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Research Article

Technical and economic efficiency of plantain production in Akinyele Local Government of Oyo State, Nigeria

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Abstract
This study examined the economic performance and production efficiency of plantain farming in Akinyele Local Government Area of Oyo State, Nigeria. The objectives were to assess farmers' socio-economic characteristics, estimate production costs and returns, determine technical efficiency using the stochastic frontier approach, and identify major production constraints. A multistage sampling technique was used to select 130 plantain farmers, while data were collected through structured questionnaires and analyzed using descriptive statistics, budgetary analysis, and stochastic frontier production function. Results showed that most farmers were economically active, experienced, and moderately educated. Plantain production was found to be profitable, with positive gross margin, net farm income, and benefit-cost ratio above one. Farm size, labour, planting materials, fertilizer, and agrochemicals significantly influenced output. The mean technical efficiency was 0.79, indicating that output could increase by 21% through better resource utilization. Factors such as education, farming experience, access to credit, cooperative membership, household size, and extension contact reduced inefficiency, while age increased inefficiency. Major constraints included limited access to credit, high labour costs, poor roads, high input costs, and inadequate extension services. The study recommends improved access to credit, stronger extension support, promotion of farmer cooperatives, and better rural infrastructure to enhance productivity and farmers' welfare.

Nomenclature and units

GM = Gross margin
TR = Total revenue
TVC = Total variable cost
TFC = Total fixed cost
TC = Total cost
Yi = The independable variable
& = Parameter to be estimated

1.0 Introduction

Plantain, which is part of the *Musa species*, is very important in the food systems of many tropical nations. Especially in Nigeria, it acts as a main food item and also helps people in rural areas earn money. Its importance extends beyond nutrition, as it also contributes to employment generation and livelihood sustainability among smallholder farmers (Afodu *et al*., 2021; Bethel, *et al.,* 2025). Even though plantains are important in Nigeria, most of the production is done by small farmers who have few resources and use old farming methods. This often leads to lower output and less efficient farming (Okoruwa, 2022; Adewuyi and Ogunlade, 2021) Plantain is the major source of food in many regions throughout the world. Plantains represent the world's second largest fruit crop with an annual production of 144 million metric tons (FAOSTAT, 2013). About 70 million people in the African sub-region are estimated to derive more than one quarter of their food energy requirements from plantain. Plantain is very critical in bridging the gap between the demand and supply of the basic carbohydrate staples. The majority (82%) of plantain in Africa is produced in the area stretching from the lowlands of Guinea and Liberia to the central basin of the Democratic Republic of Congo. West and Central Africa contribute 61 and 21%, respectively (FAO, 1986). Nigeria is one of the largest plantain producing countries in the world with annual production of about 2.8 million metric tons mostly obtained from the southern states (FAOSTAT, 2013; Maps of world, 2016). Despite its prominence, Nigeria does not feature among the plantain exporting nations as she produces more for local consumption than for export (Fortaleza, 2012). Studies show that growing plantains can be a good source of income for farmers. But the high costs of labor, materials, and moving the crops can lower the profit farmers make (Bethel *et al*., 2025; Abdulrahman *et al*., 2022). Technical efficiency, which shows how well farmers can get the most out of the resources they have, has become a key area that researchers are focusing on in agriculture (Oluwatayo and Rachoene, 2022; Abdulrahman *et al*., 2022). Research from earlier studies shows that many farmers are not using their resources as effectively as they could, which means they are not producing as much as they are capable of (Adeniyi and Olufunmilola, 2021; Bolarinwa *et al*.,, 2024).The study evaluates the technical and economic efficiency of plaintain production among smallholder farmer by identifies socioeconomic factors influencing inefficiency among plaintain farmers and provide policy for improving productivity ,profitability and resource use efficiency in plaintain production

2.0 Materials and Methods

2.1 Study Area

The Akinyele Local Government Area is situated in Oyo State, Nigeria, and consists of many rural villages and farming communities known for their agricultural practices. The local government is divided into 12 administrative wards, and each ward has many villages. In these villages, people mainly rely on farming, especially growing plantains, as their main source of income. The study took place in Akinyele Local Government Area, which is in Oyo State, Nigeria. Akinyele Local Government Area is famous for its rich soil, good weather, and farming activities. Many people there work in growing crops, especially plantains. The region has a tropical climate characterized by distinct wet and dry seasons, which affects crop planting patterns. The main crops that are grown are plantain, cassava, maize, yam, and vegetables. The reason Akinyele LGA was chosen is because it is a major area for growing plantains in the state, and the farmers there can represent the typical smallholder plantain farming practices

