



DETERMINANTS OF ECONOMIC EFFICIENCY IN GINGER PRODUCTION IN DELTA STATE, NIGERIA

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ABSTRACT

The study examined the determinants of economic efficiency in ginger production in Delta State, Nigeria. It assessed the level of economic efficiency among ginger farmers and identify key socio-economic and farm-specific factors influencing their performance. Data were collected from a cross-section of ginger farmers through structured questionnaires. Descriptive statistics, stochastic frontier analysis, and cost, and multiple regression techniques were employed for analysis. The findings showed that ginger farmers in the study area operated at varying levels of economic efficiency, with the majority performing below the optimal production frontier, indicating the presence of inefficiencies in resource use. Factors such as age (0.021), access to credit (-0.410), level of education (-0.315), farming experience (-0.228), and access to extension services (-0.372) were found to significantly influence economic efficiency. The model explained explained 84% of inefficiency variation, implying strong explanatory power. Additionally, constraints such as high cost of inputs ($\bar{x} = 3.84$), lack of credit ($\bar{x} = 3.81$), pest and disease challenges ($\bar{x} = 3.48$), inadequate infrastructure ($\bar{x} = 3.36$), and lack of credit ($\bar{x} = 3.04$) were identified as major barriers to achieving optimal efficiency. The study concluded that improving farmers' access to financial services, strengthening agricultural extension systems, and promoting the use of improved inputs and technologies were critical to enhancing economic efficiency in ginger production. It is recommended that policymakers and relevant stakeholders implement targeted interventions to address these constraints and improve the productivity and income of ginger farmers in the study area.

Keywords: Analysis, Efficiency, Frontier, Ginger and Production.

INTRODUCTION

Agriculture continues to be a pillar of the Nigerian economy, providing significant employment, income, and food security (Food and Agriculture Organization, 2023; World Bank, 2024). Nevertheless, the sector continues to grapple with issues of low productivity, poor resource utilization, and low adoption of improved technology (International Food Policy Research Institute, 2022). Increasing efficiency at the farm level as a way of increasing agricultural output without necessarily increasing the resource base has received increasing attention in recent years (Abdullahi *et al.*, 2007). Economic efficiency in Agricultural Economics is well known as a significant factor in determining the extent to which farmers make use of the available inputs for the highest output and profit (Price, 2022).

Ginger (*Zingiber officinale*) is an important spice crop of great economic and medicinal importance. Ginger demand is increasing globally because of its multiple uses in food processing, pharmaceuticals, and traditional medicine (Food and Agriculture Organization, 2023). Ginger production in Nigeria has traditionally been concentrated in the northern regions of the country,



but is now gradually spreading to the southern states, including Delta State, due to the favourable agro-ecological conditions for ginger production in the state (Muzeza *et al.*, 2023; Olagunju *et al.*, 2021). The expansion provides opportunities for income diversification among smallholder farmers, but productivity levels are below potential (Pushpa *et al.*, 2022).

Ginger production is economically important to Nigeria, however, it is characterized by inefficiencies, as a result of suboptimal use of inputs such as land, labour, seed and agrochemicals (Ackom *et al.*, 2025; Osinowo and Tolorunju, 2019). Many farmers are operating below the production frontier, meaning that higher levels of output could be produced with the resource base (Okon, 2021). The Stochastic Frontier Analysis can be used to analyze the efficiency of agricultural production as it can estimate technical, allocative and economic efficiency while controlling for random shocks outside farmers' control (Chimilia and Layero, 2022).

Understanding the determinants of economic efficiency is important for designing policies and interventions that enhance productivity. A number of socio-economic and institutional factors affecting farm efficiency have been identified in empirical studies, including farmers' age, education level, farming experience, access to credit, extension services and membership of cooperative organizations (Ackom *et al.*, 2025; Ndubueze-Oparaku *et al.*, 2022). These factors shape farmers' decision-making capacity, the adoption of improved technologies, and their ability to allocate resources optimally.

There is little recent empirical evidence on the factors determining economic efficiency of ginger production, particularly in Delta State. However, most of the previous studies have focused on other crops or other regions, thus creating a gap in the location-specific knowledge needed for effective policy formulation (Adewale and Aregbosola, 2025). Ginger is emerging as an important commercial crop and potentially important to rural livelihoods; hence, it is imperative to assess the efficiency determinants among ginger farmers in the state.

The study therefore intends to investigate the determinants of economic efficiency of ginger production in Delta state, Nigeria with a view to identifying the key factors influencing the performance of the farmers and providing evidence-based recommendations for improving the efficiency of resource use, increasing productivity and improving the income of ginger producers.

