i} - δ_{12i} = Unknown parameters to be estimated.

4 RESEARCH METHODOLOGY

Study Area: This study was conducted in Mbeere South district of Embu County, Kenya. The study area covers an area of 1,321.50 Km^2 with an altitude of above 1050 metres above sea level. The area also receives an average of 500-1495mm of rainfall. The annual mean temperature range of the area is 12-30^{0}C.

Sampling procedure and sample size: In this study, the target population was defined by the smallholder farmers producing sweet yellow passion fruit. The study area was purposively selected due to its favourable climate which is semi-arid nature known to be suitable for sweet yellow passion fruit production and the KAPAP project being implemented there. A systematic random sampling method was applied also to select two locations from each division in the district and sample respondents at an interval of one respondent to select a sample from each division for the study that is every second sweet yellow passion fruit farmer was selected. This resulted in a sample size of 90 respondents from which primary data was elicited using a structured questionnaire. Out of the sample size of 90 respondents, this study used data of 79 respondents. Data was collected by trained enumerators from the study area because of their familiarity with the region and communication in the local language with the respondents. Data were collected on the institutional characteristics as well as socio-economic characteristics of the respondents such as: age, sex, family size, level of education, farming experience, access to off-sweet yellow passion fruit income, group membership, use of irrigation water, credit access and use, trust on trader price, market information access, fertilizer application, length of supply chain, and input-output data such as farm size, cost of labour, fertilizer, agrochemicals, irrigation water and the quantity produced as well as output price. The data which was collected was then cleaned and coded for analysis. Relevant pre-analysis test were done to check for multi-collinearity, heteroscedasticity, and for normality of the data. The analytical technique that was employed in this study included the stochastic frontier profit which is in line with (Ojo *et al.*, 2009) and (Oguniyi, 2008). The parameters of the stochastic frontier profit function were estimated with FRONTIER version 4.1 software.

5 RESULTS AND DISCUSSION

5.1 Socioeconomic characteristics: The socio-economic characteristics of the respondents are presented in Table 1(appendix). The results show that majority of the farmers were males (72.15%).The respondent mean age was43.09 and majority of the farmers' mean age was (43.09) falling under the 29-39 age bracket therefore signifying that relatively younger farmers are involved in sweet yellow passion fruit production systems and raising the likelihood that there is increased productivity corroborating(Nmadu & Garba, 2013). Respondents who are in the productive young age bracket are more likely to adopt new

technology and innovation compared to old aged farmers. The mean education level of the respondents was found to be 10.20 years. Basing this education level in years to the Kenyan education system implies that most of the farmers had a secondary school education,(Dennis, 2010). Further, the lowest education level was also zero, suggesting that some farmers were illiterate and had no education. The average household size was found to be 5 persons with most 60.76% households consisting of 5-10 members in their households. While a large household size could be a reason for increased land cultivation to increase productivity when most of the household members are adults, this was not the case in the study area as most cultivated land was very small. The average size of the land cultivated was found out to be 0.25 (ha), with majority of the farmers having 0.1-0.4 total ownership of land in hectares used in sweet yellow passion fruit production. These results corroborates earlier findings by, Nmadu & Garba, (2013)&(Babatunde, Omotesho, Olorunsanya, & Amadou, (2007). The land size ownership shows that most sweet yellow passion fruit farmers are smallholders. This is due to the intensiveness nature of the enterprise, as it requires a considerable investment in buying fertilizers, agrochemicals, seedlings, expenditure on labour and above all, expenditure on irrigation. The study also found out that 93.67% of the respondents had access to off- farm (other than sweet yellow passion fruit) income explaining the small size of farm size dedicated to sweet yellow passion fruit production. Their engaging on other off-farm activities such as businesses, miraa, dairy and employment equally consumed their limited labour.

