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Effects of Socioeconomic and Institutional Characteristics on Profit Efficiency of Maize Farmers in Ogun State, Nigeria

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Abstract
Improving the profitability and efficiency of maize production is essential for enhancing farmers' livelihoods and strengthening food security in Nigeria. This study examined the effects of socioeconomic and institutional characteristics on the profit efficiency of maize farmers in Ogun State, Nigeria, with particular attention to farmers cultivating traditional varieties, improved varieties, and both varieties. The study employed cross-sectional data collected from 240 maize farmers through a structured questionnaire. Descriptive statistics were used to describe the socioeconomic and institutional characteristics of the respondents, while a Cobb–Douglas stochastic frontier profit model estimated by maximum likelihood was used to assess profit efficiency and identify the socioeconomic and institutional factors associated with profit inefficiency. The results revealed substantial differences in profit efficiency across the three variety categories, with mean efficiency scores of 0.418, 0.838, and 0.810 for traditional-variety, improved-variety, and both-variety farmers, respectively. Analysis of variance confirmed that the differences in profit efficiency across the variety categories were statistically significant ($F = 7.804$; $p<0.001$). The socioeconomic variables exerted heterogeneous effects on profit inefficiency. Gender significantly reduced profit inefficiency among traditional- and improved-variety farmers, while age significantly reduced inefficiency among improved-variety farmers. Household size reduced inefficiency among traditional-variety farmers but increased among improved and both-variety farmers. Farming experience significantly increased inefficiency among traditional-variety farmers, whereas education significantly increased inefficiency among farmers cultivating both varieties. Institutional factors also exhibited category-specific effects. Cooperative membership significantly reduced profit inefficiency among traditional-variety farmers, while extension contact significantly increased inefficiency among improved-variety farmers. Access to storage facilities significantly increased inefficiency among both traditional and improved-variety farmers, whereas credit access was not statistically significant across the relevant models. The findings demonstrate that socioeconomic and institutional characteristics influence maize farmers' profit efficiency in different ways depending on the variety-production category. The study therefore recommends targeted extension services, stronger farmer cooperatives, improved access to productive resources and market-oriented storage facilities, and farmer-specific management interventions to enhance profit efficiency, particularly among traditional-variety farmers.

Keywords: Improved maize varieties; institutional characteristics; Nigeria; Ogun State; profit efficiency; socioeconomic characteristics; stochastic frontier profit function; traditional maize varieties.

1. Introduction

Maize is one of the most important cereal crops in Nigeria, serving as food, livestock feed, industrial raw material, and a source of farm income. Despite its importance, maize profitability remains constrained by inefficient resource use, inadequate access to productive services, market imperfections, and differences in farmers' managerial capabilities - particularly among smallholders operating under heterogeneous socioeconomic and institutional conditions.

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Profit efficiency provides a broader measure of farm performance than physical productivity because it reflects a farmer's ability to attain maximum possible profit given prevailing prices and available technology. A farmer may achieve reasonable output while remaining profit-inefficient if inputs are poorly allocated, costs are excessive, or market opportunities are underexploited. The stochastic frontier profit approach is therefore useful for identifying the gap between observed and potential profitability and for examining the farmer-specific characteristics associated with that gap (Aigner et al., 1977; Battese & Coelli, 1995).

Socioeconomic characteristics—age, education, farming experience, household size, and gender—

influence farmers' managerial decisions, access to resources, and capacity to process technical and market information. Institutional characteristics—cooperative membership, extension contact, credit access, and storage facilities—also shape farmers' access to inputs, information, finance, and markets. Previous empirical evidence indicates that these factors significantly influence agricultural efficiency, but their effects are not necessarily uniform across production systems (Langvintuo, 2020; Wongnaa et al., 2019; Kehinde & Tijani, 2023).

In Ogun State, maize farmers operate under three identifiable production arrangements: traditional varieties, improved varieties, and a combination of both. These groups differ substantially in socioeconomic profile. Traditional-variety farmers had a mean age of 46 years and mean farming experience of 14.7 years, compared with 28 years and 6.2 years respectively among improved-variety farmers. Farmers cultivating both varieties had the highest average farming experience (19.6 years). Such heterogeneity suggests that a uniform policy approach may be inadequate.

