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Productivity and Technical Efficiency of Cassava Farmers Participating in National Programme for Food Security (NPFS) in Oyo State, Nigeria

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Abstract:- Failures in agricultural programs, inadequate rural infrastructure, access to inputs, and a wide range of socio-cultural issues like farmer-herder conflicts, land disputes, and environmental degradation, among other things, have been some of the difficulties Nigerian cassava farmers have faced over the years. These issues significantly impact the productivity and efficiency of rural farmers in Nigeria. As a result, this study investigates the Technical Efficiency of Nigeria's Oyo State's cassava growers. Using multi-stage sampling approaches, primary data were gathered from 200 cassava growers participating in the National Programme for Food Security (NPFS). The data were analyzed using descriptive statistics and stochastic frontier analysis (SFA). The findings reveal a larger percentage of the cassava farmers were male, 83.60%, with a mean age of 50 years; majority, 87%, were married, while the majority, 50%, had secondary education. The mean farm size was 1.1ha, the average household size was 6 household members, and the average farming experience was 16 years, while the majority, 60% of the farmers, actively participated in the National Programme on Food Security (NPFS). The (SFA) results indicate that herbicide quantity and labour used positively influenced cassava output, while the fertilizer quantity negatively affected the cassava output of farmers. The technical inefficiency of the farmers was influenced by marital status, education level, farm size, and access to farm machinery. Based on the findings' results, it is recommended that farm implements be available to farmers at a subsidized rate, with fewer administrative bottlenecks. Also, training and education of the farmers on the proper use of inputs to reduce their technical inefficiencies should be prioritized.

Keywords:- *Cassava Farmers, Technical Efficiency, Productivity, Inefficiency, Oyo State.*

I. INTRODUCTION

Agriculture is the primary source of income for most developing nations, including Nigeria. According to Itam et al. (2015), 70% of Nigeria's population lives in rural areas and relies heavily on agriculture for subsistence; 80% of agriculture, 13% of livestock, 3% of forestry, and 4% of fishing are supported by a GDP of roughly 40% (Federal Republic of Nigeria, 2006). The crop sub-sector was dominated by the cultivation of food crops such as roots and tubers; cassava is a well-known tuber. Cassava, Manihot esculenta, is the primary staple crop of preference for African households across all nations and cultures (CGIAR, 2018). Cassava is a crucial crop because most of its tubers are eaten locally in dishes like Garri, Fufu, Eba, Tapioca, and Pupuru. This makes cassava a vital crop in both production and consumption. Cassava serves various purposes because it yields both conventional and commercial goods, including starch, refined flour, ethanol, sorbitol, and animal feed. The Sahel Consulting Group argues that it will be a superior foreign exchange commodity in 2021. According to the Nigerian Cassava Master Plan (NCMP), 2006, and Food and Agricultural Statistics (FAOSTAT), 2018, it is grown in every agricultural zone. It also thrives in places with rainforests and degraded savannahs. The top records for cassava production in Nigeria are in the North-Central and South-South areas. Sixty-four percent of the world's cassava production comes from African nations, five of which are among the top ten producers worldwide. Nigeria produces the most cassava globally, accounting for 19.4%. However, compared to global best practices, Nigeria's yield per hectare of 8.2 MT is relatively low compared to the world's best practices of 33.8 MT. The FAOSTAT (2019) reports that Africa represents approximately 64% (192 million MT) of the world's cassava production, with Nigeria taking the lead with a production of over 59 million MT in 2019 (Food and Agricultural Organization, 2014).

Nigeria's low cassava yield per hectare demonstrates that the country's agricultural production management techniques fall short of the finest in the world. Nigeria's production per hectare is almost 66% lower than India's, which has the highest yield in the world at about 35.69 tons per hectare. Nigeria's output is still low when compared to the other four top-producing nations; Indonesia's yield is the highest at 23.36 tons per hectare, followed by Thailand with 22.26 tons per hectare and Brazil with 14.83 tons per hectare (FAOSTAT, 2018). The argument is that a massive amount of land under cultivation rather than enhanced technological productivity could account for Nigeria's high cassava yield—Agricultural and Rural Cooperation Technical Center

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(Spore CTA), (2015). The low yield per hectare constrains attaining the goal set for 2030. It is also a drawback for Nigeria to compete favourably with other cassava producers worldwide (Sanzidur *et al.*, 2016; Bassey *et al.*, 2014).