2.2 Data Collection

Primary data were used for this study. The data were collected through the use of a well-structured questionnaire administered to the selected plantain farmers in the study area. The questionnaire consisted of both open-ended and close-ended questions designed to obtain information relevant to the objectives of the study. Information collected included respondents' socio-economic characteristics, farm size, farming experience, sources of labour, production practices, input utilization, constraints affecting plantain production, and other relevant variables. Data collection was carried out through personal interviews with the respondents. The questionnaire used for the study was subjected to both face and content validation to ensure that it measured the intended variables effectively. A pre-test of the questionnaire was also conducted among a few plantain farmers outside the selected study area. This was done to determine the suitability, clarity, and comprehensibility of the questions. Based on the feedback obtained from the pre-test, necessary corrections and adjustments were made before the final administration of the questionnaire. The validation process therefore enhanced the reliability and accuracy of the research instrument

2.3 Sampling Technique.

A multistage sampling procedure was employed for this study in order to obtain reliable and representative data from plantain farmers in the study area. The first stage involved the purposive selection of Akinyele Local Government Area (LGA) in Oyo State, Nigeria. The LGA was deliberately selected because of its notable involvement in plantain production and the large number of farmers engaged in plantain farming activities within the area. The choice of the LGA was therefore considered appropriate for achieving the objectives of the study. The second stage involved the purposive selection of ten villages known for active participation in plantain production. The selected villages are Ajibade, Alabata, Elekuru, Akinyele, Isabiyi, Irepodun, Arulogun, Eniosa, Aroro, and Ijaye Ojedeji. These villages were selected based on the concentration of plantain farmers and accessibility for data collection.The final stage involved the random selection of plantain farmers from each of the selected villages. Thirteen (13) plantain farmers were randomly selected from each village to ensure fairness and equal chance of participation among farmers. The random sampling technique helped to minimize bias and improve the representativeness of the respondents. Consequently, a total sample size of one hundred and thirty (130) respondents was obtained and used for the study. The sample size of one hundred and thirty (130) respondents was considered adequate for the study because it provided sufficient information required to achieve the objectives of the research. The selected respondents were distributed across ten villages to ensure proper coverage of the study area and to capture variations in plantain production practices among farmers

2.4 Data analysis

Descriptive Statistics were used to analyze the socio-economic variables of the plantain farmers and constraints to plantain production while Budgetary Analysis and Stochastic Frontier.

Budgetary analysis

This was used to estimate the costs and returns on plantain production of farmers in the study area. It is specified as follows;

GM = TR – TVC…………………………………… (1)

NR = GM – TFC……………………………………. (2)

TC = TVC + TFC…………………………………… (3)

Profit = TR – TC……………………………………. (4)

Where,

GM = Gross margin

TVC = Total variable cost

TC = Total cost

TR = Total revenue

NR = Net revenue

TFC = Total fixed cost The Stochastic Frontier Production Function

$InYi = In\beta0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_{5\ S} + Vi - Ui$

Where;

Yi = Farm output in monetary terms (₦)

Xi = Vector of inputs used measured in units

X_1 = Farm size (in hectares)

X_2 = labour (man-days)

X_3 = Planting material (kg)

X_4 = quantity of fertilizer (litres)

X_5 = quantity of agro-chemical used (litres)

Vi = Random variability in production that cannot be influenced by the farmers (Random errors)

Ui = Deviation from maximum potential output attributable to technical inefficiency

β = Vector of production function parameters to be estimated.