MATERIALS AND METHODS

The Study Area

The study was conducted in Delta State, Nigeria, a region characterized by favorable agro-ecological conditions suitable for ginger (*Zingiber officinale*) production. The area experiences a humid tropical climate with adequate rainfall and fertile soils that support crop cultivation. It is geographically located at Latitude 5° 00' to 6° 30' North and Longitudes 5° 00' to 6° 45' East. The territory is one of the most populous in Nigeria, with about 198 people per square kilometre, compared to average of 130 for Nigeria (NPC, 2006). The consequence of this population density is a shortage of agricultural land. The people are mainly farmers who grow food crops such as yams, cassava, and vegetables.

Sampling Procedure and Sample Size

A total of Two hundred and twenty respondents were selected through multistage sampling procedure. The first stage comprised purposive selection of each Local Government Area (LGAs) from the three (3) agricultural zones in the State. These local governments are Ughelli North (Delta Central), Warri North (Delta south) and Ika North East (Delta North). Stage two involve random selection of two (2) communities in each of the LGAs selected. This accounted for six (6)

communities from the three LGAs selected. These communities are Agbaro, Orogun (Ughelli North), Koko, Jakpa (Warri North), Igbodo and Otolokpo (Ik North East). Stage three (3) involve selection of all ginger farmers from the six (6) communities. A sample frame of 174 respondents was obtained. Using Cochran formular at 95% confidence and error margin of 0.05, a sample size of 120 farmers were randomly selected for the study.

Method of Data Collection

Primary data were collected using structured questionnaires complemented with personal interviews. Information obtained included: Socio-economic characteristics (age, education, farming experience, and household size), Farm-level variables (farm size, labor input, seed quantity, fertilizer use, agrochemicals), Output data (quantity of ginger produced), Economic variables (input costs, output prices) and Institutional factors (access to credit, extension services, and cooperative membership).

Analytical Techniques

Data analysis involved both descriptive and inferential statistics.

- i) **Descriptive statistics:** Descriptive statistics, such as means, frequencies, and percentages, were used to summarize the socio-economic characteristics of respondents and farm-level variables.
- ii) **Stochastic Frontier Production Model:** Economic efficiency was estimated using the stochastic frontier production function. The parameters of the stochastic frontier and inefficiency models were estimated simultaneously using Maximum Likelihood Estimation (MLE). The estimation was carried out using statistical software such as STATA or SPSS. The model is specified as:

$$Y_i = f(X_i; \beta) \exp(V_i - U_i) \quad \dots(1)$$

Where;

Y_i = output of the i^{th} farmer

X_i = vector of input variables

β = parameters to be estimated

V_i = random error term (assumed $N(0, \sigma^2_v)$)

U_i = non-negative inefficiency term

Cobb–Douglas Production Function

The functional form adopted was the Cobb–Douglas production model:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + V_i - U_i \quad \dots(2)$$

Where;

X_1 = Farm size (ha)

X_2 = Labour (man-days)

X_3 = Seed (kg)

X_4 = Fertilizer (kg)

X_5 = Agrochemicals (litres)

Technical Efficiency Model

Technical efficiency (TE) of individual farmers was estimated as:

$$TE_i = \exp(-U_i) \quad \dots(3)$$

Values of TE range between 0 and 1, where 1 indicated full efficiency.

Allocative and Economic Efficiency

Economic efficiency (EE) was derived as:

$$EE = TE \times AE \quad \dots(4)$$

Where:

AE = Allocative Efficiency

Inefficiency Effects Model

The inefficiency model was specified as:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \quad \dots(5)$$

Where:

Z_1 = Age (years)

Z_2 = Education (years of schooling)

Z_3 = Farming experience (years)

Z_4 = Access to credit (dummy: 1 = yes, 0 = no)

Z_5 = Extension contact (Number of extension contact)

Z_6 = Cooperative membership (Years of membership)

Cost and Return Analysis

Profitability of ginger production was evaluated using farm budgeting techniques:

Gross Margin (GM):

$$GM = TR - TVC \quad \dots(6)$$

Where:

Net Farm Income (NFI):

$$NFI = TR - TC \quad \dots(7)$$

Where:

