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DETERMINANTS OF TECHNICAL EFFICIENCY OF SWEET POTATO FARMERS IN IMO STATE, NIGERIA

[1]OSUAGWU, Chizoma Olivia; [1]*ESIOBU, Nnaemeka Success; [1]OHAEMESI, Chidubem Francis; [1]CHIBUNDU, Emeka Ikechi; [2]ANYANWU, Rosita Chinwe; [2]NWACHUKWU, Emmanuel; [1]ONYEOMA Uruchukwu Mary; [3]AGUNANNE, Uchenna Theresa; [4]Oparaojiaku, Joy Obiageli

[1]Department of Agricultural Economics, Faculty of Agriculture, University of Agriculture and Environmental Sciences (UAES), Umuagwo, Imo State, Nigeria.

[2]Department of General Studies, University of Agriculture and Environmental Sciences (UAES), Umuagwo, Imo State, Nigeria.

[3]Department of Agricultural Management, Imo State Polytechnic Omuma, Imo State, Nigeria.

[4]Department of Agricultural Extension, University of Agriculture and Environmental Sciences (UAES) Umuagwo, Imo State, Nigeria.

*Corresponding Author

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ABSTRACT

Sweet potato (*Ipomoea batatas L.*) is a one of the vital food and nutrition security crop in sub-Saharan Africa, with Nigeria ranking as the second-largest global producer. Despite its importance, empirical evidence on the technical efficiency of sweet potato farmers in Imo State remains limited. This study analyzed technical efficiency using primary data from 126 farmers during the 2024/2025 cropping season. A multistage sampling technique was adopted, while structured questionnaire was used for data collection. The Cobb-Douglas stochastic frontier production function and Battese and Coelli model were employed for estimation. Descriptive results show a mean farm size of 0.47 ha, average age of 43 years, 8.16 years of education, and 11.06 years of farming experience. Mean output was 149.37 kg, fertilizer use 394.56 kg, labour input 30.12 man hour, and extension contact averaged 0.85 visits per year. The stochastic frontier results revealed that farm size (0.082), planting materials (0.259), agrochemicals (0.066), labour (0.197), fertilizer (0.088), and capital (0.643) significantly increased output at the 1% level. The gamma value (0.723) indicates that 72.3% of output variation is due to inefficiency, while lambda (1.615) confirms its dominance. Mean technical efficiency was 0.60 (range: 0.15-0.96), implying that farmers achieve only 60% of potential output. Efficiency was positively influenced by education (0.049), farming experience (0.085), farm size (0.063), extension contact (0.074), improved planting materials (0.088), credit access (0.082), and cooperative membership (0.056). Major constraints include high input costs (3.68), poor extension access (3.55), climate variability (3.47), limited credit (3.42), and pest infestation (3.36). The findings indicate substantial inefficiency and the need for targeted policy interventions.

Keywords: Sweet potato; Technical Efficiency; Stochastic Frontier Production Function; Constraints; Imo State, Nigeria.