Many factors have been adduced as causes of these inefficiencies in cassava production. First among those factors is the failure of policies and Agricultural programmes such as the Root and Tuber Expansion Programme (RTEP) and the Cassava Multiplication Project) to achieve better cassava productivity. Also, there are a series of international agencies' efforts to support the Cassava Multiplication Project (CMP). These combined efforts have yet to produce the expected outcome of improved cassava productivity growth in Nigeria. (Ayinde *et al.*, 2012). Most states with higher cassava output and larger areas harvested had lower yields. This scenario is similar to the situation obtainable at the international level, where countries (Nigeria inclusive) with larger areas harvested and the highest cassava producer recorded lower yields per hectare (FAOSTAT, 2018). Nigeria produced the most cassava in the world but had the lowest yield per hectare due to the combined effects of these situations (NCMP, 2006). Additionally, current research and data have demonstrated that the general rise in cassava output is primarily attributable to expanding arable land rather than increased cassava productivity and efficiency (Otung et al., 2016). The nation's food security status is severely threatened when these issues are combined. There are arguments that the population is growing faster than the food supply, which would result in higher food import costs and lower national food security (Sanzidur et al., 2016; James et al., 2015; Simpa et al., 2014; Bassey et al., 2014).

The output is often measured as the ultimate market value of the output, excluding intermediate items, and agricultural productivity is the ratio of agricultural outputs to inputs (Ibitola et al., 2019; Olajide & Omonona, 2019). A single unit, such as a farm, a particular good, or a collection of farms on any given geographic scale, can account for productivity (FAO, 2017). Multi-factor or total productivity (MFP or TFP) refers to changes in production that are not brought about by adjustments to one or more inputs, often land, labour, or capital in agriculture. The difference between production output and input changes, or what is left over after assessing the contribution of inputs to production change, is MFP/TFP (Fasakin *et al.*, 2020; OECD, 2001b). When a single input is combined with one or more outputs, this is known as partial factor productivity. According to Jean-Paul (2009), this approach to gauging agricultural productivity links an index of inputs to an index of outputs. Therefore, to recommend relevant policy alternatives to adopt and improve farmers' technological efficiency, it is crucial to empirically identify the levels of farmers' technical efficiency and their determinant elements. This is due to the direct connection between production effectiveness and the sector's productivity. According to Ajibefun (2002), increasing productivity per unit of land area is essential to overcoming the obstacles to achieving food security because most cultivable land cannot be converted on a wide scale due to physical or technological limitations. Hence, this study determines the productivity level, identifies the causes of inefficiencies, and examines the determinants of technical efficiency among cassava farmers who participated in the National Programme for Food Security (NPFS) in Oyo State, Nigeria. The findings from this study are expected to provide helpful information and technical advice to cassava farmers in Oyo State and Nigeria in general.

II. THEORETICAL FRAMEWORK: TECHNICAL EFFICIENCY AND THE STOCHASTIC PROFIT FRONTIER

Technical efficiency measures how effectively a company uses its inputs to produce outputs. The ratio of current output to prospective output is used to compute it. A technically efficient company maximizes production by using all its inputs at its best. (1980 by Greene; 1994 by Atkinson & Cornwell) The farms' technical efficiency (TE) estimation allows us to determine whether the farmer can "do things right," whether the farms effectively use the inputs at hand, and the potential income benefits from improving the inputs' utilization. As a result, it indicates how the farmers' decision-making promotes sustainability (De Koeijer *et al.*, 2002; Gonçalves *et al.*, 2009). The TE analysis calculates the real ability of the farmer to convert the resources into output under the assumption that it is possible to specify an optimal amount of input transformation. Technical inefficiency, seen as the failure of farms to produce the greatest output feasible considering the inputs provided, is measured by the difference between the optimal level of efficiency and the actual farm's TE. As a result, the technical efficiency (TE) is determined by dividing the farm's (Q) output by the ideal standard. The TE indicates the ability to convert the inputs by assessing how closely the experimental manufacturing process adheres to an ideal standard, the so-called "Efficient Production Frontier." Productivity evaluates the technological foundation for such a transition (Lansink et al., 2002; Arru et al., 2019). Technical efficiency can be calculated using the Stochastic Frontier Approach (SFA), a statistical technique. According to the SFA model, there is a frontier of technically efficient enterprises, and every company is either on or below it. The difference between a corporation's actual output and the frontier indicates how inefficient the firm is. The technical efficacy of Nigerian cassava growers can be estimated using the SFA model. The model can pinpoint the elements contributing to technical inefficiencies, including farm size, credit availability, and access to extension services.

The SFA study's findings can be utilized to create policies and actions that will help increase the technical efficacy of Nigeria's cassava crop. The well-known Stochastic Frontier Approach breaks down the error term into a random error and an inefficiency component and explains the link between output and input levels. The standard error term with a zero mean and constant variance is the random error, which is believed to have a symmetric distribution. According to Yaqoob and Fasakin (2002), the inefficiency term is assumed to have an asymmetric distribution. It can be represented as a half-normal, truncated normal, exponential, or two-parameter gamma distribution. In the frontier model, the inefficiency effects, representing farm-specific characteristics, can be written as a linear function of the explanatory factors (Battese & Coelli, 1995). The advantage of this model is that it allows the estimation of farm-specific efficiency scores and the factors explaining the efficiency differentials among farmers using a single-stage estimation procedure.

