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RESOURCE USE IN SWEET POTATO PRODUCTION IN DELTA STATE, NIGERIA: A TECHNICAL EFFICIENCY APPROACH

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ABSTRACT

Sweet potato is one of the major staple crops in Nigeria and most parts Africa sub-region. Its importance continues to rise due to increased urbanization. This increase definitely come with its share of challenges that need to be addressed. The study was conducted within the framework of the rural farming households who constitute the backbone of the Nigerian agricultural sector, producing about 80 per cent of the total national agricultural output. It examined resource use in sweet potato production in Delta state, Nigeria. The specific objectives are to determine the technical efficiency of sweet potato farmers, assess the factors determining the technical efficiency of potato farmers and to determine the technical efficiency distribution of sweet potato farmers. Multi-stage random sampling technique was adopted to select 120 respondents and stochastic frontier production function employed to realize the objectives. Result of analysis showed that the least technically efficient farmers have to increase their level of production given their inputs and technology to at least 68 % for them to operate at the production frontier while the most technically efficient farmers have to increase their production to at least by 4% for them to operate on the production frontier and be fully efficient with a mean technical efficiency of 0.71. The estimates of the parameters of the production function (sweet potato seeds, labour, fertilizers and agrochemical) were positive and significant at 5% and 1% levels respectively, while capital input was positive and not significant. Factors affecting technical inefficiency of sweet potato farmers among others included: age of farmers and farm size which were negative and significant, while household size, educational qualification, type of cropping and farming experience were all positive and significant. The following recommendations were proffered: sweet potato farmers should have access to improved sweet potato varieties, modern storage technologies, markets and extension services. Adequate financial assistance and credit facilities should also be made available to the sweet potato farmers to enable them expand their crop output.

KEYWORDS: production**,** sweet potato, resources, technical efficiency

1. INTRODUCTION

Improvement in agricultural production is a direct result of more efficient use of the factors of production- land labour, capital and entrepreneur and others like physical, socioeconomic, institutional and technological. The analysis of efficiency is generally associated with the possibility of farm producing a certain optimal level of output from a given bundle of resources or a certain level of output at a least cost (Ettah and Nweze, 2016). Optimum resource use is the wise use of resource by adopting planned management programs for the resource. This is necessary so as to prevent its exploitation, destruction or neglect, through man's activities. The essence of resource management is to hold all the resources earlier mentioned in place or improve them and increase their capacity for sustained utilization in production.

Technical efficiency according to Adewumi and Adebayo. (2008) is the ability of farms to employ the best practices in the production process, so that not more than the necessary amount of a given set of input is used in producing the best level of output. This means that for resource to be efficient, the ratio of the total output to that of total input must be equal to one. In production function analysis, technical efficiency of an individual farm is defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology. It is given as:

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$$TE = \frac{OQ}{OP}$$

Where: TE is Technical efficient, OQ is quantity of output and OP quantity of resources used.
In the context of the stochastic frontier production function technical efficiency is obtained by:

$$TE=Y_i^*/Y_i=f(X_i;\beta)\exp(V_i-U_i)/f(X_i;\beta)\exp(V_i) \quad (i)$$

$$=\exp(U_i) \quad (ii)$$

Where Y_i^* is the frontier output. Technical efficient farms are those that operate on the production boundary and the level by which a farm lies below its production boundary is regarded as the measurement of technical efficiency (Otitoju & Arene, 2010).

Sweet potato (*Ipomea batata*) is a major root crop and the third most important food crop in the world, after rice and wheat, which grows in over 125 countries and is consumed by over a billion people (Food and Agricultural Organization (FAO), 2011). According to the organization, annual production exceeds 320 million tons, were China which is the world biggest producer of the crop, produces over 70 million tons a year. Both production and consumption of the crop has been increasing. For example, sweet potato production in the world is increasing at an annual rate of 4.5% and area planted at 2.4% (National Bureau of Statistics (NBS), 2016)

