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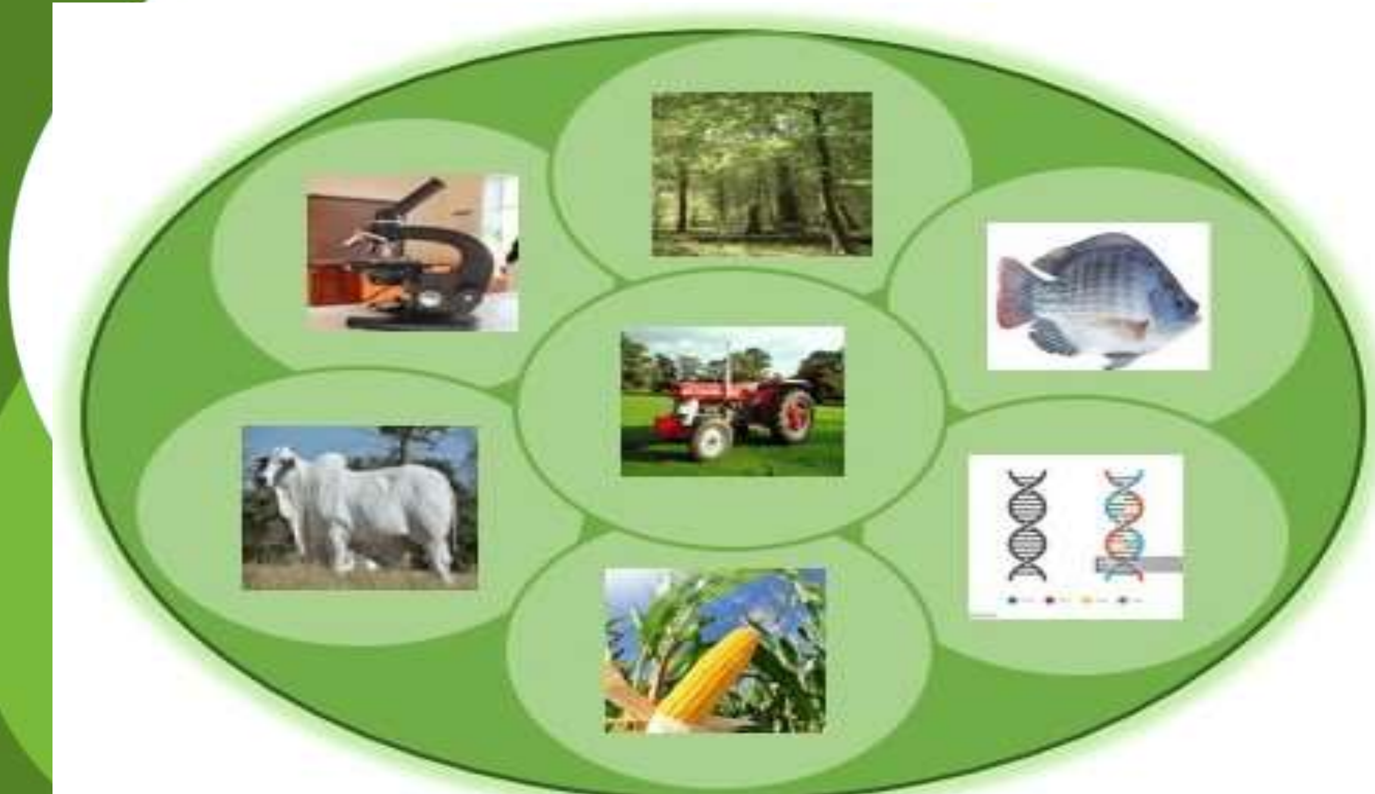

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CONTACT:
The Editor-in-Chief,
Kebbi Journal of Agriculture and Natural Sciences,
Faculty of Agriculture,
Abdullahi Fodio University of Science and Technology
Aliero,
PMB 1144, Birnin kebbi, Nigeria.
Email: kejaanseditor@ksusta.edu.ng,

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The Kebbi Journal of Agriculture and Natural Sciences has the sole aim of providing an intellectual platform and ideas for scholars, by promoting interdisciplinary studies related to agriculture and natural science through publishing the latest scientific research findings that are of direct policy implications and beneficial to the research community. Consequently, the journal covers all aspects of Crop Science, Animal Science, Agricultural Economics, Agricultural Extension and Rural Development, Food Science, Fisheries and Aquaculture, Biotechnology, Soil Science and Agricultural Engineering, Forestry and Environment, Wildlife, Agricultural Education, Agro-allied Industries as well as all Natural Science researches related to Agriculture.