III. LITERATURE REVIEW

The technical efficiencies and production performance of several agricultural commodities in Nigeria have been thoroughly analyzed in earlier research. For instance, using the stochastic profit frontier approach, Yaqoob and Fasakin (2020) looked at the factors influencing profit efficiency among catfish producers in Southwestern Nigeria. The results showed that, except for the elasticity of the coefficient of variable involving the cost of water, the estimated elasticity parameters of independent variables included in the stochastic profit function were all positively and statistically significant. Sex, age, and household size are the variables affecting profit efficiency. Awotona and Oladimeji (2020) used primary data and stochastic frontier analysis to focus on gender dynamics and technical efficiency (TE) assessments of cassava output among farmers in Oyo State, Nigeria. The findings showed that the coefficients of stem cutting, fertilizer, labour, and herbicides among adult male farmers were significant variables impacting cassava yield. At a 1% probability level, stem cutting had varying effects on the cassava yield of adult female, young male, and young female producers. The inefficiency variables revealed that TE among adult female farmers was highly impacted by the coefficients for age, education, farming experience, and access to the extension. Young female cassava producers were only influenced by age. Additionally, Fasakin and Akinbode (2019) use the stochastic frontiers analysis to investigate the Technical Efficiency of maize producers in Oyo State, Nigeria. The study's findings showed that the parameters that benefit the quantity of maize produced include the number of seeds, labourers, and farms and the amount of herbicide used. The age of the farmers, the number of households, and membership in the cooperative group are also sources of inefficiency. The farmers had a maximum technical efficiency of 0.82, a mean of 0.52 and a minimum of 0.051. According to these figures, the maize farmers did not fully utilize the resources to produce their crop, as seen by the 0.52 mean technical efficiency score. The 2019 study by Akerele et al. employed stochastic frontier analysis to examine cassava production's productivity and technical efficiency in Ogun State, Nigeria. The study's conclusions showed that labour, other planting material costs, and planting size are important factors in cassava production in the study area. Additionally, it demonstrates that the farmers' age, formal education, and gender have negative and significant coefficients, indicating that these factors negatively impact efficiency. There is room for improvement, and efficiency can increase by 41.4% according to the technical efficiency scores, which range from 0.00 to 91.86%, with an average score of 58.6%.

In addition, Fasakin and Omonona (2019) looked at the effectiveness of resource utilization in the production of rain-fed and non-rain-fed catfish in Nigeria's southwest (Oyo) and North Central (Kwara). According to the results of the stochastic frontier analysis, the quantity of stocked fish—both juvenile and fingerlings—pond size, labour, feeds, and water use were the main factors affecting the technical efficiency of catfish farmers in Southwest (Oyo state) and Northwest (Kwara state) Nigeria. Age, educational attainment, gender, prior farming experience, membership in cooperative associations, and household size all contributed to the technical inefficiency of the catfish producers.

Isitor et al. (2017) investigated the technical efficiency of smallholder cassava farmers in Anambra State, Nigeria, using the stochastic frontier technique. The production function's Maximum Likelihood Estimates reveal that the farmers' average technical efficiencies were low, at 51.5%, meaning that the average output of cassava was 48.5% below the highest attainable level. According to the study, the only variables that significantly impacted the technical inefficiency of cassava farms in the study area were education (0.210) and loan availability (0.202).

Itam et al. (2015) used the stochastic production frontier to examine the technical efficacy of small-scale cassava growers in Cross River State. The farmers of cassava had an average technical efficiency of 89%. The generalized Likelihood Ratio (LR) tests' findings suggest that there is potential for technical efficiency improvement given the farmers' current resource base and access to technology. According to the results, Cassava farmers are required to be more technically efficient. The farmers' technical efficiency was negatively yet significantly impacted by their age and gender. Contrarily, farmers' technical efficiency was considerably and favourably influenced by education, family size, farming experience, and farm size.

According to Adewuyi et al. (2013) technical efficiency analysis of cassava producers, factors such as farm size, pesticide use, the labour force (both hired and family), and fertilizer usage all greatly impacted cassava production. The efficiency of farmers ranged from 40 to 96%, with a mean of 68%. Farmers in the research area utilized resources effectively, according to the study's findings. Last but not least, farm size and cassava cuttings were discovered to be the important production predictors in Ogunniyi et al.'s (2013) study on the technical efficiency of cassava-based cropping systems, with a mean technical efficiency of 0.542. The investigation concluded that since farmers were not working at the cutting edge of production, they might have used resources more effectively. Efficiency was determined using the stochastic production frontier technique in all of the investigations, which emphasizes the value and adaptability of the SFA in production analysis.

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IV. MATERIALS AND METHODS

- *Study Area*

The study area is the state of Oyo, which is situated between latitudes 7°N and 9°N and longitudes 2°E and 4°E in the south-western part of Nigeria. It has 33 Local Governments and 5,580,894 residents (NPC, 2006). West Africa's largest city is the state capital. A sizeable portion of the population's primary occupation is farming because Oyo State's climate makes it possible to grow various crops (Okoruwa, 2015). According to data gathered from Oyo State Agricultural Development (OYSADEP), the state is divided into four (4) Agricultural Development Project (ADP) zones, according to the classification used by Oyo State Agricultural Development Project.