5.2 Institutional Characteristics: The institutional characteristics of the respondents are presented in table 2 (appendix). The results showed that 66.96% respondents received extension services from the government, NGOs or private institutions and more so farmer groups. Training is important as it endow a sweet yellow passion fruit farmer with the necessary skills to produce efficiently. A total of 67.09% respondents had access to market information prior to the sale of their fruits. This could have been because of their being members to a group. As (Eaton, Meijerink, & Bijman, 2008), pointed out, in cases where farmers have less information about prices and markets outlets, and about specific quality requirements (as in the case of export markets) that traders/collectors, then the information transfer of a producer organization becomes the more important. The results also show that 65.8% trusted trader prices offered to them for their produce. This is because 47.4 respondents were found out to have preferred selling their fruits to a contracted buyer because of their reliability to buy in large volume. Farmers who sold their fruits to middlemen couldn't sell all their fruits at once although their prices were higher.

5.3 Estimates of the Stochastic Frontier Profit Function: The maximum likelihood estimates of the parameters of the stochastic frontier profit function are presented in table 3. From the MLE estimates, the coefficient estimates of farm size (ha) and fertilizer were both statistically significant at 5% and 1% respectively. The cost of fertilizer was the most important variable determining profit efficiency. The normalized cost is positive and significant at 1% significance level. It had a coefficient of 0.405, therefore implying that for every 1% increase in the expenditure on fertilizer, profit would increase by 40.5%.The cost of seedlings was also found to be positive with a coefficient of 0.349 and significant at 1%. This means that an increase expenditure on seedlings would positively lead to profit efficiency by 34.9%. Farm size was significant at 5% level of significance and its coefficient was positive implying that an increase on farm size under sweet yellow passion fruit production would lead to increased profits. The cost of agrochemical, irrigation and expenditure on labour were found not to be significant.

5.4 Profit Inefficiency Determinants: The parameter estimates of the influence of socioeconomic and institutional characteristics on

profit efficiency are presented in the section of profit inefficiency in table 3. The results of the analysis of the inefficiency model show that farming experience and group membership had negative coefficients and were significant at 5 and 10% respectively. This result agrees with those of (Nmadu & Garba, 2013) who found out that as farming experience increases, profit inefficiency of spinach farmers in Nigeria decreases. Therefore, it means that as these variables increases, the profit inefficiency of the sweet yellow passion fruit farmers with high levels of farming experience and group membership show less loss of profits than those without. Access to market information was positive and significant at 10% level. This implies that as a farmer's access to market information increases, the profit inefficiency of the farmer also increases. This is quite contrary to theoretical expectations. It was expected that as farmers access to market information increased, they would make decisions that are more informed when it comes to selling their fruits and thus gaining from the information than those who did not have access to market information. Therefore, since this was not the case, it appears that the farmers did not use the information to their advantage or the source of their information was not reliable and trustworthy or the information was outdated.

5.5 Profit Efficiency estimates of the farmers: The profit efficiency ranged from 0.23 to 0.90 for the worst and best practiced farmer respectively and with a mean of 0.76 in the study area, (table 4). This mean indicates that the sweet yellow passion fruit farmers could improve their profit efficiency by 24% if they improved their technical and allocative efficiencies. This is an indicator that the sweet yellow passion fruit farmer has an opportunity to improve and increase their farm income thus improving their living standards and reducing poverty. Despite the variation in the efficiency estimates, these results are similar to those of (Tsue, Lawal &Ayuba, 2012) who found that the minimum profit efficiency of catfish farmers Benue state, Niger was 0.23 while the maximum was 0.99 with a mean of 0.88. They are also similar to (Raman, 2003), who found out that the mean efficiency of rice farmers in Bangladesh was 0.77 and also similar to (Bemire, Otunaiya, &Adejumo, 2013) who found the mean profit efficiency of poultry farmers to be 0.72 with a minimum of 0.11 and a maximum of 0.97 efficiency level. These indices imply that farmers were not using production resources efficiently in order to achieve higher profits.

6 CONCLUSION

This study estimated the profit efficiency of sweet yellow passion fruit in Mbeere South district, Embu County in Kenya. It was a stochastic profit frontier approach where a Cobb-Douglas profit frontier was estimated by maximum likelihood estimates to obtain ML estimates and the inefficiency estimates. The results showed a wide variation in profit efficiency among sweet yellow passion fruit farmers due to the presence of inefficiency effects in sweet yellow passion fruit production in Mbeere south, Kenya. The results further revealed that all the inputs except cost of agrochemical and cost of irrigation had a positive sign on the profitability of sweet yellow passion fruit. Farming experience, group membership and access to market information were also found to have a significant influence on profit inefficiency. Results of profit efficiency estimation showed that efficiency ranged from 0.23 to 0.90 (23% to 90%) and the mean profit efficiency of sweet yellow passion fruit farmers to be 0.76(76%) thus estimating a 24% profit loss due to technical and allocative inefficiency in sweet yellow passion production. Therefore, an average sweet yellow passion fruit farmer could improve his/her efficiency by 24% by using production resources well. Therefore, it is recommended that extension education be scaled up through producer organizations to improve agricultural productivity and agricultural marketing through proper.