This study therefore examines the extent to which socioeconomic and institutional characteristics influence profit efficiency among maize farmers in Ogun State, while explicitly recognizing differences across production systems.

1.1 Objectives of the Study

The study specifically seeks to:

1. Examine the socioeconomic and institutional characteristics of maize farmers in Ogun State;
2. Determine the influence of socioeconomic characteristics on profit efficiency among traditional, improved, and mixed-variety maize farmers; and
3. Examine the influence of institutional characteristics on profit efficiency across the three maize production systems.

1.2 Hypothesis

The null hypothesis is:

H_0: Socioeconomic and institutional characteristics have no significant influence on the profit efficiency of maize farmers in Ogun State.

2. Methodology

2.1 Study Area and Sampling

The study was conducted among maize farmers in Ogun State, Nigeria. A multistage sampling procedure was employed to select respondents cultivating traditional maize varieties, improved maize varieties and both varieties. The final sample consisted of 240 farmers, comprising 90 traditional-variety farmers, 85 improved-variety farmers and 65 farmers cultivating both varieties.

Primary data were collected using a structured questionnaire. The instrument captured socioeconomic characteristics, farm characteristics, input use, output, costs, revenue and institutional variables, including cooperative membership, extension contact, credit access and storage access. The dissertation confirms that the questionnaire specifically collected these variables.

2.2 Analytical Framework

The study adopts the stochastic frontier profit function because the central interest is not merely whether farmers make profit but whether they achieve the maximum attainable profit under prevailing production and market conditions.

2.2.1 Stochastic Frontier Profit Function

Following the standard normalized profit frontier specification (Aigner, Lovell, & Schmidt, 1977; Battese & Coelli, 1995), the general stochastic frontier profit function is specified as:

$$\ln \pi_i = \beta_0 + \sum_{j=1}^{k} \beta_j \ln X_{ji} + V_i - U_i$$

where:

π_i= normalized profit of farmer i;(gross profit divided by output price)

X_{ji}= production inputs and other frontier variables (seed, fertilizer, herbicide, pesticide, labour, farm size, transportation);

β_j= parameters to be estimated;

V_i= random error term, assumed independently and identically distributed as $\boldsymbol{N(0, \sigma_V^2)}$

U_i= non-negative profit inefficiency term, assumed independently distributed as a truncation at zero of the normal distribution $\boldsymbol{N(U_i, \sigma_V^2)}$

2.2.2 Inefficiency Effects Model

The inefficiency component is specified as a function of farmer socioeconomic and institutional characteristics:

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \cdots + \delta_8 Z_{8i} + Wi$$

where:

Z_{1i} = age (years);
Z_{2i} = education (years of formal schooling);
Z_{3i} = household size (number of persons);
Z_{4i} = sex/gender (1 = male; 0 = female);
Z_{5i} = cooperative membership (1 = member; 0 = otherwise);
Z_{6i} = farming experience (years);
Z_{7i} = extension contact (1 = contact; 0 = otherwise);
Z_{8i} = credit access (1 = access; 0 = otherwise);
δ = vector of parameters to be estimated;
Wi = random error term.

Certainly. I would refine the section for academic flow, statistical precision, and consistency with your stochastic profit frontier model as follows:

2.2.3 Variance Parameters and Model Estimation

The variance parameters of the stochastic profit frontier model are specified as:

$$\sigma^2 = \sigma_V^2 + \sigma_U^2$$

and

$$\gamma = \frac{\sigma_U^2}{\sigma_V^2 + \sigma_U^2}$$

where σ^2represents the total variance of the composite error term, σ_V^2denotes the variance of the random statistical noise, and σ_U^2represents the variance associated with profit inefficiency. The parameter γ, which lies within the interval $0 \leq \gamma \leq 1$, measures the proportion of the total error variance attributable to the inefficiency component. A value of $\gamma = 0$indicates that the error term contains no systematic inefficiency component, in which case the model reduces to a conventional regression framework. Conversely, as γapproaches unity, an increasing proportion of the variation in the composite error term is attributable to profit inefficiency rather than random statistical noise.