Technical inefficiency effects (Ui) is defined as;

$Ui = \delta 0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7$

Where;

Z_1 represents the Age (years);

Z_2 represents the household size (Numbers)

Z3 represents level of education (Years);

Z_4 represents farming experience (Years)

Z_5 represents Access to credit (Yes = 1, No = 0)

Z_6 represents membership of cooperative (Yes = 1, otherwise 0)

Z_7 represents access to extension service (Yes = 1, otherwise 0)

δ = Parameters to be estimated

3.0 Results and Discussions

The socio-economic characteristics of the plantain production were analyzed to gain insights into the background and living conditions of the farmers engaged in plantain production. The study looked at the social and economic traits of plantain growers to learn more about their background and how they make a living through plantain farming. Most of the producers are adults, who are already grown up, with 31.5% being between the ages of 51years and 60years, and 30.0% falling in the 41years to 50years age range. A substantial proportion (21.5%) were above 60 years, indicating that older farmers are significantly involved in plantain cultivation, while only 5.4% were below 30 years. The average age was 52.2 years, which shows that plantain farming is mostly done by people who have a lot of experience in life. Olagunju *et al.*, (2021) also noticed similar patterns. They found that older people were mostly involved in farming because they had more experience and good connections. Majority of the respondents were women, making up 73.1% of the sample, which shows that women play a major role in plantain farming. Male producers accounted for only 26.9% of respondents. This matches what Okunlola and Ogunwale (2019) found, where they highlighted how much women contribute to smallholder farming in Nigeria. The high level of women's participation shows how gender roles are shaped in rural farming areas, where women's work is very important for growing crops and keeping families. Most of the plantain farmers, which is 86.2%, are married. This implies that production activities may be closely associated with household responsibilities and income support for families. Most farming communities have a lot of married people, which matches earlier studies showing that family duties often lead people to work in rural agriculture (Adepoju and Olawuyi, 2012). Majority of households had 4 to 6 people (45.4%), and the next largest had 7 to 9 people (32.3%). Only 8.5% of the producers had small households of 1 to 3 people. With an average household size of 6.6, these results indicate that many producers have access to family labor, which may help in carrying out farm operations without incurring high wage costs. In other studies, bigger families have been connected with more people available to work on farms (Sanusi and Umar, 2022). Majority (37.7%) had finished secondary school, while 33.1% had no formal education, Only

9.2% had tertiary education. This mix shows that many farmers might not have proper training, which could make it harder for them to use better farming methods. Education has been recognized as a determinant of information access and technological uptake in farming (Adewumi *et al.*, 2020). While plantain production was central to most respondents, trading was the dominant main occupation (77.7%). This means that farmers are trying different ways to make money by growing crops and also selling them, which helps their families earn more. Civil service and craftsman were other jobs people did. The integration of farming with trading activities reflects broader rural livelihood strategies aimed at income stability (Akande, 2019). The majority of farmers (58.5%) had more than 20 years of farming experience, while 22.3% had 16–20 years of experience. With a mean experience of 24.6 years, it is evident that many producers have deep experience in plantain cultivation. Experience is a kind of human capital that helps farmers make better decisions and adapt to changes in the environment or market (Bello *et al*., 2021). Christianity was the most common religion practiced, with 58.5% of people following it, while Islam was followed by 40.0%. Traditional religious practices were minimal (1.5%). This distribution might show the cultural situation in the area studied, where having different religions doesn't stop people from farming. Just over a third of the producers, which is 38.5%, were part of cooperative groups. Despite the advantages of cooperative participation, such as shared resources, access to credit, and collective bargaining, a significant portion (61.5%) did not belong to any cooperative. This limited involvement might make it harder for farmers to get agricultural services and loans (Lawrence and Olayemi, 2023). Most plantain farmers, which are 76.2%, used their own money to pay for their farming, while only 1.5% got loans. Cooperative support accounted for 2.3% of capital sources. This pattern shows that smallholder farmers have limited access to formal credit, a problem that has been widely mentioned in studies (Oladejo and Sanusi, 2008).

Table1: Socio-economic Characteristics of Plantaisn Farmers

Variable	Frequency	Percentage (%)
Age (years)		
Below 30	7	5.4
31-40	15	11.5
41–50	39	30.0
51–60	41	31.5
Above 60	28	21.5
Sex		
Female	95	73.1
Male	35	26.9
Marital Status		
Single	1	0.8
Married	112	86.2
Divorced	4	3.1
Widow/Widower	13	10.0
Family Size		
1 – 3	11	8.5
4 – 6	59	45.4
7 – 9	42	32.3
10 – 12	13	10.0
Above 12	5	3.8
Education		
No formal	43	33.1
Primary	26	20.0
Secondary	49	37.7
Tertiary	12	9.2
Main Occupation		
Trading	101	77.7
Artisan	5	3.8
Self-employed	6	4.6
Civil servant	18	13.9
Farming Experience		
Below 5 years	3	2.3
5 – 10	10	7.7
11 – 15	12	9.2
16 – 20	29	22.3
>20 years	76	58.5
Religion		
Christianity	76	58.5
Islam	52	40.0
Traditional	2	1.5
Cooperative Membership		
Yes	50	38.5
No	80	61.5
Sources of Capital		
Personal savings	99	76.2
Cooperative support	29	22.3
Loan	2	1.5