1. INTRODUCTION

Sweet potatoes are a perennial crop that is grown every year on several continents (Donyina et al., 2025; Akwiwu & Promise, 2026). With a total yield of 93 million metric tonnes as of 2025, sweet potatoes are ranked as the seventh most important food commodity in the world due to their higher yield and nutritional value, making them one of the most important food sources in the world (Alam et al., 2025; Wekgari et al., 2026). Due to its significant economic value, it is ranked second among the most important food commodities in the world. Many developing nations' subregions such as Nigeria grow sweet potatoes (Adeyonu et al., 2019). About 1.5 million hectares of sweet potato are grown in sub-Saharan Africa (SSA), with an average yield of roughly 10.8 t ha-1 (Hendebo et al., 2022). It is one of the most important sources of carbohydrates in SSA and is well-known for its resilience to harsh environmental conditions as well as its high energy-fixing capacity, which allows it to quickly produce large amounts of dry matter (Aneneokeakwa et al. 2021; Chabwera et al., 2026). It can tolerate erratic rainfall and readily adjust to poor soil conditions (Tang et al., 2022). The crop is an essential part of most people's diets in the areas where it is grown because of its nutritional value (Onu et al., 2024). In Africa, it has been used to combat vitamin A deficiency, which typically causes children to lose their sight or even die (Morgan et al., 2021). Nigeria is the world's second-largest producer of sweet potatoes, after China. Approximately 4.69 million metric tonnes of sweet potatoes are produced in the nation each year [(Food and Agriculture Organization (FAO), 2026)]. Despite the strain of an expanding population on land, Nigeria has seen a rise in sweet potato production. Between 2015 and 2025, production grew from 3.5 million metric tons to 4.0 million metric tons. Improved technological inputs and national and international research and development were credited with contributing to this numerical increase in production (Okonkwo-Emegha & Obiekwe, 2025; Rincón-Cervera et al., 2026). Sweet Potato is grown for both human and animal consumption, and it is the only crop among the root and tuber crops that has a positive per capita annual rate of increase in production in SSA (Adeyonu et al., 2019). According to Udemezue (2019), within the root crop belt of Nigeria, especially the Southeast agro-ecological zone where Imo State is located, sweet potato has joined the league of life saving crops as cassava. In spite of these important aspects, less research has been done on sweet potato than on the other root crops. The few previous studies on sweet potato dwelt on seasonality and climate period effects (Feukeng et al., 2024; De Barros et al., 2024), determinants of adoption of improved sweet potato (Adeola et al., 2019), constraints to production, processing and marketing (Ezin et al., 2018) and sweet potato production, utilization and marketing (Abrham et al., 2020). None of these studies investigated technical efficiency of sweet potato farmers. However, the few studies that dwelt on efficiency of sweet potato farmers (Midamba et al., 2022; Niyonzima et al., 2024) investigated economic efficiency of the farmers and the study was not conducted in Imo State, Nigeria. Therefore, there is dearth of research on technical efficiency of sweet potato production especially in Imo State, Nigeria. Technical efficiency here refers to the ability to produce the highest level of output with a given bundle of resources at least cost (Jabuya et al., 2024). The estimation of the technical efficiency using stochastic frontier production function makes it possible to find out whether the deviation in technical efficiency from the frontier output is due to farm specific factors or external random factors. Understanding the technical efficiency of sweet potato farmers in Imo State is essential for identifying gaps in resource allocation and utilization. By assessing factors that influence efficiency levels, such as farm size, input usage, education, access to credit, and extension services, policymakers and stakeholders can develop targeted interventions to enhance productivity. Without addressing these inefficiencies, farmers will continue to experience low yields and limited economic gains, ultimately affecting the overall agricultural sector's contribution to rural development and food security in Imo State and Nigeria in general. It was against these backdrops that the study estimated the technical efficiency of sweet potato farmers in Imo State, Nigeria. From the specific objectives, the study described the socio-economic characteristics of farmers, measured the technical efficiency and determined the sources of technical efficiency of sweet potato farmers in Imo State, Nigeria.

2. METHODOLOGY

The study was carried-out in Imo State of Nigeria. Imo State is located in the South Eastern zone of Nigeria and lies between latitudes 5° 45´N and 6^0 35´N of the equator and longitude 6^0 35´E and 7^0 28´ E of the Greenwich Meridian (Nigerian Meteorological Agency (NiMET), 2020). The State is bordered by Abia State on the East and Northeast, Rivers State on the South, Anambra State to the North and Rivers State to the South. Imo State is divided into three (3) agricultural zones of Owerri, Orlu and Okigwe and twenty-seven (27) Local Government Areas. With a total land area of 5,530km^2, the State has an estimated population of about 4.8 million persons and an annual growth rate of 3.35 percent (Nigeria Populations Commission (NPC), 2006). The population of Imo State varies from 230 persons per kilometer square in Oguta/Egbema areas to about 1400 persons per kilometer square in Mbaise, Mbano, Orlu and Mbaitoli areas (National Boundary Commission (NBC) of Nigeria, 2020). Multistage sampling procedure was used to