(OYSADEP); these include Ibadan/Ibarapa zone, Oyo zone, Ogbomoso zone, and Saki zone. Nine (9) Local governments (Ido, Ogbomoso South, Oyo West, Ibarapa East, Ibarapa Central, Akinyele, Iseyin, Irepo and Afijio) out of the 33 Local governments participated in the NPFS programme, which is evenly distributed among the four ADP zones. The target population for this study is registered farmers under the OYSADEP.

The study adopted a multi-stage sampling technique to select the respondents for this research. The first stage involves random sampling of two (2) ADP zones out of the four ADP zones (the Ibadan/Ibarapa and Oyo zones). The second stage involves the purposive selection of two (2) Local governments from each of the 2 ADP zones (Ido, Akinyele, Oyo West, and Afijio) because they are the only Local Governments involved in the National Programme for Food Security (NPFS). At the same time, the third stage involves a proportionate sampling of farming households comprising NPFS participants and non-participants from each of the four selected Local Governments. Therefore, the proposed sample size for this study was two hundred (200) farming households.

- *Methods of Data Analysis*

We used descriptive statistics like frequency, percentage, and mean to describe the socioeconomic features of the household. The Stochastic Frontier Analysis (SFA) was used to investigate the factors that affect the efficiency and the sources of inefficiencies of the cassava farmers in Oyo State. Total Factor Productivity (TFP) was utilized to calculate the productivity level of the cassava farmers. Total factor productivity can be calculated as the ratio of revenue to variable costs incurred to produce the revenue, according to Fakayode et al. (2008) and Ukohaet et al. (2010). Since total factor productivity is a ratio term, this is the case. Total Fixed Cost (TFC) was not considered in this study since it has no bearing on the conditions for profit maximization and resource-use efficiency, is fixed, and is a constant (Fakayode et al., 2008).

$$TFPI_{it} = \frac{\sum P_{qit} Q_{it}}{\sum P_{xit} X_{it}} \quad (1)$$

Where:

$TFPI_{it}$ = Total factor productivity index of farmer i at time t

$\sum P_{qit} Q_{it}$ = Total revenue of cassava farmer i at time t

$\sum P_{xit} X_{it}$ = Summation of cost of inputs used by cassava farmer i at time t

X_1 = Cost of cassava stem (₦per bundle)

X_2 = Labour cost (₦ per man-day)

X_3 = Cost of pesticides (₦ per litre)

X_4 = Cost of fertilizer (₦ per liter)

X_5 =Cost of herbicides (₦ per litre)

The stochastic frontier was adopted to determine the technical efficiency of the cassava farmers. The SFA function is typically specified as:

$$Y_i = f\left(X_{ij} \beta\right) + V_i - U_i \text{ (i=1, 2, n)} \quad (2)$$

Where:

Y_i= Output of the ith firm

X_{ij} = Vector of actual jth inputs used by the ith firm

ß = Vector of production coefficients to be estimated

V_i= Systematic error, which accounts for variations. Random variability in the production that cannot be influenced by the firm and

U_i=The deviation from maximum potential output due to technical inefficiency of the ith farmer

The above specifications have been expressed in terms of a production function with the Ui interpreted as technical inefficiency effects which cause the firm to operate below the stochastic production frontier:

$$LnC_a = f\left(P_a, Y_a, \beta\right) + (V_i + U_i) \quad (3)$$

Where:

Y_a = Output of the ith firm

β = Parameters to be estimated

V_i = Systematic component which represents random disturbance cost due to factors outside the scope of the firm

U_i= One sided One-sided term used to represent cost inefficiency and is independent of the firm.

The production efficiency (CE) of an individual firm is defined in terms of the ratio of observed Cost (Cb) to the corresponding minimum Cost (Cmin) under a given technology:

$$Technical\ Efficiency\ (TE) = \frac{Y_i}{Y_i^*} \quad (4)$$

$$(TE = f(X_i, E)exp\left(V_i - \frac{U_i}{f}\right)(X_i, E)\exp(V_i) \quad (5)$$

$$TE = \exp(-U_i) \quad (6)$$

Where:

Y_i= The observed output, and Y_i* is the frontier output.

The Cobb-Douglass and Translog production functions are the most often employed functional forms in agricultural production functions, according to earlier research (Fasakin and Akinbode, 2019). The square and interaction terms of the input use, however, cause issues with multicollinearity in the Translog production form.

The stochastic frontier model in this study is specified as:

$$lnY_i = \beta_o + \beta_1 lnP_1 + \beta_2 lnP_2 + \beta_3 lnP_3 + \beta_4 lnP_4 + \beta_5 lnP_5 + V_{ij} - U_{ij} \quad (7)$$

Where;

P_1= Ln of fertilizer (kg)

P_2= Ln of seed (kg)

P_3 = Ln of herbicides (L)

P_4 = Ln of labour (Naira/man-day)

P_5= Ln of farm size (Hectares)

Y_n = Ln output of cassava produced in (kg)

The Vi are random variables which are assumed to be normally distributed N (0, σ) and independent of the which are non-negative random variables, assumed to be half normally distributed |N (0, 'u2)| and account for the cost inefficiency in production (Fasakin and Akinbode, 2019, Bravo-Ureta and Evenson, 1994).