Source: ***Field survey 2026***

Cost and Return Analysis of Plantain Farmer

The cost and return analysis in Table 3 shows how profitable plantain farming is for farmers based on current economic conditions. In recent years, Nigeria has faced rising inflation, increased costs of farm inputs, and higher labor expenses. These economic conditions have greatly affected how much it costs to produce agricultural goods, including plantains. The findings show that the total variable cost made up 93.12% of all the costs involved in production, which means that plantain farming depends heavily on things that change with each growing season, like labor, planting materials, and land preparation. This pattern is common in smallholder farming, where farmers depend a lot on manual work and buy supplies for their farming activities. Adeniran and Adeyemi (2021) also found similar things. They said that for smallholder farmers, the main costs in farming come from variable expenses. This is because these farmers don't use much machinery and often pay for workers. Among these variable costs, labor was the biggest part, taking up 37.66% of the total cost. This result highlights the labor-intensive nature of plantain cultivation, as activities such as land clearing, planting, mulching, weeding, and harvesting require significant human labor. Higher wages in rural areas and more workers moving to cities have made it more expensive to hire farm labor. The cost of planting materials, like plantain suckers, made up 22.64% of the total cost, which is the second biggest part of the overall expense. Using good quality planting materials is important for getting good results in plantain farming. Farmers who invest in improved suckers tend to achieve higher yields and better-quality bunches. However, the rising cost of better planting materials is making it hard for many smallholder farmers. Also, land preparation takes up 22.10% of the total cost, showing that a lot of resources are needed to get the farmland ready for growing plantains. Getting the land ready properly helps the soil to breathe, allows plant roots to grow well, and makes it easier for plants to get started and grow strong. Rising fuel prices and labor costs have led to an increase in the cost of land preparation in recent years. The total revenue from plantain production was ₦621,500, significantly higher than the total production cost of ₦252,260. This shows that growing plantains is still a good way to make money. The positive gross margin of ₦384,400 means farmers can pay their changing costs and still make a good amount of money. The net farm income of ₦369,240 also shows that growing plantains is a profitable business. Net farm income is the actual profit remaining after all production costs have been subtracted from the total revenue. This study shows that growing plantains helps rural families earn a steady income. The Benefit–Cost Ratio of 2.46 means that for every ₦1 spent on planting and growing plantains, farmers get back about ₦2.46. A BCR that is more than one means the company is making money in a good way. This finding aligns with previous studies that reported favorable returns from plantain production for farmers (Adewuyi and Yusuf, 2023). The Rate of Return on Investment (ROI) of 146.36% indicates that farmers earn about ₦1.46 in profit for every ₦1 invested in production. This high return indicates that farming plantains can be a good source of income and help increase earnings in rural areas. The Profitability Index of 0.59 means that about 59% of the money made from selling plantains is profit after paying all the costs involved in growing them. This shows how strong the plantain production is. The Operating Ratio of 0.38 means that just 38% of all the money the farmers makes goes toward the costs of running the business. A lower operating ratio is generally desirable as it indicates that a smaller portion of revenue is needed to cover operating expenses. Overall, the results show that plantain production continues to be a profitable agricultural enterprise even with the increasing costs of inputs in the current economic climate. The good profit signs show that growing plantains can help with food security, create jobs, and boost the economy in rural areas.