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select the sample for the study. The three (3) agricultural zones (Owerri, Orlu and Okigwe) of the State were purposively selected based on strategic importance and production performance of sweet potato in the farming communities of the sampled agricultural zones in the area. In the second stage, Ihitte-Uboma and Okigwe LGAs were selected from Okigwe zone, while Owerri-North and Ohaji/Egbema LGAs were selected from Owerri agricultural zone. In the third stage, two communities were randomly selected from each LGA, making a total of eight (18) communities sampled. The lists of registered sweet potato farmers which formed the sampling frame were collected from the Imo State Agricultural Extension Agents assigned to the communities. From this sampling frame, proportionate and simple random sampling techniques were employed in each community due to unequal sampling frames to select a sample size of one-hundred and twenty six (126) sweet potato farmers for the study. Field enumerators from the Imo State Agricultural Development Programme (ADP) were recruited and trained to assist in data collection and collation. Data collected were through primary source, using well-structured questionnaire administered on the sweet potato farmers for the year 2024/2025 cropping season using the cost-route approach. Data were collected on variables such as farm size, capital, farming experience, farm income, expenses on agrochemicals, labour inputs, and quantity of fertilizer, output, socioeconomic characteristics, costs and returns. The study employed descriptive statistical tools in analyzing the data for the study. Precisely, descriptive statistical tools such as the frequency distribution, percentages and mean ($\bar{x}$) and inferential statistics such as stochastic frontier production function 4.1 were used to realize the objectives.

The stochastic production frontier model begins by considering a stochastic production function with a multiplicative disturbance term of the form;

$Y = f(Xa; \beta)\, e^{\epsilon}$ ……………………………….(1)

Where,

Y = the quantity of agricultural output (kg)

Xa=vector of input quantities

β=vector of parameters

e=error term, and

E=stochastic disturbance term consisting of two independent elements

V and U, where; $E = U + V$ ……………..................(2)

The symmetric component V, accounts for random variation in output due to factors outside the farmer's control, such as weather and diseases/pests outbreak. It is assumed to be independently

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and identically distributed as N (0, $ð^2$). A one-sided component V < 0 reflects technical inefficiency relative to the stochastic frontier, f (Xa; β)e^E. Thus, V = 0 for a farm output lying on the frontier and V< 0 for one whose output is below the frontier as N (0, $ð_u^2$), i.e. the distribution of V is half – normal. The frontier of the farm is given by combining (1) and (2) as follows;

Y = f (Xa; β)$e^{(u+v)}$…………………………….(3)

Measure of production efficiency for each farm can be calculated as;

TE = Exp. E(U/E) ………………………. (4)

In the efficiency analysis, the Battesse and Coelli (1995) single stage model was applied, whereby V in equation (3) is a non –negative random variable which is the efficiency associated with technical efficiency factors in production of the sample farmers. It is assumed that the efficiency factors are independently distributed and that V. arises by the truncation (at zero) of the normal distribution, with mean U and variance $ð^2$where V in equation (3) is defined as;

V = f (Z_5, ð) ……………………..(5)

Where;

Z_b = vector of farmer – specific factors, and

ð = vector of parameters

The β and ð – coefficients in equations (1) and (5) respectively are unknown parameters to be simultaneously estimated together with the variance parameter which is expressed in the form,

r = $ðu^2/(ðu^2 + ðV^2)$ ……………………….(6)

Where r parameter has a value between zero and one

Empirical Stochastic Production Frontier Function

The stochastic production frontier function was represented by the Cobb-Douglas Function and it is specified as;

Ln Yij =β_0 + β_1LnX_1ij + β_2Ln X_2ij + β_3 Ln X_3ij + β_4 Ln X_4ij + β_5LnX_5ij + β_6LnX_6ij + Vij – Uij ………………….(7)

Where;

Y = Output of Sweet potato (kg)

X_1 = Farm size (Ha)

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X_2 = Expenses on planting material (Naira)

X_3 = Expenses on agro-chemicals (Naira)

X_4 = Labour input (mandays)

X_5= Quantity of fertilizer (kg)

X_6 = Capital inputs (measured in naira and composed of depreciation charges on equipment)

$\beta_0 - \beta_6$ = regression coefficients estimated

vij = Normal distribution errors assumed to be independently and identically distributed, having N (0, $ð^2$)

uij = Non-negative random variables called technical efficiency associated with the technical efficiency of the sweet potato farmers.

Uijs are the technical inefficiency effects which are assumed to be independent of Vijs such that Uij is the non-negative truncation (at zero) of the normal distribution with mean Uj and variance $ð_v^2$ where Uj is defined by;

$Ui=a_0 = a_1 Z_1i + a_2 Z_2i + a_3 Z_3i + a_4 Z_4i + a_5 Z_5i + a_6 Z_6i + a_7 Z_7i + a_8 D_1i + a_9 D_2i + a_{10} D_3i$……………………………………(8)

Where,

Ui = Technical efficiency of the ith sweet potato farmer

Z_1 = Age of the farmer (years)

Z_2= Level of education (number of years spent in school)

Z_3= Farming experience (years)

Z_4 = Household size (number of persons)

Z_5= Farm size (Ha)

Z_6= Extension contact (number of extension visits per annum)

D_1=Improved variety of planting material (Dummy variable, use of improved variety = 1, 0 if otherwise)

D_2=Sex (Dummy variable, 1 for male, 0 for female)

D_3=Credit access (Dummy variable, 1 for access to credit, 0 if otherwise)

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D_4=Membership of cooperative (Dummy variable, 1 for membership, 0 if otherwise)

a – coefficients are unknown parameters estimated.