TR = Total Revenue

TVC = Total Variable Cost

TC = Total Cost

RESULTS AND DISCUSSION

Farmers' Socio-Economic Characteristics

The results in Figure 1 indicated that the majority of the ginger farmers were within the economic active age group of 31–50 years, representing over 63% of the respondents. This result was consistent with the reports of Abdullahi *et al.* (2022) and Nwabueze-Oparaku *et al.* (2021), which state that agricultural production in Nigeria is predominantly carried out by middle-aged farmers who contribute significantly to farm labour. The study also revealed that the respondents' sex was predominantly male (65.0%), which was in line with the report of Pushpa *et al.* (2022), which stated that ginger farming in the study area was male-dominated. With respect to education, the majority of the farmers (83.4%) had formal education, and secondary education was the highest level attained. This level of literacy might facilitate better understanding and use of improved production practices. This was consistent with Okon (2021), Ewododhe and Ogisi *et al.* (2024), who observed that educated farmers were more likely to adopt improved agricultural technologies. However, access to credit was limited, as only 38.3% of the farmers had access to credit facilities. Ackom *et al.* (2025) also reported this constraint among smallholder crop farmers.

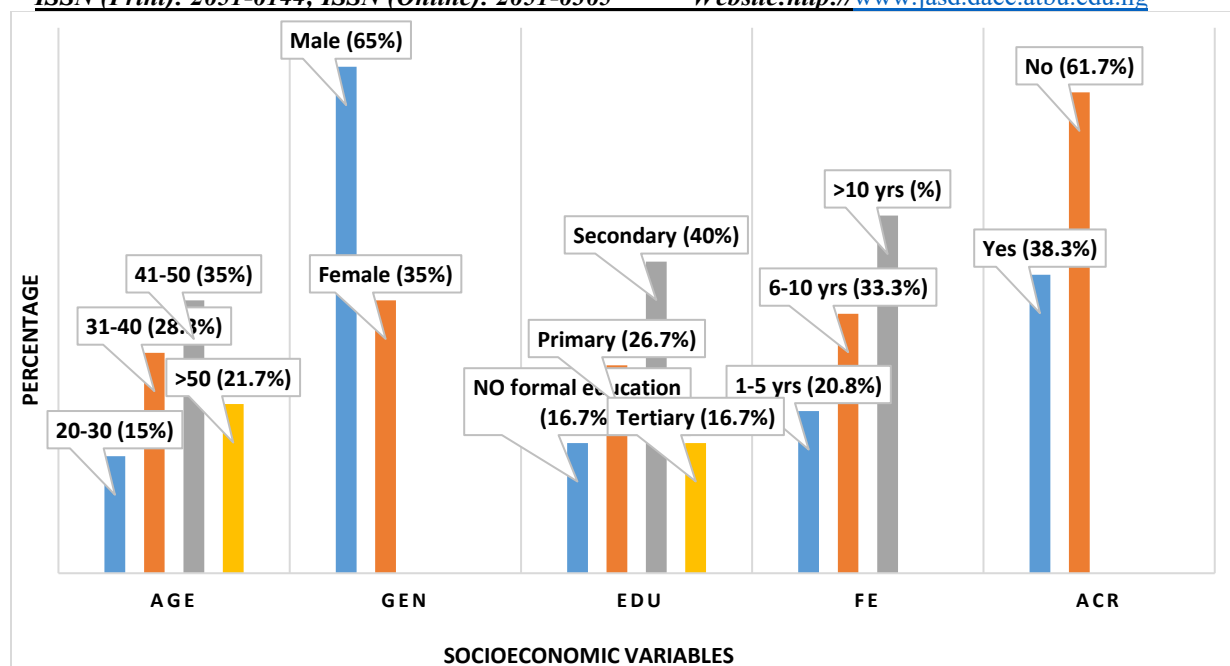


Figure 1: Socioeconomic characteristics of farmers

Farm Characteristics and Input use

The results in Table 1 showed the means of various inputs used in ginger production. The average farm size of 1.85 hectares indicated that ginger production was predominantly practiced on a small holder scale, consistent with reports by Ackom *et al.* (2025). Inputs of seed, fertiliser and labour were moderate but variation among farmers suggest difference in management practices, which may explain observed efficiency differences (Adewale and Aregbesola, 2025).

