Original Research Article

Performance Analysis of Small Scale Sweet Potato Farms in Oyo State, Nigeria

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Abstract

This study carried out an analysis of the performance of sweet potato production among small holder farmers in Oyo State of Nigeria. A combination of purposive and a two-stage random sampling technique were used to obtain information from 65 respondents. Data collected were analyzed using descriptive statistics, stochastic frontier functions and budgetary technique. Results indicated that majority of the farmers were literate, aged 43.3 years on the average, full time in sweet potato production and with mean farm size of 1.0 hectare. The gross margin and net profit were ₦76, 884.8 and ₦67,292.8, respectively (₦, naira Nigerian Currency, ₦160 = 1\$US) indicating that sweet potato production was profitable. The return to scale (RTS) for the production function revealed that farmers operated in the irrational zone (stage I) of the production surface. The stochastic production frontier analysis revealed that the technical efficiencies of farmers was found to be fairly high with a mean of 0.92% which suggest that the average sweet potato output falls 0.08% short of the maximum possible level but the efficiency can be increased by better use of available resources.

Keywords: profitability; root and tuber crops; sub-Saharan Africa; technical efficiency.

INTRODUCTION

Nigeria is the first largest producer of sweet potato (*Ipomoea batatas* (L) Lam) in Africa with 3.46 million metric tons annually (FAO, 2008). Sweet potato is one of the most important staple carbohydrate foods in sub-Saharan Africa. As a crop that requires low inputs of land, labour and capital and less management in its production; it does well on marginal soils and erratic rainfall, giving reasonable yield than most other crops (Ogbonna et al., 2005; Attaliru and Ilangantileke, 2007). It has high energy fixing efficiency, produces much dry matter at a short period of time and contains high levels of vitamins A and C (Nwokocha and Onunka, 2002). Apart from the roots, the young leaves of sweet potato serve as green vegetable for man, while the leaves and vines are cherished as fodder and hay by livestock (Villareal et al., 1985). Its short life cycle of less than 20 weeks and yield potentials make crops like yam (*Dioscorea* spp.) relatively poor competitors for general industrial starch (NRCRI, 2009).

The importance of sweet potatoes is increasing in the Nigerian food system because it is very easy to plant, matures easily and has numerous industrial and economic potentials (Chukwuka, 1999), it ranks among the five most important food crops in over 50 developing countries (All about sweet potatoes, 2008) and as the fifth primary investment commodity in south east Nigeria. It offers a particularly significant potential for increasing food production and income in Nigeria. Sweet potato is an important crop in many areas of the world being cultivated in over 100

countries (Le Van An, 2004). Globally, it is estimated that sweet potato production will grow by 2.7% annually up to 2020. This exceeds the growth rate of all other major food crops (Scott et al., 2000).

Sweet potato benefits Nigeria as a whole by reducing the level of unemployment through creation of job in the farm (production sector) and provision of raw materials for industries to expand their scale of production (industrial sector). Industrially, sweet potato flour can be used to substitute wheat flour in bread making or mixed flour balanced feeds. Baby foods have been formulated using sweet potato while some bakeries blend 15-30% of sweet potato flour for making bread and 20-30% for pastries. It is also used in the brewing of alcoholic drinks and sweeteners in non-alcoholic drinks (Agbo and Ene, 1994). Sweet potatoes also have medicinal value. It is a folk remedy for asthma, bug bite, burns, diarrhea, fever, stomach distress and weight loss; the leaf concoction is used as remedies for tumours of mouth and throat (Duke and Wain, 1981).

To harness the current potentials for sweet potato production and export, its production must be improved. Various government supported research and development activities have been undertaken in an effort to raise productivity of small-holder farmers. Despite the efforts directed at improving sweet potato production over the years, low productivity remains a major challenge in the sector. However, the resources must be used much more efficiently with more attention paid to eliminating waste. Studies have shown that food crop farmers in developing countries in general and Nigeria in particular, have low

productivity because of inefficiency in resource use (Amodu et al., 2011). For sweet potato specifically, empirical studies by Babatunde et al. (2007), Fawole (2007), and many others presented a similar picture. There is still insufficient production of sweet potato in Nigeria and room to improve on production through increased efficiency (Ndukwu, 2010).