These variables are assumed to influence technical efficiency of the sweet potato farmers.

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics of Sweet Potato Farmers

The socioeconomic characteristics of the sampled sweet potato farmers are presented in Table 1. The results indicate that the average age of farmers is 43 years, suggesting that sweet potato production in the study area is dominated by individuals within their economically active years. This finding aligns with study of Esiobu et al. (2023), who reported that agricultural productivity in Imo State is largely driven by middle-aged farmers who possess both physical strength and decision-making capacity. On average, farmers had 8.16 years of formal education, indicating a moderate level of literacy that can facilitate the adoption of improved agricultural technologies. This supports findings by Orgu et al. (2023), which emphasize that education enhances farmers' ability to access and utilize agricultural information effectively. The average farming experience of 11.06 years suggests that farmers are fairly experienced, which could positively influence productivity through accumulated knowledge and skills. The mean household size of 8 persons indicates relatively large households, which may provide family labour but could also increase consumption pressure. This observation is consistent with the study of Esiobu (2021); Osuagwu et al. (2025), that link large household sizes in Imo State to both labour availability and increased dependency ratios. Farm size averaged 0.47 hectares, confirming that sweet potato farmers in the study area are predominantly smallholders. This finding aligns with Esiobu et al. (2025), which notes that most farmers in Imo State operate on less than 2 hectares. Similarly, the average labour use of 30.12 mandays reflects reliance on both family and hired labour, typical of small-scale farming systems. The results further show that farmers spent an average of ₦69,442.03 on planting materials and ₦53,104.26 on other capital inputs, indicating relatively low levels of investment. Fertilizer use averaged 394.56 kg, suggesting moderate input utilization, although this may still be below recommended agronomic levels. The average output of 149.37 kg reflects low productivity, which may be attributed to small farm sizes, limited access to improved inputs, and inadequate extension services. Notably, extension contact averaged only 0.85 visits per year, indicating poor access to agricultural advisory services. This is consistent with finding of Ezekiel et al. (2024), who reported weak extension coverage in many parts of Nigeria. Limited extension interaction can constrain farmers' awareness and adoption of improved practices, thereby affecting productivity. Finally, the results suggest that sweet potato farmers in the study area are relatively young, moderately educated, and experienced but operate on a small scale with limited capital and poor access to extension services. These findings align with broader empirical evidence on smallholder

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agriculture in Nigeria and sub-Saharan Africa, where structural constraints such as limited land, inadequate extension services, and low input use continue to hinder agricultural productivity.

Table 1: Average Statistics of Socioeconomic Characteristics of the Sweet Potato Farmers in Imo State, Nigeria

Variable	Mean Value	Maximum Value	Minimum Value
Age (years)	43	67	28
Education (years)	8.16	19	0
Farm size (Hectare)	0.47	0.78	0.18
Farming experience (years)	11.06	19	3
Household size (number of persons)	8	12	4
Labour (mandays)	30.12	93.41	4.26
Extension contact (number of visits)	0.85	2	0
Capital (₦)	53104.26	189055	6754
Fertilizer (kg)	394.56	502.39	112.65
Planting material (₦)	69442.03	94525	21164
Output (kg)	149.37	349.53	31.44

Source: Field survey data, 2025

3.2 Estimated Production Function

The maximum likelihood (ML) estimates of the stochastic frontier production function parameters for sweet potato farmers are presented in Table 2. The table shows that the coefficients of the estimated parameters have the desired signs and are statistically significant. The ratio of the standard error of Ui (ðu) to that of V (ðv) called Lamda (λ) is estimated at 1.615 and it is statistically significant at 1%. Gamma (ƴ) derived at $(\lambda^2/(1+\lambda^2)$ is equal to 0.723. This implies that 72% of the total variation in sweet potato output is due to technical inefficiency, and suggests that systematic influences that are unexplained by the production function are the dominant sources of error. The regression coefficients are direct elasticities of the dependent variable with respect to the independent variable with which the dependent variable is associated.