Table 1: Farm characteristics and input use

Variable	Mean	Minimum	Maximum
Farm size (ha)	1.85	0.50	4.20
Seed (kg)	620	200	1,200
Fertilizer (kg)	185	50	400
Labour (man-days)	95	40	180
Agrochemicals (Litres)	6.5	2.0	12.0

Source: Survey data (2026)

Ginger Production Profitability

The result in Table 2 showed a total cost of ₦230, 000 and a corresponding revenue of ₦420,000 with a net farm income of ₦190,000. An ROI of 82.6%, meant that for every ₦1 invested in production, ₦0.83 was made as profit. In other words, you get your investment back and make an additional 82.6%. This was a strong ROI for agricultural enterprises. The farm was profitable, and returns significantly outweighed the costs. A benefit-cost ratio of 1.83 is a positive indicator, showing that \$1.83 in revenue is generated for every \$1 spent. Such figures showed that current farm management and production practices were efficient and profitable.

Table 2: Costs and return analysis (₦ per hectares)

Item	Value (₦)
Total Variable Cost	185,000
Total Fixed cost	45,000
Total Cost (TC)	230,000
Total Revenue (TR)	420,000
Net Farm Income (NTI)	190,000
Benefit-Cost Ratio	1.83
Return on Investment (ROI)	82.6%

Factors Affecting Ginger Production

The stochastic frontier production function in Table 3 showed that farm size, seed quantity, fertilizer, and labour had a significant impact on ginger output (Ibrahim *et al.*, 2022; Eze *et al.*, 2023). Farm size and seed quantity were found to be the most influential, indicating that increasing land area under cultivation and using adequate planting materials could substantially increase production. The gamma (γ) value of 0.81 suggested that 81% of the output variation could be attributed to inefficiency instead of random factors, emphasizing the importance of better resource management (Chimillia and Layero, 2022).

Table 3: Estimated Stochastic Frontier Production Function

Variable	Coefficient	Standard Error	t-value	Significance
Constant	1.245	0.312	3.99	***
Farm size	0.462	0.105	4.40	***
Seed	0.318	0.087	3.65	***
Fertilizer	0.214	0.072	2.97	**
Labour	0.156	0.065	2.40	**
Sigma-squared	0.521	0.110	-	-
Gamma (γ)	0.81	0.07	-	-

*** = 1%, ** = 5% significance level

Determinants of Economic Inefficiency

The inefficiency model in Table 4 showed that increase in age (0.021), education (-0.315), farming experience (-0.228), access to credit (-0.410), and extension services (-0.372) significantly reduced inefficiency, echoing findings by Chikezie *et al.* (2022) and Ndubueze-Oparaku *et al.* (2021). When farmers are educated and experienced, they are more efficient because they could make better decisions and allocate resources better. Access to credit allowed the timely procurement of inputs, while extension services enhanced knowledge of modern production practices, aligning with Mathew *et al.* (2024).

Table 4: Determinants of Economic Inefficiency

Variable	Coefficient	Standard Error	t-value	Significance
Constant	0.842	0.265	3.18	***
Age	0.021	0.009	2.33	**
Education	-0.315	0.102	-3.09	***
Farming Experience	-0.228	0.088	-2.59	**
Access to Credit	-0.410	0.135	-3.04	***
Extension Contact	-0.372	0.120	-3.10	***

Farmer Efficiency Levels

As a result, Figure 2 showed the distribution of economic efficiency of farmers. The mean economic efficiency of 0.68 indicated moderate farmer efficiency and potential to increase output

by approximately 32% using existing resources. Most farmers are within the 0.60–0.79 efficiency range, which implied that they achieve 60% to 70% of the maximum possible outcome given their current resources and technology, as consistent with Ackom *et al.* (2025).