The inefficiency model,

$$U_{ij} = a_o + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + \cdots, a_{10}X_{10} \quad (8)$$

X_1= Age (Years)

X_2= Gender (Male=0, Female=1)

X_3= Marital Status (Married=0, 1= Otherwise)

X_4= Education Level (Educated=0, 1= Otherwise))

X_5= Household size (Numbers)

X_6=Cassava farming experience (Years)

X_7=Years of Membership of Cooperative (Yes=0, 1= Otherwise)

X_8= Access to Credit (Yes=0, 1= Otherwise)

X_9=Source of Farmland (Inherited=0, 1= Otherwise)

X_{10}=Extension access (Yes=0, 1= Otherwise)

X_{11}=Farm machinery access (Yes=0, 1= Otherwise)

μ= Error term

V. RESULT AND DISCUSSION

➢ *Socio-economic Characteristics of the Cassava Farmers*

Table 1 shows the socio-economic characteristics of the cassava farmers in the study area. The data from the table revealed that the majority of the cassava farmers in the study area were male (83.60%) with a mean age of 50 years, indicating that the farmers are not young but of age to decide to participate in any agricultural programmes. Many farmers (87%) are married and have secondary education (50%). Access to extension distribution shows that only (45%) of the farmers had access to extension, with only (42%) having access to credit and 60 belonging to members of cooperative organizations. The farmers are small-holder farmers, with a mean farm size of 1.1ha, while the mean household size of the farmers was 6 members, with the majority 82.50% of the farmers having a household member of 5-8 members; this indicates that the households' sizes were fairly large. The mean farming experience of the farmers was 16 years, while the majority, 40.50%, had a farming experience of 1-10 years, indicating that the farmers are fairly experienced in cassava production compared with their age. Most (60%) of the farmers actively participate in the National Programme on Food Security (NPFS); this indicates that the farmers are very aware of agricultural programmes in the study area. There is a low level of access to mechanization, with only (14.5%) of the cassava farmers having access to agricultural machinery, indicating that agricultural mechanization practice is very poor in the study area. Lastly, 91% of the farmers were household heads, indicating that most cassava farmers were the providers in their families, while 9% of the farmers belonged to other members of the households.

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Table 1 Socio-economic Characteristics of the Cassava Farmers

Variable	Frequency	Percentage	Mean/max/min
Sex			
Male	33	16.50	
Female	167	83.60	
Age			Mean=50.7
20-40	26	13.00	Max=69
41-60	145	72.50	Min=27
61-80	29	14.50	
Marital status			
Married	174	87.00	
Single	21	10.50	
Divorced	05	2.50	
Education level			
Primary	63	31.50	
Secondary	100	50.00	
Tertiary	25	12.50	
No Education	12	6.00	
Access to Extension			
Yes	90	45.00	
No	110	55.00	
Access to credit			
Yes	84	42.00	
No	116	58.00	
Farm Size			Mean=1.1
0-1	190	95.00	Max=3
1-2	09	4.50	Min=0.4
2-3	01	0.50	
Membership of Associations			
Yes	80	60.00	
No	120	40.00	
Households Size			Mean= 6
0-4	20	10.00	Max=10
5-8	165	82.50	Min =1
9-12	15	7.50	
Farming Experience			Mean=16
1-10	81	40.50	Max=37
11-20	77	38.50	Mean=01
21-30	38	19.00	
31-40	04	2.00	
Participation in NPFS			
Yes	120	60.00	
No	80	40.00	
Access to farm machinery			
Yes	29	14.50	
No	171	85.50	
Position in the family			
Households Head	182	91.00	
Other members	18	9.00	

Source: Field Survey, 2021

➢ *Total Factor Productivity (TFP)*

Table 2 below shows the variable inputs cassava farmers use under the NPFS programme in Oyo State. The variables inputs used by the farmers are labour, herbicide, pesticide cost, and cost of acquiring cassava stem. The findings show that the total variable cost of the cassava farmers' TVC was ₦1,665,772.00, while the total cassava output was ₦3,251230.00. The Total Factor Productivity of the cassava farmers (TFP) is defined as the summation of all single variable inputs divided by the output, $TFP = \frac{Y}{\sum P_i X_i}$, this gives a value of 1.95. The result implied that cassava farming activities in the study area are productive since most cassava farmers have TFP higher than 1.