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Table 2: Estimated Stochastic Frontier Production Function for Sweet Potato Farmers in Imo State, Nigeria

Variables	Parameters	Estimates	t-ratios
Constant term	β_0	0.813	4.604***
Farm size (X_1)	β_1	0.082	3.113***
Planting material (X_2)	β_2	0.259	2.972***
Agro chemicals (X_3)	β_3	0.066	2.693***
Labour (X_4)	β_4	0.197	3.006***
Fertilizer (X_5)	β_5	0.088	3.115***
Capital (X_6)	β_6	0.643	2.942***
Log Likelihood function		-175.423	
Sigma (ð)		0.0405	3.105***
Lamda (λ)		1.615	3.449***
Gamma (ý)		0.723	2.814***
Sample size (n)		126	

***** Significant at 1%; *Source: Field Survey Data, 2025***

The estimate of the Sigma-squared ($ð^2$) is significantly different from zero at 0.01 levels indicating a good fit and the correctness of the specified distributional assumptions of the composite error term. The parameter estimates of the production function factors presented in Table 2 show that the estimated coefficient for Farm Size (X_1) was 0.813 which is positive and significant at 1% level. The 0.082 elasticity of farm size implies that a 1% increase in farm size would lead to an increase of 0.082 percent in the output of sweet potato. The coefficient of planting material (X_2) is also positive and significant at 0.01 level of probability. The 0.259 elasticity of planting materials implies that a 1% increase in quantity of planting material would lead to an increase of 0.259 percent in farmers' output. Agro-chemicals (X_3), a component of material input are applied to crops to mitigate the effect of crop losses and deterioration due to pests and diseases incidences. Thus, as expected, the coefficient is positive implying a positive effect on sweet potato output. The estimated coefficient for Labour (X_4) is positive as expected and significant at 0.01 level of probability. The 0.197 elasticity of labour implies that a 1% increase in labour employment would lead to an increase of 0.197 percent in the output of sweet potato. The estimated coefficient for Fertilizer (X_5) is positive and significant at 1% levels of probability. The 0.088 elasticity of

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fertilizer implies that a 1% increase in quantity of fertilizer would lead to an increase of 0.088 percent in output of sweet potato. The estimated coefficient for Capital (X_6) is positive and significant at 0.01 level of probability. The amount of capital inputs per farm determines the level of investment and status of such farm, because high level of investment translates to higher returns. Therefore, the 0.643 elasticity of capital implies that a 1% increase in capital inputs would lead to an increase of 0.643 percent in output of sweet potato in the study area. These findings on estimated coefficients of production factors are similar to the study of Egbodion et al. (2024) on technical efficiency of rice farmers in Edo State, Nigeria.

3.3 Technical Efficiency of Sweet Potato Farmers

The distribution of technical efficiency estimates of sweet potato farmers is presented in Table 3.

Table 3: Distribution of Technical Efficiency of Sweet Potato Farmers in Imo State

Efficiency class index	Frequency	Percentage
0.10 – 0.20	4	3.2
0.21 – 0.30	6	4.8
0.31 – 0.40	10	7.9
0.41 – 0.50	16	12.7
0.51 – 0.60	20	15.9
0.61 – 0.70	34	27.0
0.71 – 0.80	22	17.4
0.81 – 0.90	12	9.5
0.91 – 1.00	2	1.6
Total	126	100
Mean Technical Efficiency	0.60	
Minimum Technical efficiency	0.15	
Maximum Technical Efficiency	0.96	

Source: Field Survey Data, 2025

The Table indicates that, overall, the technical efficiency of the sample sweet potato farmers is less than 1 (100%) implying that all the farmers are producing below the maximum efficiency frontier. The best sweet potato farmer had a technical efficiency of 0.96 (96%) while the worst sweet potato farmer had a technical efficiency of 0.15 (15%) implying that some sweet potato farmers are operating far away from the frontier region. The mean technical efficiency is 0.60 which implies that on the average, the respondents were able to obtain a little over 60% of potential output from a given mix of production inputs suggesting a wider scope for the farmers to increase their level of technical efficiency by allocating the existing resources more optimally. The results further show that it will take an average sweet potato farmer in the study area (1- 0.60)/0.96 x 100, i.e. 42% cost saving to become the most efficient sweet potato farmer, while the worst performing farmer would require (1-0.15)/0.96 x 100, i.e. 88.5% cost saving to become the most technically

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efficient sweet potato farmer in the study area. The mean technical efficiency of 0.60 obtained in this study compares favourably with the 0.65 obtained by Parajuli and Thapa (2024) for sweet potato farmers in Nepal. The level of technical efficiency obtained in this study suggests that opportunities exist for increasing productivity and income through increased efficiency in resource utilization by sweet potato farmers in Imo State, Nigeria.