The parameters of the stochastic profit frontier and the associated inefficiency-effects model were estimated simultaneously using the Maximum Likelihood (ML) estimation technique. The estimation was implemented using FRONTIER 4.1 software developed by Coelli (1996). The simultaneous estimation procedure allows the parameters of the profit frontier and those explaining variations in profit inefficiency to be obtained within a single likelihood framework.

To determine whether profit inefficiency effects are present in the model, a Likelihood Ratio (LR) test was employed. The null hypothesis was specified as:

$$H_0: \gamma = \delta_0 = \delta_1 = \delta_2 = \cdots = \delta_8 = 0$$

against the alternative hypothesis:

H_1:At least one of the inefficiency parameters is non-zero Under the null hypothesis, the model assumes that there are no systematic profit inefficiency effects, implying that deviations from the frontier are attributable solely to random statistical noise. Rejection of the null hypothesis provides evidence of the presence of significant profit inefficiency effects among the maize farmers. The LR statistic is computed as:

$$LR = -2[\ln L\,(H_0) - \ln L\,(H_1)]$$

where $\ln L\,(H_0)$and $\ln L\,(H_1)$are the maximised log-likelihood values under the null and alternative hypotheses, respectively. The calculated LR statistic is compared with the appropriate critical value to determine whether the null hypothesis should be rejected. This procedure provides a basis for establishing the appropriateness of the stochastic frontier specification for analysing differences in profit efficiency among traditional and improved maize variety farmers.

2.2.4 Profit Efficiency Estimation

Profit efficiency for farmer $i$is estimated as:

$$\boxed{PE_i = \exp(-U_i)}$$

where PE_irepresents the profit efficiency score of farmers i, while $U_i$denotes the non-negative profit inefficiency term. The value of PE_iranges from 0 to 1. A value of $PE_i = 1$indicates that the farmer is fully profit-efficient and operates on the estimated profit frontier, while values closer to zero indicate increasing levels of profit inefficiency.

2.2.5 Analysis of Variance (ANOVA) Model

To test whether mean profit efficiency differs significantly among traditional, improved, and both maize variety farmers, a one-way ANOVA model was specified as:

$$\boxed{PE_{ik} = \mu + \tau_k + \varepsilon_{ik}}$$

where $PE_{ik}$is the profit efficiency of farmer $i$in variety category k; $\mu$is the overall mean profit efficiency; $\tau_k$is the effect of the k-th variety category $(k, =, 123)$; and $\varepsilon_{ik}$is the random error term, assumed to follow $N(0, \sigma^2)$.

The hypotheses were specified as:

$$H_0: \tau_1 = \tau_2 = \tau_3 = 0$$

against

H_1:At least one category mean differs.

The ANOVA test statistic is:

$$\boxed{F = \frac{MS_{\text{between}}}{MS_{\text{within}}}}$$

with $(k-1)$and $(N-k)$degrees of freedom. The result, $F = 7.804$ with $p < 0.001$, indicates a statistically significant difference in mean profit efficiency among the three variety categories.

2.2.6 Interpretation of Inefficiency Effects

Since $U_i$represents profit inefficiency, the estimated coefficients in the inefficiency-effects model are interpreted inversely in relation to profit efficiency:

i. A **negative coefficient** indicates a reduction in profit inefficiency and, consequently, an increase in profit efficiency.
ii. A **positive coefficient** indicates an increase in profit inefficiency and, consequently, a reduction in profit efficiency.
iii. The **statistical significance** of the coefficient determines whether the observed relationship is statistically supported by the data.