Table 2 Cassava Total Factor Productivity

variable Inputs	cost (₦)
cost of labour	404492.43
cost of pesticide	426548.54
cost fertilizer	265500
cost cassava stem	264081.50
cost of herbicide	305150
Total Variable Cost (TVC)	1665772
Total cassava output	3251230
Total Factor Productivity =TVC/cassava output	**1.95**

Source: Authors Computation, 2022

- *Maximum Likelihood Estimates of Stochastic Frontier Function*

Table 2 shows the Maximum Likelihood Estimate (MLE) of the stochastic frontier analysis of cassava farmers in Oyo state, Nigeria. The results show that the gamma (γ) estimate of 0.478 (α0.067) reflects the degree of variation in cassava output caused by the technical inefficiencies of the cassava farmers, while the sigma-square (δ^2) estimate of 0.00561 (α--) supports the validity and good fit of the model. Thus, technological efficiency accounted for 58% of the variation in output among maize growers. The results also showed that factors like fertilizer, herbicides, and labour input impacted the amount of cassava produced in the study area. However, only the quantity of herbicides and labour input positively impacted cassava production. This is in line with Isitor et al. (2017) findings from a related study. Since the coefficient of herbicide quantity was significant at (p0.01), it can be concluded that as cassava farmers use more herbicide, more cassava will also be produced. The coefficient of fertilizer used was negative but significant at (p0.01), indicating that a reduction in the farmers' fertilizer use will reduce the output of cassava. The findings contradict those of Girei et al. (2013), who found a correlation between fertilizer use and cassava output. The labour used coefficient was statistically significant at (p 0.01), indicating that an increase in the amount of labour employed by cassava farmers will increase the amount of cassava the farmers produce.

- *The Inefficiency Model*

The inefficiency model is also displayed in Table 3, and the findings demonstrate that the factors that affect inefficiency among the cassava farmers in the study area include marital status, educational attainment, farm size, and access to farm machinery. The fact that marriage reduced the technical inefficiency of the farm was significant at 5% with a negative coefficient. Additionally, it implies that farmers who are not married produce cassava more technically effectively than farmers who are married. Since education attainment can minimize inefficiencies among the cassava farmers in the study area, the farmers' level of technical inefficiency rises, and their education level falls. Education level was significant at 5% with a negative coefficient. Education plays a significant role in influencing the adoption of new technologies. Educated farmers are believed to exploit enhanced agricultural innovations more profitably than their less educated colleagues and will be more responsive to new farming approaches. They should, therefore, be more technically proficient than farmers with little or no schooling. This conclusion supports Isitor et al. (2017) and Raphael's (2008) findings that there is a link between education and a farmer's level of technical inefficiency. However, it contrasts with the findings of Itam et al. (2015). The farming experience had a positive coefficient and was significant at 5%. This implies that when farmers gain more farming experience, their technical inefficiency also grows. This implies that experienced farmers obtained higher levels of technical efficiency because farmers usually count on experienced farmers and are more likely to accept innovations than inexperienced farmers. This finding agrees with Itam *et al.* (2015) but disagrees with Makinde *et al.* (2015)'s results of their study. Access to farm machinery was significant at 10% with a positive coefficient; access to farm machinery is supposed to reduce the technical inefficiency of the farmers. Nevertheless, this is the reverse result. This might be due to the need for farm implements to help the farmers in their farm operations. Where the implements are available, the farmers are continuously subjected to a different bureaucratic process to access those implements. The frustration and delays encountered when accessing the farm implements might contribute to technical inefficiency in their production.

Table 3 Estimates of Stochastic Frontier Analysis, and the Inefficiency Model

Variables	Coef.	Standard Error	z-value
Fertilizer	-0.095***	0.0266	-3.56
Herbicide	0.715***	0.0315	22.65
Farm size	0.402***	0.020	19.77
Labour	-0.041	0.032	-1.27
Constant	3.367	0.037	90.89
Variance Parameters			
Sigma-v	0.0099	0.000	0.000***
Sigma-u	0.3159	0.019	0.279***

Sigma squared	0.0991		
Lambda	31.7178		
Gamma			
Inefficiency Model			
Age	-0.005	0.005	-1.02
Marital Status	-0.101	0.046	-2.20**
Education Level	-0.048	0.021	-2.32**
Household size	0.022	0.019	1.17
Farming experience	0.005	0.006	2.09**
Membership	-0.002	0.007	-0.31
Access to Credit	0.01	0.03	0.33
Access to Extension	0.024	0.034	0.70
Access to Farm Machinery	0.122	0.071	1.73*
Constant	3.988	0.184	21.68
R-squared	0.331	No. of obs	200
F-test	9.337	Prob > F	0.000

Source: Stata Output *** p<0.01, ** p<0.05, * p<0.1

- *Technical Efficiency Scores*

The technical efficiency scores are indicated in Table 4; the maximum technical efficiency of the farmers was 0.645, the mean was 0.397, and the minimum was 0.288. These statistics indicated that the available resources for the cassava farmers were not utilized for their production, judging by the values of these statistics. The poor efficiency scores might be due to the factors identified to cause technical inefficiencies by the farmers. Hence, cassava farmers in the study area need to improve on their production skills in order to maximize their efficiencies. This can be done by combining various resources available to the farmers effectively to maximize their production.