Table 2: Cost and Return Structure of Plantain Production (Farmers)

Cost Components	Mean (₦)	% of Total Cost
Variable Cost		
Land preparation	56,280.00	22.10
Planting materials (suckers)	57,640.00	22.64
Fertilizer and agrochemicals	10,250.00	4.02
Labour (planting, weeding, harvesting)	95,880.00	37.66
Feeding/maintenance	17,050.00	6.70
Total Variable Cost (TVC)	**237,100.0**	**93.12**
Fixed Cost		
Land rent	14,900.00	5.91
Farm tools depreciation	260.00	0.10
Total Fixed Cost (TFC)	**15,160.00**	**6.88**
Total Cost (TC)	**252,260.0**	**100**
Revenue		
Revenue from small size bunches	195,400.0	
Revenue from medium size bunches	257,600.0	
Revenue from large size bunches	168,500.0	
Total Revenue (TR)	**621,500.0**	
Gross Margin (TR − TVC)	**384,400.0**	
Net Farm Income (TR − TC)	**369,240.0**	
Profitability Indicators		
Benefit–Cost Ratio (BCR = TR / TC)	**2.46**	
Rate of Return on Investment (ROI = Net Income / TC ×100)	**146.36%**	
Profitability Index (PI = Net Income / TR)	**0.59**	
Operating Ratio (OR = TVC / TR)	**0.38**	

Source: *Field survey 2026*

Technical efficiency of plantain farmers; The estimated log-likelihood value of −128.47 suggests that the stochastic frontier model fits the data well. In efficiency analysis, a higher (less negative) log-likelihood value typically indicates a more accurate representation of the production process. Also, the likelihood ratio test, which is significant at the 1% level, shows that the stochastic frontier approach is better than the ordinary least squares model. This result shows that changes in production are not just by chance but are mostly because of how efficient the farmers are, Other research has found that the stochastic frontier model is more effective than OLS because it considers inefficiency directly (Oluwatayo and Rachoene, 2022; Abdulrahman *et al*., 2022). The gamma value of 0.748, which is statistically significant at the 1% level, indicates that approximately 74.8% of the changes in plantain production are due to technical inefficiency.The rest is due to other random factors like weather and measurement errors. This result indicates that inefficiency is a major source of variation in output among farmers. Earlier research has shown that high gamma values are often found in smallholder farming. In these situations, differences in how well farmers manage their operations and how easily they can get resources greatly affect how much they can produce (Akinbode and Dipeolu, 2023**).**

Production (Efficiency) Variables: The Maximum Likelihood Estimation (MLE) results presented in the stochastic frontier production model provide deeper insight into the efficiency of production and the factors influencing inefficiency among the farmers. The MLE coefficients are considered more reliable than the Ordinary Least Squares (OLS) estimates because MLE separates random error from technical inefficiency effects. The analysis therefore explains not only the contribution of production inputs to output, but also the socio-economic factors responsible for inefficiency among farmers. The coefficient of the constant in the production function was 0.936 and statistically significant at 1% level. This indicates that when all explanatory variables are held constant, the average level of output remains positive. The significance of the intercept further confirms the suitability of the stochastic frontier model in explaining production efficiency. Farm size had a positive and significant MLE coefficient of 0.489 at 1% level. This implies that a 1% increase in farm size would increase output by about 48.9%, holding other factors constant. The result suggests that larger farm holdings enhance production efficiency because farmers are able to utilize resources more effectively and benefit from economies of scale. The MLE coefficient being higher than the OLS coefficient (0.421) indicates that the true contribution of farm size to output was underestimated under OLS due to the inability of OLS to account for inefficiency effects.Labour also showed a positive and highly significant coefficient of 0.362 at 1% level. This means that increased labour utilization improves output and efficiency among the farmers. Specifically, a 1% increase in labour input increases output by approximately 36.2%. The significance of labour indicates that crop production in the study area is labour intensive and depends greatly on human effort during land preparation, planting, weeding, and harvesting operations. Planting materials had a positive coefficient of 0.244 and was significant at 5% level. This suggests that improved and adequate planting materials contribute positively to output. A 1% increase in the quantity of suckers planted increases output by about 24.4%. The result implies that access to quality planting materials enhances productivity and technical efficiency Fertilizer application also positively influenced production efficiency with a coefficient of 0.205, significant at 5% level. This indicates that increasing fertilizer use by 1% would raise output by approximately 20.5%. The finding confirms the importance of soil nutrient improvement in enhancing crop productivity. Proper fertilizer application therefore remains essential for improving farm efficiency. Agrochemical had a positive coefficient of 0.118 and was significant at 10% level. This means that the use of herbicides and pesticides contributes positively to output, although the effect was smaller compared with other inputs. A 1% increase in agrochemical use would increase output by about 11.8%. The significance of agrochemicals suggests that effective control of weeds, pests, and diseases helps farmers minimize losses and improve efficiency.