3. Results

3.1 Socioeconomic Characteristics of Maize Farmers

The descriptive results shown considerable socioeconomic heterogeneity among the three farmer categories. Traditional-variety farmers were substantially older than improved-variety farmers, with

Table 1: Socioeconomic Characteristics of Maize Farmers by Production System

Variable	Traditional n (%)	Improved n (%)	Both n (%)
Age (years)			
≤30	9 (10.00)	80 (94.12)	—
31–40	7 (7.78)	—	—
41–50	32 (35.56)	1 (1.18)	55 (84.62)
51–60	37 (41.11)	1 (1.18)	10 (15.38)
>61	5 (5.56)	3 (3.53)	—
Mean age	46	28	43
Male	61 (67.78)	4 (4.71)	27 (41.54)
Female	29 (32.22)	81 (95.29)	38 (58.46)
Mean household size	6	2	5
Mean farming experience (years)	14.7	6.2	19.6
Mean farm size (ha)	6.3	2.8	7.6

Source: Field Survey, 2025.

Table 2: Institutional Characteristics of Maize Farmers by Variety Category

Institutional characteristic	Traditional n (%)	Improved n (%)	Both n (%)
Cooperative membership			
Non-member	13 (14.44)	6 (7.06)	0 (0.00)
Member	77 (85.56)	79 (92.94)	65 (100.00)
Extension contacts			
No extension contacts	13 (14.44)	6 (7.06)	0 (0.00)
Extension contacts	77 (85.56)	79 (92.94)	65 (100.00)
Credit access			
No access	13 (14.44)	6 (7.06)	0 (0.00)
Access	77 (85.56)	79 (92.94)	65 (100.00)
Access to storage facilities			
No access	13 (14.44)	6 (7.06)	0 (0.00)
Access	77 (85.56)	79 (92.94)	65 (100.00)

Source: Field Survey, 2025.

mean ages of 46 and 28 years, respectively, while farmers cultivating both varieties had a mean age of 43 years. Improved-variety farmers were overwhelmingly concentrated in the youngest age category, with 94.12% aged 30 years or below.

Gender composition was also markedly different. Traditional maize production was male dominated, with males accounting for 67.78% of farmers, whereas females represented 95.29% of farmers cultivating improved varieties. Among farmers cultivating both varieties, females constituted 58.46%.

Farm-related characteristics further demonstrate substantial heterogeneity. Traditional-variety farmers had an average farming experience of 14.7 years and farm size of 6.3 ha, while improved-variety farmers recorded much lower averages of 6.2 years and 2.8 ha, respectively. Farmers cultivating both varieties recorded the highest average farming experience (19.6 years) and farm size (7.6 ha).

3.2 Institutional Characteristics of Maize Farmers

Table 2 shows the institutional characteristics of maize farmers across the traditional, improved, and both-variety production categories. The results indicate a generally high level of institutional participation among the sampled farmers, although the pattern varies across the different institutional indicators.

Regarding cooperative membership, the majority of farmers in all three categories were cooperative members. Among traditional-variety farmers, 77 (85.56%) belonged to cooperatives, compared with 79 (92.94%) of improved-variety farmers and 65 (100.00%) of farmers cultivating both traditional and improved varieties. Only 14.44% of traditional-variety farmers and 7.06% of improved-variety farmers were non-members, while no non-member was recorded among farmers cultivating both varieties. The relatively high cooperative participation suggests that collective organization constitutes an important institutional feature of maize farming in the study area and may facilitate access to information, inputs, markets and other agricultural support services.

With respect to extension contact, the table indicates that 77 (85.56%) of traditional-variety farmers, 79 (92.94%) of improved-variety farmers and 65 (100.00%) of farmers cultivating both varieties had extension contact. Conversely, 14.44% of traditional-variety farmers and 7.06% of improved-variety farmers had no extension contact. The relatively higher proportion of extension contact among improved-variety farmers is noteworthy because improved varieties generally require farmers to possess appropriate knowledge of recommended agronomic practices for their effective utilization. The complete extension contact reported among farmers cultivating

Table 3: Estimated Effects of Socioeconomic and Institutional Characteristics on Profit Inefficiency of Maize Farmers