Table 4 Technical Efficiency Scores

TE range	Frequency	Percentage
0.000-0.300	23	11.5
0.310-0.400	12	6
0.410-0.500	56	28
0.510-0.600	75	37.5
>0.610	34	17
Total	200	
Mean	0.397	
Min	0.288	
Max	0.645	

Source: Author's Computation, 2022

VI. CONCLUSION AND RECOMMENDATIONS

In Nigeria, cassava is still a staple food item for both urban and rural populations, and its widespread use helps to address the nation's food insecurity issue. Its significance among Nigeria's major food crops cannot be overstated. The stochastic frontier analysis model was utilised to assess the technical efficiency of cassava farmers in Oyo State, Nigeria. Findings from the study suggest that labour, herbicide, and fertilizer quantity are the variables that affect the amount of cassava output. The use of labour and herbicides had a beneficial impact on cassava production, but the use of fertilizer had a negative impact. Marital status, educational attainment, the size of the farm, and access to farm equipment all impacted the farmers' technical inefficiency. These variables determine how efficient were the cassava farmers in Oyo State. Based on the findings of this study, the study, therefore, recommends that farm implements should be made available to the farmers at a subsidized price, while priority should be given to training and education of the farmers on the proper use of inputs as this will reduce technical inefficiencies among the farmers.

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- *Conflict of Interest*

The authors declared no conflicts of interest concerning this article's research, authorship, and publication.

REFERENCES

[1]. Akerele E. O., Odojukan D. M., Yangomodou O. D., Olugbemi M. T., Solana O. I., Ilori A. R. and Fadipe M. O. (2019) Productivity and Technical Efficiency of Cassava Production in Ogun State, Nigeria. Journal of Agriculture and Veterinary Science (IOSR-JAVS) 12 (11): 33-40

[2]. Arru B, Furesi R, Madau FA, Pulina P (2019) Recreational services provision and farm diversification: a technical efficiency analysis on Italian agri-tourism. Agriculture 9(2):1–15

[3]. Ajibefun, I. A. (2002). Analysis of Policy Issues in Technical Efficiency of small-scale farmers using the Stochastic Frontier Production Function with Application to Nigerian Farmers. A paper presentation at the International Farm Management Association Conference. Wageningen, Netherland.

[4]. Atkinson, S.E.; Cornwell, C. (1994) Estimating output and input technical efficiency using a flexible functional form and panel data. Int. Econ. Rev. 1994, 245–255.

[5]. Ayinde, O. E; Adenuga, A. H; Omotesho K.F.; and Oke, A. O. (2012). Comparative Analysis of Root and Tuber Expansion Programme in Kwara State, Nigeria. Journal of Agriculture and Social Research 12 (2): 19-28.

[6]. Bassey Nsikan Edet, Aniekan Jim Akpaeti, & Idaraesit Uwem Umoh (2014). Determinants of Cassava Output among Small Scale Farmers in Nigeria: A Survey of Akwa Ibom State Farmers. Asian Journal of Agricultural Extension, Economics & Sociology 3(4): 319-330.

[7]. Battese, G. E, Coelli, T. (1995) 1995). A model of technical inefficiency effects in a stochastic frontier production function for panel data. Empirical Economics 20, 325 332.

[8]. CGIAR (2018). What is the True Impact of Improved Cassava Varieties in Nigeria? Brief No. 64. Available at https://cas.cgiar.org/sites/default/files/pdf/ispc_brief_64_impact_cassava_nigeria.pdf (Accessed: 29 March 2022)

[9]. De Koeijer T.J, Wossink G.A.A, Struik PC, Renkema J.A (2002) Measuring agricultural sustainability in terms of efficiency: the case of Dutch sugar beet growers. Journal Environ Management 66:9–17

[10]. FAOSTAT (2019). Production Indices. Available at <https://www.fao.org/faostat/en/#search/Cassava%20and%20products> (Accessed: 29 March 2022)

[11]. FAOSTAT (2018). http://faostat3.fao.org/download/Q/QC/E, 2018/Sep/09

[12]. FAO (2014). The state of food and agriculture. Available at <https://www.fao.org/3/i4040e/i4040e.pdf> (Accessed: 29 March 2022)

[13]. Fakayode Segun, Bamidele, R.O. Babatunde and Ajao Rasheed (2008). Productivity analysis of cassava-based production systems in the Guinea Savannah: Kwara State, Nigeria Case study. American-Eurasian Journal of Scientific Research 3 (1): 33-39.

