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Technical Efficiency of Cassava Producers in Odogbolu Local Government Area of Ogun State

***Akinsulu Alaba Augustine, Odusina Olaniyi Adegoke and Ebofin Happiness Temitayo**

Department of Agricultural Economics & Extension, College of Agriculture and Hospitality Management, Tai Solarin Federal University of Education, Ijagun, Ogun State, Nigeria.

*Corresponding authors' email: akinsulula@gmail.com

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ABSTRACT
This study assessed the technical efficiency and profitability of cassava production in Odogbolu Local Government Area of Ogun State, Nigeria. Specifically, it described the socio-economic characteristics of cassava farmers, estimated their technical efficiency, identified the determinants of technical inefficiency, and examined the costs and returns of cassava production. Primary data were collected from 200 cassava farmers selected through a simple proportionate random sampling technique using a structured questionnaire. Data were analyzed using descriptive statistics, gross margin analysis, and the Cobb–Douglas stochastic frontier production function. The results showed that the mean age of the farmers was 45 years, with an average farming experience of 16 years. The mean technical efficiency was 0.88, indicating that farmers realized about 88% of their potential output, leaving a 12% scope for improvement. Farm size ($\beta = 0.655$; $p < 0.01$), fertilizer ($\beta = 0.116$; $p < 0.05$), and herbicide ($\beta = 0.366$; $p < 0.01$) significantly increased cassava output, while age, household size, farming experience, extension contact, and access to credit significantly reduced technical inefficiency. Cost and return analysis revealed a total revenue of ₦765,892.00, a total production cost of ₦549,990.00, and a gross margin of ₦317,771.00, confirming that cassava farming is profitable in the study area. The study concludes that cassava farmers are highly technically efficient and that improving access to extension services, affordable credit, improved inputs, and farmer cooperatives will further enhance productivity, efficiency, and profitability. It recommends strengthening agricultural extension services, improving farmers' access to credit, promoting cooperative membership.

Keywords: Cassava Production, Technical Efficiency, Stochastic Frontier Analysis, Profitability, Gross Margin

INTRODUCTION

Cassava has attracted greater attention because of its global market and the attendant demand but also because of its potential to produce ethanol which can be used to complement petroleum. Presently, the crop has achieved 'export status' because of the increasing demand for cassava with Nigeria holding the esteemed position of the largest producer in the world with an annual production of over 54tons from an estimated land area of 1.4 million hectares (Chinaka et al., 2013) Cassava ranks high as a major staple food crop particularly for the low-income earners and resource-poor farmers in the developing economies of Sub-Saharan Africa particularly in Nigeria, it serves as the major daily calorie intake for over 50 million people in the country. With the low cost of production and improved varieties, cassava has a high potential to reduce poverty among the smallholder farm households in Nigeria, also contribute immensely to the country's Gross Domestic Product (Osun et al., 2014).

Omoluabi and Ibitoye (2024) opined that despite cassava's potential in contributing significantly to food security, inefficiencies in farming systems, combined with limited access to agricultural technologies, have resulted in stagnated productivity. The yield from and products accruing to cassava farming among the farmers in Nigeria remained appallingly low, despite the potential of cassava to address the increasing food demand of the growing population in Nigeria as well as its diverse uses (Adeniji et al., 2003). This study therefore finds it necessary to assess the technical efficiency of cassava production in Odogbolu Local Government Area of Ogun State, as it may offer explanation for the poor stance of its production and the poor economy of its farmers.

Dossou (2024) posits that a farmer is said to be technically efficient if, for a given level of inputs and outputs, it is impossible to increase the quantity of one output without increasing the quantity of one or more inputs or reducing the quantity of another output. He argues further that the technically efficient farmer is the one who at the same level of output, used the least number of inputs or at the same inputs, obtained more outputs. This suggests a gap between the observed level of output and a potentially achievable output on a production frontier.

The broad objective of this research work is to examine the technical efficiency of cassava producers in Odogbolu Local Government Area, Ogun State. The specific objectives are to: describe the socio-economic profile of the cassava producers, determine the level of technical efficiency of cassava producers and estimate the cost and returns of cassava production in Odogbolu Local Government Area, Ogun State.