Variable	Traditional Coefficient	Improved Coefficient	Both Coefficient
Age	-0.011	-0.002***	0.399
Gender	-1.252**	-0.454***	-4.414
Level of education	-0.083	-0.004	0.079***
Household size	-0.379***	0.014***	0.750**
Farming experience	0.099***	0.005	-0.345
Cooperative membership	-2.234***	0.000	—
Extension visit/contact	-0.026	0.123***	0.116
Credit access	0.505	0.000	0.000
Access to storage facilities	2.576***	0.251***	-0.292
Constant	3.377	-2.144***	-154.495
Sigma²	0.442***	0.822***	0.818
Gamma (γ)	0.297***	0.117***	0.011

Notes: ***, ** and * denote significance at 1%, 5% and 10%, respectively. A dash (—) indicates that the parameter was not estimated/reported in the original model.
Source: Field Survey, 2025.

both varieties also indicates substantial institutional engagement within this category.

For credit access, 77 (85.56%) of traditional-variety farmers, 79 (92.94%) of improved-variety farmers and all 65 (100.00%) of farmers cultivating both varieties were reported to have access to credit, while 14.44%, 7.06% and 0.00%, respectively, had no access. This pattern suggests relatively broad access to agricultural finance among the sampled farmers. Improved-variety farmers and farmers cultivating both varieties recorded higher levels of credit access than traditional-variety farmers, which may facilitate timely acquisition of seed and other production inputs and potentially support more efficient farm resource management.

Similarly, access to storage facilities was reported for 77 (85.56%) of traditional-variety farmers, 79 (92.94%) of improved-variety farmers and 65 (100.00%) of farmers cultivating both varieties. The corresponding proportions without access were 14.44%, 7.06% and 0.00%, respectively. Access to storage facilities is particularly relevant to profit efficiency because appropriate storage can reduce post-harvest losses and provide farmers with greater flexibility in deciding when to sell their produce. The higher reported access among improved and both-variety farmers may therefore contribute to their ability to manage production and marketing decisions more effectively.

Overall, the results show that institutional participation was relatively high across the three variety categories, with farmers cultivating both traditional and improved varieties recording the highest reported participation across all four institutional indicators. Improved-variety farmers also generally recorded higher institutional participation than traditional-variety farmers. These differences provide an important basis for examining whether institutional characteristics are associated with variations in profit efficiency. This is particularly relevant to the subsequent econometric analysis, where cooperative membership, extension contact, credit access and storage facilities are considered among the factors potentially influencing profit inefficiency.

3.3 Effects of Socioeconomic and Institutional Characteristics on Profit Inefficiency

As shown in Table 3, the estimated effects of socioeconomic and institutional characteristics on profit inefficiency across traditional, improved and mixed-variety maize farmers. The results demonstrate that the factors associated with profit inefficiency differ substantially across the three farmer categories, indicating that a uniform institutional policy may not produce identical efficiency outcomes across production systems.

Among traditional-variety farmers, gender, household size, farming experience and cooperative membership were statistically significant determinants of profit inefficiency. Gender had a negative and significant coefficient (−1.252), indicating that the category coded as the higher value of the gender variable was associated with lower predicted inefficiency, holding other factors constant. Household size also had a negative and significant coefficient (−0.379), suggesting an association with reduced inefficiency. In contrast, farming experience had a positive and significant coefficient (0.099), implying increased inefficiency as experience increased within the estimated model. Cooperative membership recorded a relatively large negative coefficient (−2.234), indicating an important association between cooperative participation and reduced profit inefficiency among traditional-variety farmers.

For improved-variety farmers, age, gender, household size, extension contact and access to storage facilities were statistically significant. Age had a negative coefficient (−0.002), while gender also had a negative and highly significant coefficient (−0.454). Household size had a positive and significant coefficient (0.014), indicating an association with increased inefficiency. Extension contact was positive and significant (0.123), while access to storage facilities was also positive and significant (0.251). These findings suggest that

Table 4: Profit Efficiency across Maize Variety Categories

Variety category	Sample size (n)	Mean profit efficiency	Standard deviation	Minimum	Maximum
Traditional varieties	90	**0.418**	0.304	0.030	0.999
Improved varieties	85	**0.838**	0.183	0.247	0.999
Both varieties	65	**0.810**	0.276	0.190	0.991
ANOVA	**240**				
F-statistic		**7.804***			
p-value		**<0.001**			

Note: * indicates significance at 1%.
Source: Field Survey, 2025.

institutional variables do not necessarily reduce inefficiency automatically; their effects depend on how the services and resources are accessed and utilized within the particular production system.