3.4 Sources of Technical Efficiency

The determinants of technical efficiency in sweet potato production are presented in Table 4.

Table 4: Estimated Determinants of Technical Efficiency in Sweet Potato Production in Imo State, Nigeria

Variables	Parameters	Estimates	t-ratios
Constant term	a_0	1.309	4.055***
Age (Z_1)	a_1	-0.062	-1.667
Level of education (Z_2)	a_2	0.049	2.973***
Farming experience (Z_3)	a_3	0.085	3.106***
Household size (Z_4)	a_4	-0.057	-1.822
Farm size (Z_5)	a_5	0.063	3.437***
Extension contact (Z_6)	a_6	0.074	2.911***
Improved variety of planting material (D_1)	a_7	0.088	3.094***
Sex (D_2)	a_8	0.031	1.743
Credit access (D_3)	a_9	0.082	3.449***
Cooperative membership (D_4)	a_{10}	0.056	2.716***

***** Significant at 1%; *Source: Field Survey Data, 2025***

The table shows that level of **education (Z_2)** is positively and significantly related to technical efficiency. Education enhances farmer’s ability to derive, decode and evaluate useful information as well as improving labour quality. This result agrees with study of Esiobu (2019), on important of education to farmers production.

Farming experience (Z_3) was positively and significantly related to technical efficiency. The more experienced a farmer is the more efficient his decision-making processes and the more he will be willing to take risks associated with the adoption of improved agricultural technologies. This result is consistent with those Thapa and Dhakal (2024), whose result showed a positive relationship between farming experience and technical efficiency in cotton production in Nigeria.

Farm size (Z_5) was positively and significantly related to technical efficiency. Larger farms can spread fixed costs (e.g., machinery, irrigation, labour) over a greater output, leading to higher efficiency. The result is in consonance with those of Ghimire and Kattel (2024) who found a significant relationship between farm size and technical efficiency.

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Extension contact (Z_6) was positively and significantly related to technical efficiency as expected. Extension services play a crucial role in improving the technical efficiency of sweet potato farmers by providing them with the necessary knowledge, skills, and technology to enhance productivity. This result agrees with the study of Joseph et al. (2024) who asserted that extension officers introduce farmers to improved innovation, fertilizers, irrigation methods, and mechanization.

Use of improved variety of planting material (D_1) was positively and significantly related to technical efficiency. This result is consistent with that of Ganiyu et al. (2024) who noted that the use of improved sweet potato varieties has a significant positive impact on the technical efficiency of farmers by increasing yield, reducing production risks, and optimizing resource use.

Credit access (D_2) was positively and significantly related to technical efficiency. Credit is needed to adopt improved innovations and expand production, and hence the positive relationship between credit access and technical efficiency. This result is consistent with the Ezekiel et al. (2024); Esiobu et al. (2026), who asserted that credit enables farmers to invest in mechanization, storage facilities, and post-harvest processing, reducing losses and enhancing productivity.

Membership of farmers' cooperatives (D_4) was positively and significantly related to technical efficiency. Members of farmers' associations have more access to agricultural information, credit and other production inputs as well as more enhanced ability to adopt innovations, and are consistent with the result obtained by Ezekiel et al. (2024). However, age (Z_1), household size (Z_4), and sex (D_2) show no significant relationship with technical efficiency.

3.5 Constraints Faced by Sweet Potato Farmers Affecting Technical Efficiency

Technical efficiency refers to the ability of farmers to obtain maximum output from a given set of inputs. In the study area, several production constraints limit farmers' ability to operate efficiently. These constraints are presented in Figure 1 and discussed accordingly.