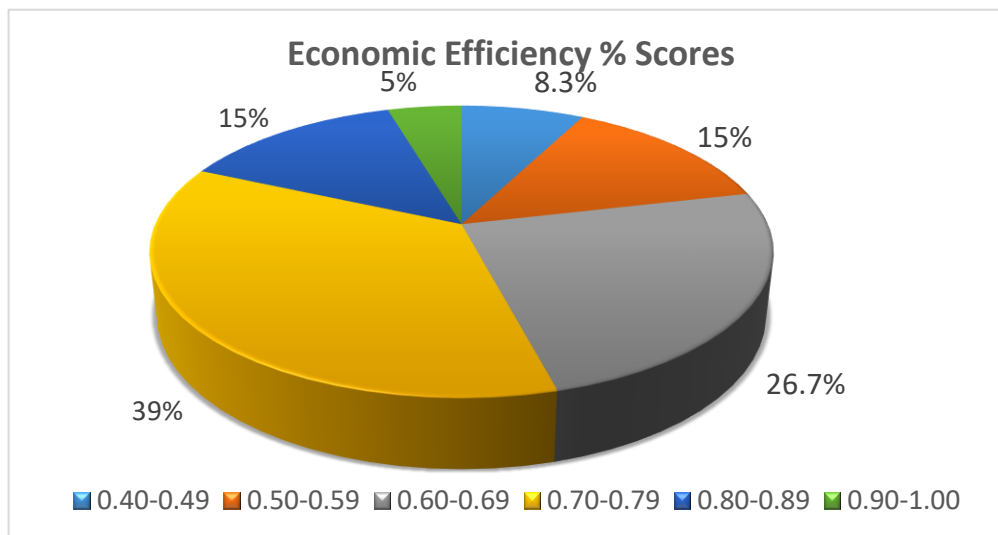


Figure 2: Distribution of economic efficiency of farmers

Constraint to Ginger Production

The major constraints in Table 5 identified were high cost of inputs (3.85), Inadequate credit (3.81), pest and disease challenges (3.48) and poor infrastructure (3.36) which affirmed the observations of Mahmud (2022); Adewale and Aregbesola (2025). These factors limit farmers' ability to achieve optimal efficiency and productivity.

The results revealed that ginger production was profitable but inefficiencies existed due to socio-economic and institutional constraints. Availability of credit, extension services, education, and farming experience increased efficiency significantly, whereas limitations on inputs, poor infrastructure, and pest/disease problems reduced productivity. Addressing these constraints through targeted interventions could greatly improve resource use efficiency, output, and farmer income (Pushpa *et al.*, 2022; Osinowo and Tolorunju, 2019; Olagunju *et al.*, 2021).

Table 5: Constraints to Ginger Production (n=120)

Challenges	Very serious	Serious	Moderate	Minor	Not a problem	Top box	Mean	Ranking
High cost of inputs	34(28.3%)	53(44.2%)	20(16.7%)	8(6.7%)	5 (4.2%)	72.5	3.85	1 st
Poor infrastructure	25(20.8%)	47(39.2%)	30(25%)	12(10%)	6 (5%)	60.0	3.36	4 th
Limited financial literacy	10(8.3%)	35(29.2%)	27(22.5%)	22(18.3%)	26(21.7%)	37.5	2.59	7 th
Inadequate improved seeds	11(9.2%)	46(38.3%)	31(25.8%)	21(17.5%)	11 (9.2%)	47.5	3.04	5 th
Inadequate extension services	15(12.5%)	30(25%)	25(20.8%)	30(25%)	20(16.7%)	37.5	2.92	6 th
Inadequate credit	31(25.8%)	53(44.2%)	23(19.2%)	8(6.7%)	5 (4.2%)	70	3.81	2 nd
Pest and disease	23(19.2%)	34(28.3%)	44(36.7%)	12(10%)	7 (5.8%)	47.5	3.48	3 rd

CONCLUSION AND RECOMMENDATIONS



Based on findings, the results showed that ginger farming was a profitable venture with positive net farm income and benefit-cost ratio. This profitability, however, does not imply optimum efficiency levels of the farmers, as average economic efficiency was found to be 0.68. This indicated that there was a significant scope for improving resource use, as the farmers could increase output by around 32% without necessarily increasing input levels.

The stochastic frontier analysis showed that the main determinants of ginger output were farm size, quantity of seeds, fertiliser, and labour. Moreover, the socio-economic factors such as education, experience of farming, credit access, and extension services were also found to significantly influence efficiency levels. Farmers who had better access to these resources and services were more efficient in their production practices.

However, a number of constraints still limited optimal productivity. These were high costs of inputs, inadequate access to credit, pest and disease challenges, poor infrastructure, and limited access to improved planting materials. These challenges resulted in inefficiencies and limited the overall performance of ginger farmers in the study area. Conclusively, ginger production has high economic potential in Delta State, but it is important to improve efficiency among farmers in order to maximize productivity and income. Based on the findings, the following recommendations were made:

- i. Credit should be made available and affordable to farmers by government and financial institutions. This would enable them to buy quality inputs and to adopt improved technologies.
- ii. Extension services should be strengthened to provide farmers with up-to-date information on best agronomic practices, pest control, and resource management.
- iii. The government should provide subsidies for key inputs such as improved seeds, fertilizers and agrochemicals to lower production costs and encourage increased use.
- iv. Organization of training programs and workshops to improve the knowledge, skills and managerial capabilities of farmers.
- v. Investment in roads, storage facilities, and market access would reduce post-harvest losses and improve profitability.
- vi. Promote the organization of farmers in cooperatives or their affiliation with cooperatives, in order to improve access to credit, inputs, and market opportunities.

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