MATERIALS AND METHODS

Sample and Sampling Technique

A simple proportionate random sampling technique was employed to first select 50 cassava farmers in each of the four (4) selected districts in the Odogbolu Local Government Area of Ogun State, which are Imaka, Adofe, Aiyepe, and Araromi. Structured questionnaire and interview schedule were used

for the collection of data and information on cassava output per farmer, farm size, labour, quantity of cassava cuttings used, and farmers' socioeconomic characteristics etc.

Method of Data Collection

The researchers alongside trained enumerators (3) personally visited the farmers in the study area, and all the administered questionnaires was collected back on the spot. The researchers also ensured that all the questionnaires were filled and returned for data analysis.

Method of Data Analysis and Model Specification

Descriptive statistics and multiple regression analysis involving the specification of the Cobb-Douglas production function was used in the study. The stochastic frontier model was also used to determine the technical efficiency of the mechanized cassava farmers. The stochastic frontier production function model is specified in the implicit form as follows:

$Yi = f(Xi\ \beta) + (Vi - Ui)$

Where: Yi is the output of the i^{th} farm

Xi is a K Xi vector of input quantities of the i^{th} farm β is a vector of unknown parameters estimated, Vi are random variables that are assumed to be normally distributed and independent of the Ui. It is assumed to account for measurement error and other factors, not under the control of the farmers. Ui are non-negative random variables called technical inefficiency effects.

Cobb–Douglas Model

A Cobb–Douglas Production form of the frontier used for this study is presented as follows:

$$\text{In } Y = \beta_0+\beta_1 \text{In}X_1+\beta_2 \text{In}X_2+\beta_3 \text{In}X_3+\beta_4 \text{In}X_4+\beta_5 \text{In}X_5 + V_1-U_1 \quad (1)$$

Where Y = crop output of cassava (kg)

X_1 = Farm size (hectares)

X_2 = Family Labour (man-day)

X_3 = Hired labour (man-day)

X_4 = Quantity of fertilizer used (kg)

X_5 = Quantity of Herbicides (litre)

The inefficiency model is represented by

$$U_1 = d_0+ d_1\text{In}Z_1+ d_2\text{In}Z_2+ d_3\text{In}Z_3+ d_4\text{In}Z_4+ d_5\text{In}Z_5+d_6\text{In}Z_6+d_7\text{In}Z_7+ d_8\text{In}Z_8+ d_9\text{In}Z9 \quad (2)$$

Z_1 = Age of farmers (years)

Z_2 = Marital Status (single 1, 0 = others)

Z_3 = Sex (dummy variable. 1 if male, 0 = others)

Z_4 = Level of education (years)

Z_5 = Household size (number)

Z_6 = Farming experience (years)

Z_7 = No of extension visit (1, 2 …n)

Z_8 = Access to credit (Yes =1 Otherwise = 0)

Z_9 = Membership of Cooperative Society.

And gross margin analysis was used to determine the profitability of cassava producers in the study area. The gross margin is expressed as:

$$GM = TR - TVC \quad (3)$$

Where GM = Gross margin

TC = Total revenue, TVC = Total variable cost

RESULTS AND DISCUSSION

Table 1: Socio Economic Characteristics of Cassava Farmers in Odogbolu Local Government Area

Variable	Frequency	Percentage	Mean	Standard Deviation
Age				
≤ 30	25	12.5	45	10.95
31-60	156	78.0		
Above 60	19	9.5		
Total	200	100.00		
Sex Male				
	121	60.5		
Female	79	39.5		
Total	200	100.00		
Household Size				
≤ 3	25	12.5	6	2.15
4 – 6	97	48.5		
7 – 10	73	36.5		
Above 10	5	2.5		
Total	200	100.00		
Marital status				
Single	28	14.0		
Married	152	76.0		
Divorced	20	10.0		
Total	200	100.00		
Level of Educational				
None	7	3.5	6.5	
Primary	36	18.0		
Secondary	79	39.5		
Tertiary	78	39.0		
Total	200	100.00		
Years of farming experience				
≤ 10	84	42.0	16	11.18
11 – 20	66	33.0		
21 – 30	29	14.5		

Variable	Frequency	Percentage	Mean	Standard Deviation
31 – 40	13	6.5		
Above 40	8	4.0		
Total	200	100.00		

Source: Field survey, 2024

Results presented in Table 1 show the socioeconomic characteristics of the cassava farmers. It reveals that 78% are between 31-60 years old, with a mean age of 45 years and 12.5% of the respondents are 30 years old or less. This suggests that most farmers are in their active and productive years. The results show that 60.5% of the respondents are male and 39.5% of the respondents are female. This implies that more males are involved in cassava farming in the study area.