Inefficiency Variables: The inefficiency model explains the factors responsible for differences in farmers' technical efficiency. The coefficient of age was positive (0.132) and significant at 5% level, indicating that older farmers were more technically inefficient. This may be because aging reduces physical strength and willingness to adopt improved technologies, thereby lowering production efficiency. Household size had a negative coefficient of -0.156 and was significant at 5% level. This implies that larger household sizes reduce technical inefficiency. Farmers with larger households may have greater access to family labour, which reduces labor costs and improves farm operations .Farming experience showed a negative and highly significant coefficient of -0.249. This indicates that increased farming experience reduces inefficiency and improves technical efficiency. Experienced farmers are likely to possess better managerial skills, practical knowledge, and decision-making ability which enhance productivity. Education level also had a negative coefficient of -0.214 and was significant at 5% level. This suggests that educated farmers are more efficient because they are better able to understand and adopt improved farming practices and technologies. Access to credit negatively influenced inefficiency with a coefficient of -0.327, significant at 1% level. This implies that farmers who had access to credit were more technically efficient. Credit availability enables farmers to purchase inputs at the right time and adopt improved technologies, thereby increasing productivity. Cooperative membership had a negative and significant coefficient of -0.191. This indicates that farmers who belonged to cooperatives were less inefficient. Cooperative societies provide access to information, inputs, financial assistance, and group support which improve farmers' efficiency.Extension contact also negatively affected inefficiency with a coefficient of -0.273, significant at 1% level. This means that frequent interaction with extension agents improves farmers' efficiency by exposing them to modern farming practices, better management techniques, and innovations.The estimated sigma square (σ^2) value of 0.561 was statistically significant, indicating a good fit of the stochastic frontier model and confirming the presence of variation in output among farmers due to inefficiency effects.The gamma (γ) coefficient was 0.748 and significant at 1% level. This means that approximately 74.8% of the variation in output among farmers was due to differences in technical inefficiency rather than random factors outside the farmers' control. This confirms that inefficiency effects played a major role in determining farmers' productivity.The log-likelihood value of -128.47 and the significant likelihood ratio (LR) test value of

46.82 further confirmed the adequacy and overall fitness of the stochastic frontier model. The significance of the LR test indicates that the stochastic frontier model provided a better explanation of production efficiency than the conventional OLS regression model.Overall, the findings reveal that farm size, labour, planting materials, fertilizer, and agrochemicals significantly increased production efficiency, while factors such as education, farming experience, cooperative membership, access to credit, and extension services reduced technical inefficiency among farmers.

Table 3; Result of Technical efficiency of plantain farmers Production

Variables	OLS Coefficient	MLE Coefficient	Std. Error	t–value
Production (Efficiency) Variables				
Constant	0.802	0.936***	0.228	4.11
Farm size (ha)	0.421***	0.489***	0.120	4.08
Labour (man-days)	0.305***	0.362***	0.097	3.73
Planting materials (suckers)	0.198**	0.244**	0.084	2.90
Fertilizer (kg)	0.167**	0.205**	0.073	2.81
Agrochemicals (litres)	0.082	0.118*	0.048	2.46
Inefficiency Variables				
Constant	—	0.871**	0.338	2.58
Age of farmer	—	0.132**	0.056	2.36
Household size	—	-0.156**	0.072	-2.17
Farming experience (years)	—	-0.249***	0.090	-2.77
Education level (years)	—	-0.214**	0.083	-2.58
Access to credit	—	-0.327***	0.118	-2.77
Cooperative membership	—	-0.191**	0.077	-2.48
Extension contact	—	-0.273***	0.096	-2.84
Sigma square (σ^2)	—	0.561	0.146	3.84
Gamma (γ)	—	0.748***	0.089	8.41
Log-Likelihood Function	—	-128.47		
LR Test of the model (χ^2)	—	46.82***		