Many researchers have tried to justify why efficiency is important in developing countries' agriculture. Obwona (2006) stated that productivity increases do not depend on adoption rates of new technologies but effective use of available technologies. Thus, real productivity problems emanate from social and economic characteristics of the farmers. To achieve higher productivity, technological innovation is a necessary but not sufficient condition; efficient use of old technology is necessary. In developing countries, new technologies have partially succeeded in improving productivity due to institutional and cultural constraints (Xu and Jeffrey, 1998). If farmers are not efficiently using existing technologies, then ways of improving efficiency will be more cost effective in the short run than introducing another technology (Shapiro, 1983). Unless the potential of existing technology is known and completely exploited, the benefits from new one may not be realized in the short run (Feder, 1985).

Sweet potato is largely grown potentially as food, animal feeds, and raw materials source in Oyo State, Nigeria. Production of the crop is therefore motivated by the economic objective of producing maximum output to earning a positive economic return (profit). Meeting this objective requires efficient utilization of scarce resources. However, there could be intervening variables which may hinder agents to realize this objective. Hence there is need to examine the variables that influence technical efficiency of small-scale sweet potato farmers in Oyo State and their profitability. Specifically, the study examines the socio-economic characteristics of small-scale sweet potato farmers, determine the variables that influence technical efficiency of sweet potato production and estimate the profitability of small-scale sweet potato farmers in Oyo State with a view to determining profitability. Knowledge of this is necessary by suggesting measures that could be adopted towards increasing the level of production of sweet potato in the study area and in Nigeria.

MATERIALS AND METHODS

The study was carried out in Oyo State located in the south west Nigeria. The State has the population of 5,591,589 (NPC, 2006). Oyo State has thirty-three Local Government Areas (LGAs) distributed into two agro-ecological zones; rainforest and savannah zones. These zones are conducive for the practice of agriculture. The climate is equatorial,

notably with dry and wet season, the dry season starts from November to March while the wet season starts from April and ends in October. It is characterized by minimum rainfall of 1,211 mm and maximum of 1,262 mm which is suitable for the production of sweet potato in the State. A multi-stage sampling procedure was employed in selecting the sample. First stage involved a purposively sampling of three Local Government Areas (LGAs) namely Oyo East, Oyo West and Atiba LGAs in Oyo State because they are the major sweet potato producing areas in the State. At the second stage, four villages were randomly selected from each of the LGAs and at the last stage six sweet potato farmers from each of the four selected villages were randomly selected totaling seventy-two respondents. Out of the 72 copies of the questionnaire administered only 65 were found analyzable. Both primary and secondary data were used in this study. The primary data were collected using a pre-tested questionnaire on the socio-economic characteristics of the respondents; physical quantities and prices of inputs and output in the area during the 2013/2014 farming season. Data collected were analyzed using descriptive statistics, stochastic frontier functions and budgetary technique. The specific type of budgetary technique used was the gross margin analysis as well as the net farm income. The model is stated thus:

$$GM = GI - TVC \quad (1)$$

Where: GM = Gross Margin; GI = Gross Income; TVC = Total Variable Cost

$$NFI = GM - TFC \quad (2)$$

Where: NFI = Net Farm Income; GM = Gross Margin; TFC = Total Fixed Cost

The model used for estimating net farm income can be expressed by the equation:

$$NFI = \sum_{i=1}^n P_{yi} Y_i - \sum_{i=1}^n P_{xj} Y_{ij} - \sum_{k=1}^k F_k \quad (3)$$

Where:

Y_i = Enterprise's Product(s) (where $i = 1, 2, 3, \dots, n$ products); P_{yi} = Unit price of the product

X_j = Quantity of the variable inputs (where $j = 1, 2, 3, \dots, m$ variable inputs)

P_{xj} = Price per unit of variable inputs; F_k = Cost of fixed inputs; Σ = Summation (addition) sign

The total variable costs (TVC) include items like total cost of labour, transportation, fertilizer and seed. The total fixed cost (TFC) includes the depreciation on farm tools like hoes and cutlasses and the cost of renting land.