The marital status distribution of the cassava farmers as presented in Table 1 indicates that 76% are married, while 14% of the respondents are single and 10% are divorced. Married farmers are likely to have access to family labour and a sense of responsibility to the business to meet family needs, which could boost productivity.

The respondents' household size distribution results reveal that almost half (48.5%) of the sampled cassava farmers have a household size of 4-6 individuals, some others (36.5%) have between 7 and 10 individuals living together, a few others (12.5%) have a household size of 3 individuals or less. Only very few (2.5%) of the sampled cassava farmers have a household size above 10 individuals. The average household size of respondents in the study area is 6 persons. This suggests that farmers could make use of family labour on their respective farms.

The results showed further that 39% of the respondents had completed tertiary education, 39.5% had secondary education, and 18% had completed primary education. Only a few (3.5%) have no form of education. This shows that the majority of farmers are literate, a crucial factor in commercializing farming and the adoption of technologies to improve cassava production. This implies that farmers will likely adopt agricultural innovations easily, thus improving their financial status. With mean farming experience of 11.18 years, it shows that cassava farmers in the study area have appreciable number of years that can improve their technical efficiency.

Discussion of Factors Affecting Technical Efficiency and Inefficiency of Cassava Producers in Odogbolu Local Government Area

The Cobb Douglas Stochastic Frontier Production Function (SFPF) and inefficiency model for cassava farmers results are shown in Table 2. Sigma-square and gamma, the variance parameters, were calculated to be 0.568 ($p<0.01$) and 0.830 ($p<0.01$), respectively. Gamma displays systematic factors that are not explained by the production function and the main causes of random mistakes, whereas sigma-square shows the model's accuracy and the expected error term distribution form.

This indicates that technical inefficiency accounts for 83% of output variation among cassava farmers. The parameter estimates for the production function demonstrate that the farm size ($p<0.01$), quantity of fertilizer ($p<0.05$), and the quantity of herbicide used ($p<0.01$) have a significant effect on output.

Farm size had a positive and highly significant coefficient ($\beta = 0.655$; $p < 0.01$), indicating that an increase in cultivated land leads to a corresponding increase in cassava output. Specifically, a 1% increase in farm size increases output by approximately 0.655%. This shows that farmers with larger farm holdings are able to exploit economies of scale and achieve higher production levels. The result agrees with the finding of Adepoju and Salman (2013) who found that farm size significantly increased cassava output among farmers in Southwestern Nigeria and Mairabo et al. (2023) who found positive relationship between technical efficiency of soybean production in Niger State, Nigeria.

The use of fertilizer was positive and significant ($\beta = 0.116$; $p < 0.05$), implying that increased fertilizer application enhances cassava productivity. This may result from improves soil nutrient availability, which promotes plant growth, and increases yield. The finding supports the observations of the Food and Agriculture Organization (FAO, 2022), which emphasized that fertilizer remains one of the most important yield-enhancing technologies in crop production

Herbicide use had a positive and significant effect on cassava output ($\beta = 0.366$; $p < 0.01$). This indicates that effective weed control contributes substantially to increased cassava production. Effective weed control reduces competition, increase aeration and enhances crop performance. This finding corroborates the report of International Institute of Tropical Agriculture (IITA, 2021), which identified weed management as a major factor influencing cassava yield in tropical farming systems.

Age had a negative and significant coefficient ($\delta = -0.026$; $p < 0.10$), indicating that older farmers are less technically inefficient than younger farmers. This may result from the fact that older farmers accumulate knowledge and better managerial capabilities. The finding is line with Coelli et al. (2005), who reported that older farmers often possess greater practical farming experience that contributes to improved efficiency.