For farmers cultivating both traditional and improved varieties, educational attainment and household size were the statistically significant socioeconomic determinants. Education had a positive and significant coefficient (0.079), while household size was also positive and significant (0.750). The remaining institutional variables were statistically insignificant in this model. The relatively small number of significant institutional effects in the mixed-variety group may reflect differences in the production strategies and resource-use patterns of farmers combining both varieties.

A particularly important finding is that the direction and significance of institutional effects vary across variety categories. This demonstrates that socioeconomic and institutional characteristics should not be treated as universally efficiency-enhancing factors. Rather, their effects are conditional on the production system and the circumstances under which farmers cultivate maize.

3.4 Profit Efficiency across Maize Variety Categories

Table 4 shows substantial differences in profit efficiency across the three maize variety categories. Traditional-variety farmers recorded the lowest mean profit efficiency of 0.418, indicating that, on average, they operated considerably below the estimated profit frontier. Improved-variety farmers recorded the highest mean profit efficiency of 0.838, while farmers cultivating both traditional and improved varieties recorded a mean profit efficiency of 0.810. In percentage terms, these correspond to 41.8% efficiency among traditional-variety farmers, 83.8% among improved-variety farmers, and 81.0% among farmers cultivating both varieties. Thus, a substantial efficiency gap exists between traditional-variety farmers and the other two categories.

The standard deviation also indicates differences in the dispersion of efficiency scores. Improved-variety farmers recorded the lowest standard deviation (0.183), suggesting relatively greater concentration of farmers around their mean efficiency level. Traditional-variety farmers had a standard deviation of 0.304, while the mixed-variety group recorded 0.276, indicating greater heterogeneity in efficiency performance.

The ANOVA result confirms that the observed differences in mean profit efficiency across the three groups are statistically significant ($F = 7.804$; $p<0.001$). Therefore, the differences cannot reasonably be attributed solely to random sampling variation. The result provides empirical support for examining variety choice together with socioeconomic and institutional characteristics when explaining differences in maize farmers' profit efficiency.

4. Discussion

4.1 Socioeconomic Characteristics and Profit Inefficiency

Socioeconomic characteristics significantly influenced profit inefficiency, but their effects were heterogeneous across the three variety categories. This indicates that demographic attributes interact with production choices and resource endowments rather than operating uniformly.

Gender significantly reduced inefficiency among traditional-variety farmers (-1.252; $p< 0.05$) and improved-variety farmers (-0.454; $p < 0.01$), though it was insignificant in the both-variety model. The descriptive results provide context: traditional-variety production was male-dominated (67.78%), while improved-variety production was overwhelmingly female (95.29%). The finding that women dominate improved-maize production demonstrates that female farmers are not excluded from improved-technology systems, and it supports the argument that gender should be treated as a factor influencing access to productive resources and information rather than merely a demographic variable (Olashehinde et al., 2023; Hailemariam et al., 2024).

Age was insignificant among traditional-variety farmers but negative and significant among improved-variety farmers (-0.002; $p< 0.01$), suggesting that older farmers manage improved technologies more effectively, possibly through accumulated managerial knowledge. This extends the literature on age and innovation adoption (Oluwatomi, 2024) by showing that age can influence not only adoption decisions but also the efficiency with which adopted technologies are converted into returns.

Household size was significant in all three models but with contrasting directions. It reduced inefficiency among traditional-variety farmers (−0.379; p< 0.01), consistent with the family-labour advantage in labour-intensive traditional systems. However, it increased inefficiency among improved-variety (0.014; p< 0.01) and both-variety (0.750; p< 0.05) farmers, suggesting that additional household members increase consumption pressure more than they contribute productive labour. This contrasts with evidence from Kenya (Uasin Gishu) where larger households reduced inefficiency, highlighting the importance of context in interpreting household-size effects (Olasehinde et al., 2023).