A stochastic production frontier model was used to measure technical efficiency and inefficiency of resources. The approach specifies the relationship between output and input levels using two errors terms. One error term is the traditional normal error term with a mean zero and constant variance. The other error term represents the

technical inefficiency which is subsequently estimated via Maximum Likelihood Estimation method (MLE) (Aigner et al., 1977; Rahji, 2005). The implicit function of the model can be written as:

$$Y_i = f(X_i, \beta) e^{\varepsilon_i} \quad (4)$$

Where:

Y_i = sweet potato output; X_i = vector of input; β = the parameter to be estimated,

$f(X_i, \beta)$ = the deterministic part; e^{ε} = the stochastic part of the production frontier

ε = is the random error term;

$$\varepsilon_i = V_i - U_i \quad (5)$$

Where,

V_i = random variables called technical efficiency associated with the technical efficiency of production of farmers involved.

U_i = random variables called technical inefficiency of production of farmers involved.

An explicit function of the technical efficiency model is assumed to be specified by a Cobb Douglas frontier production function and defined as

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + V_i - U_i \quad (6)$$

Where,

$\ln$ = Natural logarithm i.e (logarithm to base e); Y_i = Output of sweet potato in Kilogram (Kg)

X_1 = Land area in hectares (Ha); X_2 = Fertilizer used (Kg); X_3 = Seeds (sweet potato vine) (Kg)

X_4 = Labor (man-days); β_0 = Technical efficiency level

$\beta_1, \beta_2, \beta_3, \beta_4$ = Coefficients of various inputs with respect to output level.

An inefficiency model which assumes that the inefficiency effects are independently distributed is written in form of Cobb-Douglas production function.

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 \quad (7)$$

Where,

U_i = Farmers technical inefficiency; Z_1 = Household size (Number); Z_2 = Sex of farmer

Z_3 = Educational level; Z_4 = Income from other crops (₦);

$\delta_0, \delta_1, \delta_2, \delta_3, \delta_4$ = Parameters to be estimated

If $U_i = 0$ no technical inefficiency occurs, the production lies on the stochastic frontier. If $U_i > 0$, production lies below the frontier and it is inefficient.

Because the dependent variable in equation (7) is a measure of inefficiency, farm-specific variables with negative (positive) coefficient will have a positive (negative) effect on efficiency levels.

RESULTS AND DISCUSSION

Socio-economic characteristics of farmers

The majority (52.3%) of the respondents were within the age range of 41-50 years. The mean age (43.3 years)

of the respondents indicated that sweet potato farmers were mostly middle aged people. This falls within the economically productive proportion of the population as defined by Food and Agriculture Organization (1983). Gender distribution among farmers in sweet potato production is skewed slightly towards males (78.5%). This finding agrees with Mbanaso et al. (2012) in the Southeast agro-ecological zone of Nigeria but at variance with the findings of Jude et al. (2011) in Imo State, Nigeria. Large proportions of (73.8%) of the sweet potato farmers were married with mean family size of 6. This may have a positive effect on the availability of family labour and thereby reduce the cost of hiring labour for sweet potato production. Table 1 also revealed that 30.8% of the farmers had no formal education, 20% had primary education, and 41.5% had secondary education, and 7.7% had tertiary education. The high (69.2%) literacy of the farmer will not only increases his productivity but also enhances his ability to understand and evaluate new production techniques (Amanze et al., 2010). Over 63% of farmers were primarily into sweet potato farming showed that sweet potato production can be relied upon as a major source of income for the family. None of the farmers cultivated more than 4.0 hectares of land. This means that all the sweet potato farmers in the study area were small-scale farmers. This in agreement with the findings by Amanze et al. (2010). The implication of this is that agricultural production in the study area is still not mechanized. Acquisition of farmland among sweet potato farmers had not deviated from the age-long trend as most of the farmers (60%) acquired their farmland through inheritance.

Stochastic frontier production function

The estimated sigma-square, (s^2) (1.06) is statistically significant and different from zero at 1% level of significant indicates a good fit and correctness of the specified distribution assumption of composite error term (Table 2). The estimate of the gamma (g) parameter is quite large (0.96) which is closest to 1 confirming that technical inefficiency effects are highly statistically significant at 1% in the stated model indicating that only 0.04% of the total variation in sweet potato output was due to technical inefficiency. This means that systematic influences that are unexplained by the production function are the dominant sources of random errors. The value of g suggests that the variance in production inefficiency effects accounts for 96% of the total variance in production. The log likelihood function was estimated to be 58.39. This value represents the value that maximizes the joint densities in the estimated model. Estimates of the coefficients of the frontier and inefficiency models are presented in Table 2.