Gender had a positive but insignificant coefficient ($\delta = 0.022$), indicating that gender differences do not significantly influence technical efficiency among cassava farmers. This finding agrees with studies showing that both male and female farmers can achieve similar productivity levels when provided equal access to production resources (FAO, 2023).

Education level showed a positive but insignificant relationship with technical inefficiency ($\delta = 0.032$). This result suggests that formal education alone may not guarantee improved farming efficiency. Practical agricultural knowledge and experience may be more important than years of schooling in determining farm performance. Similar observations were made by Amaza and Maurice (2005).

The coefficient of household size was negative and significant ($\delta = -0.011$; $p < 0.10$), implying that larger households reduce technical inefficiency. This may be attributed to the availability of family labour, which lowers labour costs and enhances farm operations. This supports the finding of Ayeni et al. (2023) who found that adjusted household size had a negative and significant effect on technical inefficiency among dry-season okra farmers in Nigeria, and Joseph et al. (2024) who identified household size as one of the significant socio-economic factors influencing technical efficiency among dry-season crop farmers in Gombe State, Nigeria.

Farming experience had a negative and highly significant coefficient ($\delta = -0.087$; $p < 0.01$). This indicates that

experienced farmers are more technically efficient than less experienced farmers. Experienced farmers are better able to allocate resources, adopt appropriate technologies, and manage production risks. This result agrees with Battese and Coelli (1995) and Adeagbo et al. (2023), who found farming experience to be a major determinant of technical efficiency.

The coefficient of extension visit (-0.214) is negative and significant at the 5% level (t = -2.184). This implies that increased contact with extension agents significantly reduces technical inefficiency among cassava farmers. Farmers who receive extension services are more likely to adopt improved production technologies, better agronomic practices, and efficient resource management techniques, thereby increasing their productivity and technical efficiency. The result suggests that extension services play an important role in enhancing farm performance and should be strengthened to improve cassava production. This finding agrees with the work of Aigner et al. (1977) and Battese and Coelli (1995), who reported that access to extension information improves farmers' managerial ability and technical efficiency. Similar findings were reported by Adeagbo et al. (2023) among crop farmers in Southwest Nigeria.

The coefficient of access to credit (-0.371) is negative and statistically significant at the 5% level (t = -2.541). This indicates that access to credit reduces technical inefficiency among cassava farmers. Farmers with access to credit can purchase improved planting materials, fertilizers, herbicides, and other production inputs on time, thereby enhancing their productive efficiency. It can also enable farmers to adopt modern technologies and expand farm size, leading to improved output levels. The result corroborates findings by Battese and Coelli (1995), who observed that credit availability enhances farmers' productive efficiency through improved access to production inputs. Similarly, Adeagbo et al. (2023) found that access to institutional support services significantly improved farmers' adaptation capacity and production efficiency.

Table 2: Maximum Likelihood Estimates of Cobb-Douglas Stochastic Production Frontier for Cassava Producers

Variable	Coefficient	Standard-Error	t-Ratio
Constant	-1.133***	0.118	-9.630
Farm size	0.655***	0.067	9.760
Fertilizer	0.116**	0.048	-2.400
Herbicide	0.366***	0.066	5.520
Hired labour	-0.002	0.076	-0.020
Family labour	-0.147	0.073	-2.020
Inefficiency Model			
Constant	-1.813	2.731	-0.660
Age	-0.026*	0.015	-1.726
Marital Status	-0.823	1.184	-0.700
Gender	0.022	0.968	0.020
Education Level	0.032	0.092	0.350
Household size	-0.011*	0.006	-1.750
Farming experience	-0.087***	0.028	-3.166
Extension visit	-0.214**	0.098	-2.184
Access to credit	-0.271**	0.146	-2.341
Cooperative membership	-3.742	3.488	-1.070
sigma-squared	0.568***	0.033	0.637
Gamma	0.830***	0.010	33.070

Significance levels: *** p < 0.01, ** p < 0.05, * p < 0.10.
Source: Field survey, 2023

Technical Efficiency Distribution of Cassava Producers in Odogbolu Local Government Area

The result presented in Table 3 shows the technical efficiency distribution of the cassava farmers in the study area. It reveals that the majority (62%) of the cassava farmers have a technical efficiency of above 0.90, and many (36.5%) of the respondents have a technical efficiency of 0.61 – 0.90. Only a few (1.5%) have a technical efficiency of below 0.60 with the average technical efficiency of the sample population being 0.88. This implies that cassava farmers in the study area realized 88% of potential output from inputs. Furthermore, this suggests that a 12% improvement in technical efficiency is still possible with the available technology.