Studies on sweet potatoes by Etudaiye, Oti, Aniedu and Omodamiro, (2015) showed that sweet potato farming is a profitable business with attractive net return on investment. In spite of this, sweet potato production in Cross River State, Nigeria is still not being carried out at a sustained level. This according to Agbo & Ene (1999) is because of resource use related issue, which has caused the farmers to live in abject poverty. It is against this background that the researcher intends to conduct an in-depth study to determine the level of resource use in sweet potato production in the area. The development of a vibrant, profitable and sustainable sweet potato subsector in developing countries like Nigeria depends on measures to overcome a number of persistent constraints such as resource use problems. According to Ettah and Kuye (2017) both the empirical and analytical inclinations to resource use in agricultural production tilts to the fact that farmers are inefficient in the use of resources resulting to low production, hence the justification for this study. Production and productivity would be sustained to levels that would be marched with the fast growing population, if the result of this study is considered. The study is further justified by the fact that resource use has emerged as an effective strategy to achieve goals of sustainable sweet potato production, transformation and development, because of its ability to provide solutions to non-sustainability of production. It will also identify and provide better information about the variables that may be responsible for the difference in levels of efficiency of resource utilization by farmers. Efficiency measurement is very important because it leads to resource savings. Efficient farms are more likely to generate higher income and then stand a better chance of surviving (Agbo & Ene, 1999).

Against this backdrop, the study is therefore apt and sought to address the following objectives:

(i) determine the technical efficiency of sweet potato farmers;

(ii) assess the factors determining the technical efficiency of sweet potato farmers

(iii) determine the technical efficiency distribution of sweet potato farmers

2. METHODOLOGY

2.1 Study Area:

The study was conducted in Delta State, Nigeria one of the States in the Niger Delta with a total of 25 local government areas (LGAs). It is located between latitude 5°30′N and longitude 6°00′E, Delta State is endowed with a total land area of 16,842 square kilometres (6,503 sq mi) (National Population Commission (NPC), 2011). According to Delta (2011) the State is an oil producing one and the richest agricultural producing states in Nigeria, situated in the region known as the South-South geo-political zone with a population of 4,098,291. Agriculture, Forestry and Fishing are prominent sources of livelihood in the state. The food crops produced in the state include sweet potato, cassava, fruits, rice, yam, vegetables, mangoes, etc. (Delta, 2011).

2.2 Sampling Plan:

The study sample comprised of 120 potato farmers randomly selected from a list of potato farmers registered with the Delta State Agricultural Development Project (DSADP) spread across four local government areas that were randomly selected from 25 local government areas (LGAs) in the State. These LGAs included Aniocha north, Uvwie, Sapele and Ugheli LGAs. In each of these LGAs, three communities were randomly selected from which 10 farmers each were selected. This gave a total sample of 120 farmers (i.e. 3 x 10 x 4 = 120). Delta state was selected purposively based on its potential in sweet potato production.

2.3 Data Collection Method and Analytical Tool:

Data were collected from the primary source through the use of a structured questionnaire. One hundred and twenty copies of the questionnaire were administered to the selected farmers. Focused Group Discussions were conducted with selected farmers and leaders of farm associations in addition to personal interviews conducted on the respondents. Preliminary visits were carried out to the study area and locations before the commencement of the actual data collection. The visits were an aid for the familiarization of the researchers with the study locations. Four enumerators and one

extension agent were used for the data collection. The questionnaires and interview schedule were pre-tested. Stochastic frontier production function models were employed to realize the objectives

2.4. Model Specification:

Study used the Cobb-Douglas form of the stochastic frontier production function to analyse the technical efficiency of potato farmers in the study area. This function has been employed in other studies to determine technical efficiency of agricultural production (Dube, Ozkan, Ayele, Idahe and Aliye, 2018). The Cobb-Douglas stochastic frontier production function model used is explicitly specified as:

$l_nY = \beta_o + \beta_1 l_n x_1 + \beta_2 l_n x_2 + l_3 L_n x_3 + \beta_4 l_n x_4 + \beta_5 l_n x_5 + \beta_6 l_n x_6 + - U_1$ (iii) where:

l_n = logarithm to base
Y = Technical efficiency of the farmer
x_1 = potato seed (kg)
x_2 = hired labour (₦/ man day)
x_3 = fertilizer (kg)
x_4 = Agrochemicals (₦)
x_5 = Farm size (Hectare)
x_6 = capital inputs (₦)
β_o = constant term
β_0-β_2..... β_6 = Regression coefficients
U_i= random errors which were assumed to be independent and identically distributed having N (0, δ^2)
U_i= Non-negative random variables associated with technical inefficiency.