Farming experience increased inefficiency among traditional-variety farmers (0.099; p< 0.01), implying that long-established routines may reinforce existing practices rather than encourage profit-maximizing adjustments. This supports the argument that experience is not a substitute for continuous learning (Asfaw et al., 2012; Teklewold et al., 2013).

Education was insignificant in the traditional- and improved-variety models but positive and significant among both-variety farmers (0.079; p< 0.01). This suggests that formal education alone does not provide the agricultural-specific managerial knowledge required to manage multiple production technologies efficiently (Manda et al., 2020). The result highlights the distinction between general human capital and agricultural-specific human capital.

Overall, the heterogeneity confirms that socioeconomic characteristics cannot be treated as uniformly efficiency-enhancing or efficiency-reducing; their effects depend on the production system and farmers' resource circumstances.

4.2 Institutional Characteristics and Profit Inefficiency

Institutional variables also exerted heterogeneous effects, demonstrating that access does not automatically translate into efficiency gains.

Cooperative membership significantly reduced inefficiency among traditional-variety farmers (−2.234; p< 0.01), consistent with the role of collective action in improving access to inputs, information, credit, and markets (Langvintuo, 2020; Kehinde & Tijani, 2023). It was insignificant among improved-variety farmers and not estimable among both-variety farmers because all were members a lack of variation rather than evidence of no effect.

Extension contact was insignificant among traditional-variety and both-variety farmers but positive and significant among improved-variety farmers (0.123; p < 0.01). While counterintuitive, this may reflect reverse causality (farmers facing problems seek extension) or insufficient quality/frequency of contact. This contrasts with findings in Bangladesh and Ghana where extension enhanced efficiency (Adnan et al., 2021; Wongnaa et al., 2019), suggesting that contact alone is insufficient without relevant, timely, and practical advice.

Storage access was positive and significant among traditional-variety (2.576; p<0.01) and improved-variety (0.251; p< 0.01) farmers, and insignificant among both-variety farmers (−0.292; p< 0.638). This indicates that physical access to storage does not guarantee efficient use; quality, cost, and market information determine whether storage translates into economic gains (Shao & Marwa, 2025).

Credit access was statistically insignificant in all models. This does not imply credit is unimportant but suggests that nominal access alone is insufficient; the amount, cost, timing, and utilization of credit matter (Langvintuo, 2020; Jimoh et al., 2023).

Overall, institutional interventions should shift from access-oriented to effectiveness-oriented policies, emphasizing quality, relevance, and utilization rather than mere availability.

4.3 Differences in Profit Efficiency across Variety Categories

Mean profit efficiency differed substantially and significantly across variety categories: 0.418 (traditional), 0.838 (improved), and 0.810 (both); F = 7.804; p< 0.001. The distributional evidence reinforces this: 64.44% of traditional-variety farmers had efficiency ≤ 0.50, compared with 4.71% of improved-variety and 18.46% of both-variety farmers; only 10.00% of traditional-variety farmers exceeded 0.90, compared with 54.12% and 64.62% respectively. These findings are consistent with evidence that improved maize technologies generate superior economic returns (Khan et al., 2023; Garba et al., 2019; Obeng-Ackah et al., 2023; Kassie et al., 2018; Takahashi et al., 2020; Ngeno, 2024). However, they should not be interpreted as a purely causal effect of variety choice, since farmers differ in access to information, institutions, inputs, and managerial capacity. The high efficiency of both-variety farmers (0.810) suggests that varietal diversification does not compromise efficiency and may serve risk-management and market objectives.

Policy should therefore target traditional-variety farmers, who have the greatest scope for improvement, while recognizing that improved-seed promotion must be accompanied by complementary inputs, extension advice, and market support (Austin et al., 2023).