Source: *Field survey 2026*

*** = Significant at 1% level ** = Significant at 5% level
*= Significant at 10% level

The Distribution of Technical Efficiency Estimates

Looking at how efficiently plantain farmers use their production resources can be clearly understood by looking at the spread of technical efficiency estimates. Technical efficiency indicates how effectively farmers can achieve the highest possible output using a specific mix of inputs like land, labor, and capital. Differences in how efficiently farmers work often come from how well they manage their farms, how easily they get the things they need to grow crops, and how much help they get from organizations or groups (Oluwatayo and Rachoene, 2022). From the table showing how efficient farmers are, their scores are split into groups from 0.40–0.50 up to 0.91–1.00. This helps sort farmers into different levels of performance. Only a few farmers are in the lowest group, which is 0.40–0.50. These farmers are not producing as much as they could; making less than half of what their land is capable of yielding. This level of inefficiency is often linked to limited access to improved inputs, insufficient knowledge of modern farming practices, and weak institutional support systems (Abdulrahman, *et al.*, 2022). Farmers within the 0.51–0.60 range demonstrate a slight improvement, yet they still face significant inefficiency. At this level, a big part of what could be produced is still not being made. This situation might happen because farmers aren't using their inputs well or are delaying important farm tasks, which are common problems for smallholder farmers (Akinbode and Dipeolu, 2023). A bigger number of farmers fall into the 0.61–0.70 group, showing they have a moderate level of efficiency. Farmers in this region are utilizing available resources more effectively, but there is still potential for further improvement. Research shows that farmers in this group can boost their productivity a lot by improving how they manage their farms and by getting help from extension services (Ojo, *et al.*, 2020). The group with efficiency levels between 0.71 and 0.80 has the most farmers, which means it's the most common level of efficiency. Farmers in this group are doing pretty well, reaching between 71% and 80% of what they're capable of producing. This indicates that many farmers have implemented some improved practices but have not yet achieved optimal efficiency. Better access to loans and training might help farmers get closer to the maximum level of production they can achieve (Adewuyi and Ogunlade, 2021). Also, a large number of farmers are in the 0.81–0.90 range, which shows they are very efficient. These farmers are successfully integrating inputs and managing their farms to achieve significant results. Their performance might be connected to having more education, more experience in farming, and better links with extension services and cooperatives (Oluwatayo and Rachoene, 2022). A smaller group works within the highest level of efficiency, which is between 0.91 and 1.00. These farmers are nearly fully efficient and exemplify best practices in the study area. They show that it's possible to get almost the best possible results with the current ways of making things. These farmers often act as examples, demonstrating how using resources wisely and improving farming methods can be beneficial (Akinbode and Dipeolu, 2023). The average technical efficiency of 0.79 shows that, on average, farmers are getting around 79% of what they could possibly produce, meaning there's still a 21% gap in how efficiently they're operating. This gap represents the amount of output lost due to inefficiency. Recent studies show that fixing these gaps doesn't always need more resources. Instead, it often comes down to better management, easier access to tools and materials, and stronger support from institutions (Abdulrahman *et al*., 2022). The differences in how efficient farmers are reflect variations in their skills, knowledge, and access to useful resources. Farmers who are not as efficient can boost their performance by using the methods that more efficient farmers already use. Making extension services better, helping farmers get more credit and getting them to work together in cooperatives are important ways to cut down on waste and make farming more productive (Ojo *et al.,* 2020). In general, the way technical efficiency is spread out shows that banana farming in this area has a lot of room to get better. By addressing the constraints faced by less efficient farmers, overall production can be increased, leading to higher incomes and improved livelihoods for rural households.

Table 4: Distribution of Technical Efficiency Estimates among Plantain Farmers

Efficiency Level	Frequency	Percentage (%)
0.40 – 0.50	6	4.6
0.51 – 0.60	14	10.8
0.61 – 0.70	28	21.5
0.71 – 0.80	36	27.7
0.81 – 0.90	32	24.6
0.91 – 1.00	14	10.8
Total	130	100

Source: *Field survey 2026*

Mean Technical Efficiency = 0.78

Minimum Efficiency = 0.43
Maximum Efficiency = 0.95

Constraints Affecting Plantain Farmers

The ranking analysis highlights the key challenges affecting plantain farmers in the study area. The results show that inadequate access to credit is the most critical constraint, with the highest mean score of 4.52 and affecting over 86% of respondents. This indicates that most farmers lack the financial capacity to purchase essential inputs such as fertilizer, improved suckers, and agrochemicals. Limited access to credit has been widely identified as a major barrier to agricultural productivity, as it restricts farmers' ability to invest in improved technologies and expand production.The high cost of labour, ranked second (mean = 4.38), reflects the labour-intensive nature of plantain production. Activities such as land clearing, planting, and harvesting require significant human effort. Rising rural wage rates and labour shortages contribute to increased production costs, which reduce farmers' profit margins. Similar findings have been reported in studies where labour cost was identified as a major limitation to smallholder crop production.Poor road and transportation systems ranked third with a mean score of 4.21. This constraint affects farmers' ability to transport produce to markets, leading to increased post-harvest losses and reduced income. Poor infrastructure has been shown to limit market access and reduce agricultural productivity, especially in rural