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APPENDICES

Table 1: Socioeconomic characteristics of sweet yellow passion fruit farmers in Mbeere South District

Variable	**Percentage**
Males	72.15
Females	27.85
Age	
18-29	11.39
29-39	29.11
39-49	27.85
50-56	10.13
>56	21.52
Total	100.00
Mean age	43.09
Household size	
1-5 35.44	
5-10	60.76
10-15	3.80
Total	100.00
Mean Hhld	43.09
Farm size	
<= 0.06	7.59
0.1-0.4	75.95
0.4-0.8	12.66
0.8-1.2	2.53
>1.2	1.27
Level of education	
Non-formal education	3.80
Primary education	35.41
Secondary education	36.71
Tertiary(certificate/diploma) education	11.39
University education	5.06
Total	100.00
Years spent in school	
0	3.80
1-5	2.53
5-10	36.71
10-15	44.30
15-20	12.66
Total100.00	
Mean (years) spent in school	10.20
Access to non-passion income	
Access	93.67
No access	6.33
Total100.00	
Group membership	
Member	64.56
Non-member	35.44

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Table 2: Institutional factors of sweet yellow passion fruit farmers in Mbeere South District

Variable	Percentage
Extension contact	
No	43.04
Yes	66.96
Total	100.00
Credit access/used	
Accessed/used	12.66
No access	87.34
Total	100.00
Access to market information	
Yes	67.09
No	32.91
Total	100.00
Trust on trader price	
Highly trusted	8.9
Trusted	65.8
Mistrusted	24.1
Very mistrusted	1.3
Total	100.00
Farming experience	
8months- 1year	5.07
1 year & 4 months	69.62
3-6 years	25.31
Total	100.00
Length of supply chain	
Farmgate	16.5
Middlemen	17.5
Spot market	17.5
Cooperative	1.0
Contracted buyer	47.4

Table 3: Frontier function estimates

Production factors	**Estimated Coefficient**
Constant	8.133***(15.779)
ln farm size(ha)	0.067**(2.1138)
ln cost of fertilizer	0.405***(4.434)
ln cost of agrochemical	-0.047(-0.482)
ln cost of seedlings	0.349***(3.748)
ln expenditure on labour	0.047(0.692)
ln cost of irrigation	-0.101(-0.827)
Profit Inefficiency factors	
Age (G1)	-0.389(-1.389)
Level of education (G2)	-0.029(-0.219)
Farming experience G3)	-1.251**(-1.976)
Household size (G4)	0.266(1.469)

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Extension contact (G5)	-1.234(-1.345)
Sex (G6)	-1.168(-1.030)
Credit status (G7)	0.587(0.509)
Group membership (G8)	-2.798*(-1.840)
Trust on trader price (G9)	0-0.294(-0.565)
Access to market information (G10)	1.614*(1.665)
Access to off-swy income (G11)	
Length of supply chain	
Diagnosis statistics	2.011(1.349)
Sigma-square (δ^2)	-1.128(-1.111)
Lambda λ	
Log likelihood function	1.613(4.284)
LR Test	2.894(11.125)
	-80.148)
	8.49

NB: Values in parentheses are t-ratios, *significant at 10%, ** significant at 5%, *** significant at 1%.

Table 4: Profit efficiency estimates of sweet yellow passion fruit farmers in Mbeere south district

Efficiency index	Frequency	Percentage
0.20-0.40	2	2.53
0.40-0.60	4	5.06
0.60-0.80	32	40.51
0.80-1.00	41	51.90
Mean 0.76		
Minimum 0.23		
Maximum 0.90		
Standard deviation 0.12		