Table 1. Percentage distribution of respondents according to their socio-economic characteristics

Characteristics	Distribution (%)	Mean
Age of farmers (Years)		
20-30	7.7	43.3 (8.21)*
31-40	23.1	
41-50	52.3	
51 and above	16.9	
Gender of farmers		
Male	78.5	21.5
Female	21.5	
Marital status		
Single	6.2	73.8
Married	73.8	
Divorced	4.6	
Widowed	15.4	
Household size		
Less than 3	6.2	5.6 (1.82) *
3-5	33.8	
6 and above	60.0	
Literacy level		
Primary	20.0	41.5
Secondary	41.5	
Tertiary	7.7	
No formal education	30.8	
Mode of farming		
Full time	63.1	36.9
Part time	36.9	
Farm Size distribution (Ha)		
0.50- 0.999	69.2	1.0 (1.51) *
1.00- 1.499	24.7	
1.50-1.999	4.6	
2.00 and above	1.5	
Farmland acquired		
Gift	20.0	60.0
Lease	12.3	
Purchase	7.7	
Inheritances	60.0	

Source: Data analysis, 2014

* Standard deviations

In both frontier and inefficiency models, the coefficients estimated for most parameters have the anticipated impacts on production and efficiency. In the frontier model, the positive and highly significant coefficient of land and other variables confirm the expected positive relationship between output of sweet potato and variables. The more the hectares of land and other variables used in production, the more the yield. The functional form used in the efficiency model was that of Cobb Douglas, so the coefficients are elasticity. The elasticity for all input parameters is >1 , meaning that a 1% increase in the input of each coefficient would cause a $>1\%$ increase in the sweet potato production. The output elasticities for land

Table 2. Maximum likelihood estimates of the stochastic frontier production function

Variable	Parameter	Coefficient	t-ratio
Frontier Model			
Constant	β_0	4.57 (0.87)	5.25***
Land	β_4	0.42 (0.19)	2.21***
Fertilizer	β_2	0.52 (0.15)	3.47***
Seed	β_3	0.51 (0.13)	3.92***
Labour	β_4	0.86 (0.32)	2.69***
Inefficiency model			
Constant	δ_0	-0.10(-0.51)	-2.00
Farming experience	δ_1	0.73(0.25)	2.93**
Level of education	δ_2	-0.59(0.32)	-2.71**
Farm size	δ_3	-0.26 (0.14)	-1.84*
Household size	δ_4	0.36(0.19)	1.89*
Diagnostic statistics			
Sigma-Squared	σ^2	-1.06(0.29)	3.65***
($\sigma^2 = \sigma_v^2 + \sigma_m^2$)	γ	0.96	17.61***
Gamma ($\gamma = \sigma_m^2 / \sigma^2$)	λ	58.39	
Log Likelihood.		0.92	
Mean efficiency			

Source: Computed from survey data, 2014

*, **, *** Statistically significant at the 10%, 5%, and 1% levels, respectively.

Note: A negative sign of the parameters in the inefficiency function means that the associated variable has a positive effect on technical efficiency, and vice versa.

(0.42%), fertilizer (0.52%), seed (0.51%) and labour (0.86%) means that a 10% increase in land, fertilizer, seed and labour would lead to increases output of sweet potato by 4.2%, 5.2%, 5.1%, and 8.6% respectively. The return to scale estimate (2.31) indicates that sweet potato production in the study area was in stage one of production curve. Stage one is a region of increasing return to scale. This is an inefficient stage because increase in the use of inputs will lead to more than proportional increase in output. This means that sweet potato producers were inefficient at their level of production, their income and output can be improved if more inputs are utilized.

In inefficiency model, positive but less than unity of coefficients of farming experience, and household size indicates that these factors lead to decrease in technical efficiency. The positive and significant of farming experience at 5% does not follow the *a priori* expectation. In general, the more experience a farmer has the higher is his output and higher is the technical efficiency (Revilla-Molina et al., 2009). The finding is in line with the results of Fasasi (2007) and Raphael (2008). The implication of estimated coefficient for household size been positive and significant at 10% level is that large household size would have negative impact on profitability of sweet potato production. This finding agrees with Okoye et