farming communities The high cost of inputs, including fertilizer and planting materials, ranked fourth (mean = 4.05). This suggests that many farmers are unable to apply adequate input levels, which negatively affects yield. Studies have shown that input affordability plays a significant role in determining farm productivity and efficiency.Pest and disease infestation, ranked fifth (mean = 3.88), remains a major biological constraint. Plantain crops are highly susceptible to pests and diseases, which can significantly reduce output if not properly managed. Evidence from previous studies confirms that pest attacks and crop diseases are persistent challenges in plantain production systems.The lack of extension services, ranked sixth (mean = 3.72), indicates that farmers have limited access to technical knowledge and advisory support. Extension services are essential for disseminating improved farming practices, and their absence contributes to inefficiency and low productivity. Research has consistently shown that access to extension services improves farm performance and resource use efficiency. Inadequate processing and storage facilities (mean = 3.55) also pose a significant challenge. Without proper storage, plantain fruits are highly perishable, leading to losses and reduced income. This constraint has been identified as a major issue affecting value addition and profitability among plantain farmers. Market-related issues, including price fluctuation (mean = 3.41), further limit farmers' earnings. Unstable market prices make it difficult for farmers to predict income, discouraging investment in production. Similar findings indicate that unstable prices are a major concern in agricultural production systems. Limited access to land (mean = 3.20) was also identified as a constraint. Since land is a key production factor, limited availability restricts farm expansion and reduces output levels. Smallholder farmers often operate on fragmented land holdings, which limit economies of scale.Finally, climate-related challenges, including drought and flooding (mean = 3.05), ranked lowest but still remain significant. Changes in rainfall patterns and extreme weather conditions affect plantain growth and yield. Recent evidence shows that climate variability is increasingly impacting agricultural production and food security in Nigeria.

Table: 5 Constraints Affecting Plantain Farmers in Akinyele LGA

Constraints	Frequency (n = 130)	Percentage (%)	Mean Score	Rank

Inadequate access to credit	112	86.2	4.52	1st
High cost of labour	108	83.1	4.38	2nd
Poor road/transport system	102	78.5	4.21	3rd
High cost of inputs (fertilizer, suckers)	97	74.6	4.05	4th
Pest and disease infestation	90	69.2	3.88	5th
Lack of extension services	85	65.4	3.72	6th
Inadequate processing/storage facilities	79	60.8	3.55	7th
Price fluctuation/market instability	73	56.2	3.41	8th
Limited access to land	65	50.0	3.20	9th
Climate-related challenges (drought/flood)	60	46.2	3.05	10th

Source: *Field survey 2026*

Decision rule: Mean score ≥ 3.00 = major constraint

5.0 Conclusions

This study examined the economic performance and technical efficiency of plantain production in Akinyele Local Government Area of Oyo State using data from 130 farmers. The findings provide a comprehensive understanding of the factors influencing productivity, profitability, and efficiency in plantain farming. From the analysis of socio-economic characteristics, it was observed that most farmers are within their economically active age, with moderate household sizes and varying levels of education. These characteristics play a significant role in shaping production decisions and resource utilization. Farmers with more experience and better educational backgrounds were found to manage their farms more effectively. The cost and return analysis revealed that plantain production is a profitable enterprise, as indicated by the positive gross margin, net farm income, and favorable benefit-cost ratio.The stochastic frontier analysis showed that key production inputs such as farm size, labour, planting materials, fertilizer, and agrochemicals significantly influence output. The inefficiency model further revealed that age increases inefficiency, while education, farming experience, access to credit, cooperative membership, household size, and extension contact significantly reduces inefficiency. The constraint analysis identified limited access to credit, high labour cost, poor infrastructure, high input cost, and weak extension services as the major challenges faced by plantain farmers. These constraints limit farmers' ability to adopt improved practices and reduce overall productivity.

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Declaration of conflict of interest

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