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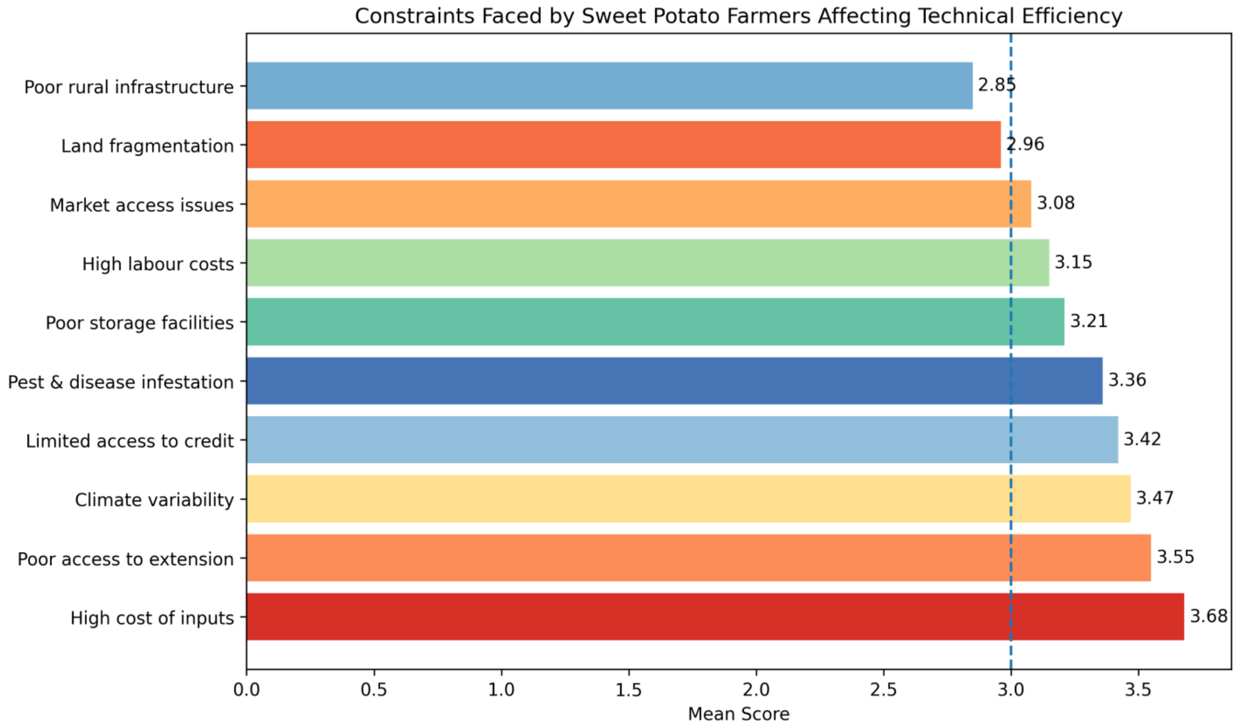

Decision Rule: Mean ≥ 3.00 = Severe constraint; Mean < 3.00 = Moderate constraint

Figure 1: Constraints Faced by Sweet Potato Farmers Affecting Technical Efficiency

Source: Field Survey Data, 2025

The results in Figure 1 show that high cost of inputs (Mean = 3.68) is the most critical constraint affecting technical efficiency. When farmers cannot afford adequate inputs such as fertilizer and improved planting materials, they operate below optimal production levels, thereby reducing efficiency. This supports findings by Orgu et al. (2024), who emphasized that input constraints significantly reduce farmers' productivity and adaptive capacity in Nigeria. Poor access to extension services (Mean = 3.55) ranked second. Extension services play a vital role in disseminating improved farming techniques and resource-use optimization strategies. Limited access implies that farmers may not apply inputs efficiently or adopt best agronomic practices. According to FAO, (2026), extension delivery is a key determinant of farm-level efficiency in smallholder systems. Climate variability (Mean = 3.47) also significantly affects efficiency by disrupting planting calendars, reducing yields, and increasing uncertainty in production decisions. This finding aligns with Orgu et al. (2024), who reported that climate shocks such as flooding and irregular rainfall reduce farmers' efficiency and productivity. Limited access to credit (Mean = 3.42) further constrains farmers from investing in productivity-enhancing inputs and technologies, thereby reducing their ability to achieve optimal output levels. Similarly, pest and disease

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infestation (Mean = 3.36) leads to yield losses and inefficient use of resources. Moderate constraints such as poor storage facilities (Mean = 3.21) and high labour costs (Mean = 3.15) also affect efficiency indirectly by increasing production costs and post-harvest losses.