It is assumed that the technical efficiency effects are independently distributed and arise by truncation at (zero) of the normal distribution with mean U_1 and various δ^2, where U_1 is specified thus;

$U_i = \delta_0 + \delta, z_1 + \delta_2 z_{2i} \delta_{3i} z_{3i} + \delta_4 2_{4i} + \delta_5 z_{5i} + \delta_6 z_{6i} + \delta_7 z_{7i} + \delta_8 z_{8i} + \sum$ ... ... (iv)

U_i = Technical inefficiency of the i^{th} farmer
Z_1= Age of farmer (years)
Z_2= Level of education (No of years spent in school)
Z_3 = Farming experience (years)
Z_4 = Household size (number)
Z_5 = Extension contact (number)
Z_6 = Credit status (Dummy variable, 1 for access, zero otherwise)
Z_7 = Membership of cooperative (1 for membership, zero otherwise)
Z_8 = Sex (binary variable, male = 1, female = 0)
$\sum$ = error term
δ_0- δ_8 = parameters

The above model was incorporated in the frontier model in determining the technical inefficiency of sweet potato farmers. This was done with the belief that the variables have direct influence on the level of efficiency (Ogundari and Ojo, 2007)

2. Result and discussion

3.1 Technical Efficiency of Sweet potato Farmers

A very important characteristic of production frontier model is its ability to estimate technical efficiency of farmers. The result as shown in table 1 below

Table 1 Technical Efficiency Distribution of Potato Farmers

Efficiency level	Frequency	Percentage
0.31 – 0.40	1	0.83
0.41 – 0.50	2	1.66
0.51 – 0.60	4	3.33
0.61 – 0.70	15	12.5
0.71 – 0.80	63	52.5
0.81 – 0.90	32	26.6
0.91 – 1.0	3	2.5
Total	**120**	**100.0**
Minimum	0.32	
Maximum	0.95	
Mean	0.712	
Mean of worst 10	0.51	
Mean of best 10	0.8	

Source: field Survey (2020) Analysis of output from Frontier 4.1c.

indicated that, technical efficiency of sampled farmers is less than 1. This implies that sweet potato farmers are producing below the maximum frontier output, this finding conforms to that of Agbo, & Ene (1999). The range of technical efficiency showed that 0.83% of the farmers had technical efficiency between the range of 0.31-0.40, 1.66% had technical efficiency of 0.41-0.50, 3.33% had technical efficiency of 0.51-0.60, 12.5% had technical efficiency of 0.61-0.70, 52.5% had technical efficiency of 0.71- 0.80, 26.6% had technical efficiency of 0.81-0.90 and 2.5% had technical efficiency of 0.91-1.0. The least technically efficient farmer had a technical efficiency of 0.32 which means that the farmer has to increase his level of production given his inputs and technology to at least 68% for him to operate at the production frontier while the most technically efficient farmer had technical efficiency of 0.96 which means that he has to increase his production to at least by 4% for him to operate on the production frontier and be fully efficient. The mean technical efficiency was 0.71; this implies that all sampled farmers will need to increase production at least by 29% given the available mix of inputs at a given technology for it to operate on the production frontier. The mean of the worst 10 technically efficient farmer was 0.51 while the mean of the best 10 technically efficient farmer had a technical efficiency of 0.8, this result is in line with that of Adewumi and Adebayo (2008) who also found the most technical efficient sweet potato farmers to be 0.90%.

3.2 Factors Affecting Technical Efficiency of Sweet Potato Farmers.

Result of factors affecting technical efficiency shown in Table 2 below:

Table 2 Factors affecting Technical Efficiency of Potato Farmers

Variable	Coefficient	Standard error	t
Constant	-0.5906	0.2960	-1.9951**
Potato seeds	0.6543	0.2956	2.213**
Labour	10.03858	4.7484	2.1141**
Agrochemicals	0.6105	0.1819	3.5514*
Capital input	0.5314	47.4464	-0.0112
Fertilizer	18.5603	9.3303	1.9892**
Variance Measures			
Sigma-squared	4.4891	1.3312	3.2714
Gamma	0.7988	0.0873	9.1415
Log likelihood function	-301.50098		
Technical Inefficiency Model			
Age	-0.0053	0.0025	-2.1211**
Sex	0.0032	0.0024	1..3112
Occupation	-0.0524	0.0531	- 0.9861
Household size	1.5643	0.7895	1.9812**
Educational qualification	0.0612	0.0275	2.2234**
Farming experience	2.1777	1.0123	2.1512**
Farm size	-0.2212	0.1042	2.1213**
Non-farm Income	0.2689	0.1345	1.998**
Type of cropping	0.2069	0.2065	1.0021