al. (2007) who reported that a relatively large household size enhances the availability of labour though large household sizes may not guarantee increased efficiency since family labour which comprises mostly children of school age are always in school. Negativity of coefficient of education implies that increase in educational level of the farmers has the tendency of reducing the inefficiency level of sweet potato production. Education is expected to increase efficiency. This conforms to Amaza and Olayemi (2000) findings. The coefficient for farm size was significant and negatively related to technical efficiency at 1% levels of probability respectively. These results imply that smallholder farmers were more efficient; this reflects an intensive use of land resources by smallholder farmers (Jude et al., 2011). This is contrary to *a priori* expectations but agrees with Helfand and Levine (2004) who noted that if farm size is small, farmers are able to combine their resources better. A higher level of efficiency is due to the higher productivity of farm family labour and lower supervision costs compared to large farms (Eastwood et. al., 2010).

Budgetary analysis

The estimated costs and return for 1 hectare of sweet potatoes enterprises were ₦41,457.2 and ₦108,750, respectively (Table 3). Cost of labour had the highest share of 25.3% of total cost followed by seed cost (22.4%) and fertilizer cost (20.4%). The highest share of total cost of labour indicates that labour is an important input, and may be attributed to frequent harvesting of sweet potato vines. The high cost of labour emphasis that most farm operation was done by labour under small-scale farming system with little or no uses of machinery equipment for their farm operation. This indicates the need to evaluate mechanized options to determine whether it is cost effective. The total variable costs and total fixed costs constituted 76.9% and 23.1% of the total cost of production, respectively, suggesting that the enterprise is not rigid. The total revenue on the average was ₦108,750/ha while the gross margin and return to management were ₦76,884.8 and ₦67,292.8 per farmer per hectare for last season production cycle respectively.

The profit margin percentage of 61.9% and return per capital outlay of 1.6 implied that for every ₦1 invested in sweet potato production enterprise there is a return of ₦1.60 to the enterprise and the operating cash expenses ratio of 29.3% connotes that 29.3% of gross revenue was to cover the operating expenses. The benefit cost ratio (BCR) was ₦2.6; it shows profit and indicates that the enterprise is profitable even with little capital invested into it. It is therefore possible to have higher value of BCR with increased capita, skilled labour. Using all these

measures of performance, sweet potato enterprise can be said to be profitable and profitability can still be increased under improved management.

Table 3. Enterprise budget for one hectare of sweet potato production in Oyo State

Item	Mean amount ₦ ^a	Percentage of revenue/cost
Revenue		
1087.54kg of Sweet potato output at 100*kg ⁻¹	108,750	
Total Revenue (TR)	108,750	
Variable costs		
Seed cost (464.16 kg at ₦20. kg ⁻¹)	9,283.2	22.4
Fertilizer cost(84.62 kg at ₦100-Kg ⁻¹)	8,462	20.4
Pesticide cost (0.62 L at ₦1000 L ⁻¹)	620	1.4
Total labor cost (₦750. man-day ⁻¹)	10,500	25.3
Transportation cost	3,000	7.2
Total Variable Cost (TVC)	31,865.2	76.9
Gross margin (GM) = (TR-TVC)	76,884.8	
Fixed costs		
Land rent	4,500	10.8
Depreciation on tools	5,092	12.3
Total Fixed Costs (TFC)	9,592	23.1
Total Cost (TC) = (TVC +TFC)	41,457.2	
Net Income (NI) = (GM-TFC)	67,292.8	
Profit margin (%) = NI/TR x100		61.9
Rate of Return On Investment (RORI)= NI/TC		1.6
Operating expenses ratio (%) = TVC/TR x 100		29.3
Benefit cost ratio (BCR) = TR/TC		2.6

Source: Field Survey, 2014.^a₦ (Nigerian currency) = 1\$ = ₦160

CONCLUSION

The study examined the performance analysis of small scale sweet potato production in Oyo State in relation to the objective of the study. Sweet potato farmers were small scale and resource-poor, but they are fairly efficient in the use of their resources and any expansion in the use of any resources would bring more than proportionate increase in their output, given the increase returns – to – scale value obtained for the study. In order to meet the objective of boosting food production so as to reduce the level of food insecurity in Nigeria, it is suggested that sweet potato production should be increased by empowering sweet potato farmers and mobilizing them to enable them acquire production resources necessary to expand their farmland. Farm size, planting material, fertilizer and labour inputs were significant variables having positive impact on sweet potato output. For better efficiency, improvement on those key variables needed to be address.

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