Market access issues (Mean = 3.08) can discourage production expansion, while land fragmentation (Mean = 2.96) limits economies of scale and mechanization. Finally, inadequate rural infrastructure (Mean = 2.85) affects the timely availability of inputs and access to markets, thereby increasing inefficiencies in the production system. However, the presence of multiple severe constraints indicates that sweet potato farmers in the study area are operating below the production frontier. These inefficiencies arise from both allocative inefficiency (wrong combination of inputs due to cost and credit constraints) and technical inefficiency (inability to maximize output due to poor knowledge and environmental factors). The findings are consistent with empirical evidence of Adeyonu et al. (2019); Esiobu (2019); Midamba et al. (2022), which shows that reducing institutional and environmental constraints can significantly improve farmers' technical efficiency.

4. CONCLUSION

Sweet potato remains a globally important food crop, ranked among the top staple commodities due to its high yield, nutritional value, and adaptability to harsh environmental conditions. In sub-Saharan Africa, and particularly in Nigeria the world's second-largest producer the crop plays a critical role in food security, income generation, and combating micronutrient deficiencies such as vitamin A deficiency. Despite its importance and increasing production trends, empirical evidence on the technical efficiency of sweet potato farmers, especially in Imo State, has remained limited. Against this backdrop, this study evaluated the socioeconomic characteristics, technical efficiency, and constraints affecting sweet potato farmers in Imo State using a stochastic frontier approach. The findings revealed that farmers operate at a mean technical efficiency of 0.60, indicating that they achieve only 60% of their potential output. This suggests a significant efficiency gap of about 40%, implying that output can be increased without necessarily increasing input levels, but by improving resource use efficiency. The stochastic frontier results further showed that 72.3% of the variation in output is attributed to technical inefficiency, highlighting that farm-level factors play a dominant role in limiting productivity. Key determinants of technical efficiency include education, farming experience, farm size, and extension contact, use of improved planting materials, credit access, and cooperative membership all of which positively influenced efficiency. In addition, the constraint analysis based on the decision rule (Mean ≥ 3.00 = severe; Mean < 3.00 = moderate) revealed that most of the production challenges are severe, particularly high cost of inputs, poor extension services, climate variability, and limited access to credit. These constraints contribute to both technical inefficiency (inadequate knowledge and suboptimal practices) and allocative inefficiency (inability to use inputs optimally due to financial limitations). These findings are consistent with Orgu et al. (2024), who reported that climate-related risks, poor institutional support, and input constraints significantly reduce farmers' productivity and adaptive capacity in Nigeria. Ultimately, the study concludes that although sweet potato has strong potential to enhance food security and rural livelihoods, farmers in Imo State are still operating below optimal efficiency levels due to a combination of economic, institutional, and environmental constraints.

5. RECOMMENDATIONS

Based on the empirical findings of this study, the following targeted recommendations are proposed to enhance the technical efficiency of sweet potato farmers in Imo State:

i. Given that high input cost ranked as the most severe constraint, government should strengthen input subsidy programmes and promote private sector participation in input supply chains. Ensuring timely availability of improved vines, fertilizers, and agrochemicals will enable farmers to achieve optimal input combinations.
ii. The low extension contact calls for urgent reform. More extension agents should be recruited and trained, while ICT-based platforms (mobile advisory, SMS alerts) should be introduced to improve outreach and dissemination of best agronomic practices.
iii. Financial institutions and government agencies should develop inclusive agricultural credit schemes with low interest rates and minimal collateral requirements. This will enable farmers to invest in improved technologies and expand production scale.
iv. Considering the severity of climate variability, farmers should be supported with drought-tolerant and early-maturing sweet potato varieties, improved soil management practices, and access to climate information services to reduce production risks.
v. Extension services and research institutions should intensify training on Integrated Pest Management (IPM) and ensure availability of effective and affordable agrochemicals to minimize yield losses.
vi. Farmers should be mobilized into cooperatives to improve access to credit, bulk input purchase, shared machinery, and better market negotiation power. Cooperative membership was found to significantly improve technical efficiency.
vii. Distribution and awareness campaigns on improved, high-yielding, and disease-resistant sweet potato varieties should be intensified to boost productivity and efficiency.
viii. Provision of modern storage facilities and processing technologies will reduce post-harvest losses and increase the market value of sweet potato products.

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Conflicts of Interest

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