*,**, significant at 1% and 5% level respectively
Source: field survey, 2020

Table 2 above shows the result of the maximum likelihood estimates (MLEs) of the stochastic frontier production function for potato farmers. The estimates of sigma squared (σ^2) for potato farmers were 4.4891. This was significant at 1% probability level, indicating that it is significantly different from zero. It assures us of the goodness-of-fit as well as the correctness of the composite error term. The value of the gamma (γ) 0.7988 showed that the unexplained variation in output of sweet potato farmers is the major source of random errors. It also indicates that about 80 percent of the variation in output of sweet potato is caused by inefficiency of the producers. This result confirms the presence of one sided error components in the model and hence makes the use of Ordinary Least Square (OLS) inadequate in estimating the production function.

The estimates of the parameters of the production function are; potato seeds, labour and fertilizers which were positive and significant at 5%, this implies that an increase or decrease in potato seeds, labour and fertilizer will result to a corresponding increase or decrease in output of potato farmers respectively. Agrochemical was found to be positive and significant at 1% level of significance, while capital input was positive and not significant.

Factors affecting technical inefficiency of potato farmers are shown in the lower part of table 2 above. Age of farmers and farm size were negative and significant at 0.05 levels of probability, while household size, educational qualification and farming experience were all positive and significant at 5% levels of significance and type of cropping was positive and significant at 10% level of significance. Non-farm income was positive and significant at 5% level of probability. This means that a unit increase in these variables would increase technical inefficiency of the farmers and hence decrease their technical efficiency. The larger the household size the more resources are diverted to non - farm activities like medical care, education, welfare, etc. This development causes farmers to be inefficient in the use of these

resources for farm work. The result agrees with findings of Otitoju & Arene (2010) that family demands affect the efficient use of resources to farm production.

The more farmers are educated, the more they turn away from potato farming, to other businesses perceived to bring quicker returns on investment. The less educated ones who cannot efficiently utilize resources dominate the farm industry. Following this findings Ogundari and Ojo (2007) asserted that highly experienced farmers tend to stick to their old methods of production which may be inefficient. Potato farmers do not invest their non-farm income in their farm they concentrate on investments on high returning ones. This result agrees with that of Ettah and Nweze (2016) who found out that farmers give priority to investments outside agriculture because they are relatively fast in return to capital.

Table 3 Production Elasticity (EP) and Returns to Scale in Cassava production

Inputs	Production elasticity
Farm Size	0.519
Labour	0.036
Potato seeds	0.211
Agrochemicals	0.336
Fertilizer	0.046
Other capital inputs	-0.015
RTS	1.231

Source: field survey 2020

The summation of the values (1.231) showed that production of potato in the study area was in the positive increasing return to scale. Based on the return to scale of 1.231, sweet potato production in the study area is in the first part of stage ii of production region i.e. rational or efficient stage of factor usage in the area. Each additional unit of input results in a more than proportionate increase in output than the preceding unit. This result conforms to that of Abidin (2004) that potato production is in the positive increasing return to scale.

4.0 Conclusion and Policy Recommendations

Despite the documented evidence in support of the need for efficient resource use for sweet potato production, not much has been done in the study area so as to enjoy maximum benefit from the crop. Result of analysis showed that the least technically efficient farmers have to increase his level of production given their inputs and technology to at least 68 % for them to operate at the production frontier, while the most technically efficient farmers have to increase their production to at least by 4% for them to operate on the production frontier and be fully efficient with a mean technical efficiency of 0.71.

The estimates of the parameters of the production function are; sweet potato seeds, labour and fertilizers, agrochemical which were positive and significant at 5% and 1%, while capital input was positive and not significant. Factors affecting technical inefficiency of sweet potato farmers among others included: age of farmers and farm size were negative and significant, while household size, educational qualification, type of cropping and farming experience were all positive and significant. The following recommendations were proffered Sweet potato farmers should have access to improved varieties, modern storage technologies, markets and extension services. Adequate financial assistance and credit facilities should also be made available to the sweet potato farmers to enable them expand their production.

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