Table 3: Technical Efficiency Distribution of Cassava Producers in Odogbolu Local Government Area

Technical Efficiency	Frequency	Percentage
Efficiency Distribution		
0.30 - 0.60	3	1.50
0.61 - 0.90	73	36.50
Above 0.90	124	62.00
Total	200	100.00
Mean	0.88	
Standard Error	0.007	
Minimum	0.44	
Maximum	0.98	

Source: Field survey, 2024

Cost and Return of Cassava Farming in Odogbolu Local Government Area

The results presented in Table 4 reveal that the total revenue (TR) realized from cassava production was ₦765,892.00 per production cycle. Revenue from the sale of cassava tubers amounted to ₦763,597.00, representing 99.70% of total revenue, while income from garri was ₦2,295.00, accounting for only 0.30%. This finding suggests that farmers primarily marketed fresh cassava tubers rather than processing them into value-added products such as garri.

The result is similarly to report of FAO, (2023) and IITA, (2024) that the sale of fresh cassava roots remains the major source of farm income among smallholder cassava farmers in Nigeria,

The total production cost (TC), comprising fixed and variable costs, was ₦549,990.00, while the gross margin (GM), calculated as total revenue minus total variable cost, was ₦317,771.00. The positive gross margin indicates that cassava farming generated sufficient revenue to cover all variable production costs and still leave substantial returns to compensate fixed costs and provide profit to the farmer. This confirms that cassava production remains an economically viable enterprise in the study area.

Table 4: Cost and Return Analysis of Cassava Farming

Variable Revenue	Values(₦)	Percentage (%)
Cassava Tuber	763,597.00	99.70
Garri	2,295.00	0.30
Total Revenue (TR)	765,892.00	100.00
Fixed Cost		
Land	91,652.00	89.97
Machinery (plough)	10,217.00	10.03
Total Fixed Cost (TFC)	101,869.00	100.00
Variable Cost		
Cassava stem	69,316.34	15.47
Fertilizer	232,382.00	51.86
Herbicide	14,064.00	3.14
Labour	16,274.00	3.63
Transport	116,084.00	25.90
Total Variable Cost (TVC)	448120.9	
Total Cost (TFC +TVC) Gross	549,990.00	
Margin (TR - TVC)	317,771.00	

Field survey, 2024

CONCLUSION

This study examined the economics of cassava production among farmers in the study area with emphasis on the socio-economic characteristics of farmers, production efficiency, determinants of technical inefficiency, and profitability of cassava farming. The findings revealed that cassava production is a profitable enterprise, with an average total revenue of ₦765,892.00 and a gross margin of ₦317,771.00, indicating that farmers realized substantial returns after covering variable production costs. The stochastic frontier analysis showed that farm size, labour, fertilizer, and planting materials contributed positively to cassava output. The socio-economic factors influence the technical efficiency of the farmers including farming experience, education, extension contact, access to credit, and cooperative membership, household size and farming experience also played important roles in influencing production efficiency.

The cost and return analysis further revealed that fertilizer constituted the largest proportion of variable production costs, followed by transportation expenses, while land represented the largest component of fixed costs. The findings demonstrate that improving farmers' access to improved production technologies, extension services, affordable credit, and organized farmer groups would further enhance technical efficiency, increase productivity, and improve farm profitability. The study concludes that cassava farming is a profitable and economically sustainable enterprise in the study area.

Based on the findings of the study, the following recommendations are made: Government and agricultural development agencies should recruit and adequately train extension personnel to provide farmers with timely information on improved cassava production technologies.

Farmers should be encouraged to join and actively participate in cooperative organizations, which can facilitate access to credit, improved inputs, collective marketing, training opportunities, and government support programmes. Government should strengthen fertilizer subsidy programmes, support local production of fertilizers, and regular training programmes, workshops, and demonstrations should be organized to improve farmers' managerial skills.

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