4.4 Policy Implications

The findings support a differentiated, integrated policy strategy:

1. Promote effective access to improved varieties with varietal-selection and agronomic information.
2. Implement gender-responsive extension and input programmes.
3. Promote labour-saving technologies and productive

use of family labour.
4. Include experienced farmers in continuous training to update established practices.
5. Provide agricultural-specific training in budgeting, input allocation, and marketing.
6. Strengthen cooperatives, particularly among traditional-variety farmers.
7. Improve the quality, timing, and relevance of extension services.
8. Integrate storage interventions with market information and post-harvest management.
9. Focus credit policy on adequacy, affordability, and timely disbursement rather than nominal access.

5. Conclusion

This study examined the effects of socioeconomic and institutional characteristics on the profit efficiency of maize farmers in Ogun State, Nigeria, with particular attention to farmers cultivating traditional varieties, improved varieties, and both. Using data from 240 maize farmers and a stochastic frontier profit function estimated by maximum likelihood, the study established that substantial differences exist in farmers' ability to convert production resources into economic returns.

The results revealed a clear difference in profit efficiency across the three variety categories. Traditional-variety farmers recorded a mean profit efficiency of 0.418, compared with 0.838 for improved-variety farmers and 0.810 for farmers cultivating both varieties. The analysis of variance confirmed that these differences were statistically significant ($F = 7.804$; $p<0.001$). This indicates that considerable opportunities exist for improving the profitability of maize production, particularly among traditional-variety farmers. The relatively higher efficiency of improved-variety farmers suggests that the adoption and effective management of improved maize varieties may contribute to better economic performance, although technology alone does not fully determine profit efficiency.

The stochastic frontier estimates further showed that the effects of production inputs on normalized profit were mixed. Seed, herbicide, pesticide, and transportation had positive effects on normalized profit, while fertilizer, farm size, and labour recorded negative effects in the relevant model. These results demonstrate that increasing the quantity or expenditure on an input does not necessarily guarantee higher profit; profitability depends on efficient allocation and appropriate combination of production resources.

The study also established that socioeconomic characteristics significantly influenced profit inefficiency, although their effects varied across variety categories. Gender significantly influenced inefficiency among traditional- and improved-variety farmers, while age was significant among improved-variety farmers. Household size significantly influenced all three groups but with different directions, while farming experience was significant among traditional-variety farmers and education was significant among farmers cultivating both varieties. These findings demonstrate that socioeconomic characteristics do not have uniform effects on profit efficiency; their influence depends on the production system and the socioeconomic circumstances of individual farmers.

Similarly, institutional characteristics produced heterogeneous effects. Cooperative membership significantly reduced profit inefficiency among traditional-variety farmers, highlighting the potential importance of collective organization. Extension contact was significant among improved-variety farmers, although its positive coefficient indicates that contact alone did not necessarily translate into greater efficiency. Access to storage facilities was significant in the traditional- and improved-variety models but was positively associated with predicted inefficiency. Credit access was not statistically significant in the models. These findings suggest that the mere availability of institutional services is insufficient; the quality, accessibility, timing, and effective utilization of such services are equally important.

Overall, the study concludes that improving maize profit efficiency in Ogun State requires more than promoting improved varieties or increasing farmers' access to production inputs. Profit efficiency is shaped by the interaction between technology, resource allocation, socioeconomic conditions, and institutional support. Policies should therefore adopt a differentiated approach that strengthens access to quality improved seed, promotes efficient input use, improves the quality of extension services, strengthens farmer cooperatives, facilitates effective storage and market support, and provides practical farmer-oriented training. Particular attention should be given to traditional-variety farmers, who recorded the lowest mean profit efficiency and therefore have the greatest potential for efficiency improvement.

The study consequently recommends that agricultural development programmes in Ogun State should move towards farmer-specific and variety-sensitive interventions, rather than applying uniform strategies to all maize farmers. Such an approach will improve farmers' capacity to use available resources efficiently, enhance profitability, encourage appropriate technology adoption, and ultimately contribute to sustainable maize production, improved farm incomes, and food security in Ogun State and Nigeria.

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