[14]. Fasakin I.J. and Akinbode B.B. (2019) Technical Efficiency of Maize Farmers in Oyo State, Nigeria. Medwell Agricultural Journal 14 (4): 70-74

[15]. Fasakin I. J. Umeokeke N. I, and Olajide O. O. (2021) Rice Productivity and Land Ownership among Rice Farmers in Nigeria. A paper presented at Proceedings of the 1st Annual International Conference, University of Nigeria, Nsukka 2021

[16]. Fasakin I. J. and Omonona B.T. (2020) Resource use Efficiency among Rain-Fed and Non-Rainfed Catfish Farmers in South West and North Central Nigeria. Medwell Agricultural Journal 15 (6): 176-184

[17]. Food and Agriculture Organization (2017). Productivity and Efficiency Measurement in Agriculture. Literature Review and Gaps Analysis. Publication prepared in the framework of the Global Strategy to improve Agricultural and Rural Statistics.

[18]. Girei, A.A., Dire, B., Yuguda, R.M. and Salihu, M. (2013). Analysis of productivity and technical efficiency of cassava production in Ardo-Kola and Gassol Local Government Areas of Taraba State, Nigeria. Agriculture, Forestry and Fisheries, 3: 1-5.

[19]. Greene, W.H. On the estimation of a flexible frontier production model. Journal. Econometric. 1980, 13, 101–1

[20]. Ibitola O.R, Fasakin I.J, Popoola O.O, Olajide O.O. (2019). Determinants of Maize Farmers' Productivity among Smallholder Farmers in Oyo State, Nigeria. Greener Journal of Agricultural Sciences. 9(2):189-198,http://doi.org/10.15580/GJAS.2019.2.040219062

[21]. Isitor, S.U., Adeyonu, A.G. and Aniegboka, U.N., (2017). An Analysis of Technical Efficiency of Smallholder Cassava Farmers in Anambra State, Nigeria. A publication of the School of Agriculture and Agricultural Technology, The Federal University of Technology, Akure, Nigeria 22(2), 10–15.

[22]. Itam K. O, Ajah E. A., Ofem U. I., and Abam O. E., (2015). Technical Efficiency Analysis of Small Scale Cassava Farmers in Cross River State, Nigeria : A Stochastic Production Frontier Approach. Applied Economics and Finance. https://doi.org/10.11114/aef.v2i4.1028

[23]. Jean-Paul C (2009). Productivity analysis in agriculture: Concepts and Challenges. University of Wisconsin, Madison, USA.

[24]. Lansink AO, Pietola K, Bäckman S (2002) Efficiency and productivity of conventional and organic farms in Finland 1994–1997. European Review Agricultural Econ 29(1):51–65

[25]. Makinde Y. O, Balogun O. L, Bello AT and Afodu, O. J (2015) Technical Efficiency of Cassava Farmers in Ikenne Local Government Area of Ogun State, Nigeria. Ethiopian Journal of Environmental Studies & Management 8(3): 342 – 350doi: http://dx.doi.org/10.4314/ejesm.v8i3.11

[26]. Nigeria Cassava Master Plan (2006). A strategic action plan for the development of the Nigeria cassava industry. Prepared within the Nigeria country service framework and cooperating with the presidential initiative on cassava.

[27]. OECD 2001b. Measuring productivity- OECD Manual: Measurement of Aggregate and Industry-level Productivity Growth. OECD, Paris
[28]. Olajide, O.O and Omonona B.T (2019). Productivity of Catfish Production in Osun State, Nigeria International Journal of Agricultural Research, Sustainability, and Food Sufficiency (IJARSFS) Vol. 6(04) 409-420
[29]. Raphael, I.O. (2008). Technical efficiency level of Cassava farmers in South Eastern Nigeria: Stochastic frontier approach. *Agricultural Journal*, 3: 152- 156.
[30]. Sahel Consulting Group, (2021) The Cassava Value Chain in Nigeria. A quarterly report of Sahel Consulting Group. Available at www.sahelcapital.com|www.sahelconsult.com| www.nourishingafrica.com
[31]. Sanzidur, Rahman & Brodrick O. Awerije (2016). Exploring the potential of cassava in promoting agricultural growth in Nigeria. Journal of Agricultural and Rural Development in tne Tropics and Subtropic .117(1): 149-163.
[32]. Simpa, James O., Job N. Nmadu and Okino.A. (2014). Technical Efficiency of Smallholder Cassava Farmers in Selected Local Government Areas in Kogi State, Nigeria. PAT 2014; 10 (1):74-92.
[33]. Spore CTA (2015). The magazine for agricultural and rural development in ACP countries, No 176, June – July 2015, Pp 4 and 20; http: //spore.cta. int.
[34]. Ukoha, O.O, Okoye, B.C. and Emetu, J. (2010). Analysis of the Determinants of Total Factor Productivity among Small-Holder Cassava Farmers in Ohafia L.G.A of Abia State. Online at http://mpra.ub.uni-muenchen.de/26125/ MPRA Paper No. 26125, posted 25. October 2010 07:54 UTC.
[35]. Yaqoob A.M and Fasakin I.J. (2021) Determinants of Profit Efficiency among Cat Fish Farmers in South Western Nigeria: Stochastic Profit Frontier Approach. Journal of Agriculture and Veterinary Science (IOSR-JAVS) 14 (10): 01-09.