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TECHNICAL EFFICIENCYOF MAIZE PRODUCTION AMONG SMALLHOLDER FARMERS IN SOUTHWEST NIGERIA

[1]Lasisi, Aminu Jacob, [2]Michael Chisonum and [3]Ugboh, Onyemaechi

[1-3] Department of Agricultural Economics and Extension, Faculty of Agriculture, University of Delta, P.M.B 2090, Agbor, Delta State. Nigeria

[1]jacob.lasisi@unidel.edu.ng | +2347038079730
[1]https://orcid.org/0009-0004-4781-3743

ABSTRACT

This study examined the technical efficiency of maize production among smallholder farmers in Southwest Nigeria, utilizing cross-sectional data from 384 randomly selected farmers across three states. The research employed a multi-stage sampling technique and analyzed data using stochastic frontier production function and Data Envelopment Analysis (DEA). Results revealed that the mean technical efficiency was 0.67, indicating that farmers could increase their output by 33% using existing technology and input levels. Farm size (β=0.342, p<0.01), fertilizer application (β=0.278, p<0.05), and labor input (β=0.224, p<0.05) significantly influenced technical efficiency. Age of farmers negatively affected efficiency (β=-0.156, p<0.01), while education level showed positive correlation (β=0.189, p<0.05). The study found that 62% of farmers operated below optimal efficiency levels, with smallholder farmers (≤2 hectares) achieving 58% efficiency compared to 74% for larger farms. Credit access improved efficiency by 28%, while extension service contact increased efficiency by 15%. The findings suggest significant potential for productivity improvement through enhanced resource allocation, improved farming techniques, and better access to agricultural support services.

Keywords**:** Technical efficiency, Maize production, Smallholder farmers, stochastic frontier analysis, Southwest Nigeria

Introduction

Agriculture remains the cornerstone of Nigeria's economy, employing approximately 70% of the rural population and contributing significantly to food security and poverty alleviation (Oluwole et al., 2021). Maize (Zea mays L.) stands as one of the most important cereal crops in Nigeria, serving as a staple food for millions and a vital source of livelihood for smallholder farmers across the country. In Southwest Nigeria, maize production has gained considerable prominence, with the region contributing approximately 35% of the country's total maize output (Christopher et al., 2019).

The significance of maize in Nigeria's agricultural landscape cannot be overstated. Beyond its role as a food security crop, maize serves as raw material for numerous agro-allied industries, including livestock feed production, brewing, and food processing (Adams, 2018). The crop's adaptability to various agro-ecological zones in Southwest Nigeria has made it an attractive option for smallholder farmers seeking to diversify their cropping systems and improve household incomes.

However, despite its importance, maize production in Southwest Nigeria faces numerous challenges that constrain its productivity and efficiency. Smallholder farmers, who constitute the majority of maize producers in the region, often operate under sub-optimal conditions characterized by limited access to improved seeds, fertilizers, credit facilities, and modern farming techniques (Adegoroye et al., 2021). These constraints have resulted in yield gaps that limit the sector's potential contribution to food security and economic development.

The concept of technical efficiency in agricultural production has gained increasing attention among researchers and policymakers as a crucial indicator of farm performance and resource utilization. Technical efficiency measures the ability of a farm to produce maximum output from a given set of inputs, or alternatively, to minimize input use for a given level of output (Barrett et al., 2018). Understanding the technical efficiency levels of smallholder maize farmers is essential for identifying opportunities for productivity improvement and designing targeted interventions to enhance agricultural performance.

Despite the strategic importance of maize production in Southwest Nigeria, several critical problems continue to undermine the sector's performance and limit its contribution to food security and economic development.

There exists a significant productivity gap among smallholder maize farmers in Southwest Nigeria, with many farmers achieving yields far below their potential. This productivity gap is attributed to inefficient resource utilization, poor farming practices, and limited access to modern agricultural technologies (Olubunmi-Ajayi & Amos, 2023). The inability of farmers to optimize their production processes results in suboptimal returns on investment and perpetuates rural poverty.

Smallholder maize farmers in the region face persistent challenges in accessing essential production inputs and support services. Limited access to credit facilities constrains farmers' ability to purchase improved seeds, fertilizers, and other productivity-enhancing inputs (Olutumise, 2023). Additionally, inadequate extension services limit farmers' exposure to best practices and modern farming techniques, further contributing to inefficient production systems.

There is insufficient empirical evidence on the determinants of technical efficiency in maize production among smallholder farmers in Southwest Nigeria. While several studies have examined various aspects of agricultural productivity in the region, comprehensive analyses of technical efficiency specifically focusing on maize production remain limited. This knowledge gap hinders the development of evidence-based policies and interventions aimed at improving agricultural productivity and farmer welfare.

The broad objective of this study is to analyze the technical efficiency of maize production among smallholder farmers in Southwest Nigeria and identify strategies for improvement.

The specific objectives are:

(i) to estimate the level of technical efficiency in maize production among smallholder farmers in Southwest Nigeria;

(ii) to identify the factors influencing technical efficiency in maize production among smallholder farmers and

(iii) to assess the relationship between farm size and technical efficiency in maize production

The study tested the following null hypotheses:

(H_{01}) There is no significant difference in technical efficiency levels between smallholder and medium-scale maize farmers in Southwest Nigeria. (**H_{02}**) Socioeconomic characteristics of farmers do not significantly influence technical efficiency in maize production.

This study contributes significantly to the existing body of knowledge on agricultural productivity and efficiency analysis in developing countries. The findings provide valuable insights for policymakers, agricultural development agencies, and farmer organizations seeking to enhance maize productivity and improve rural livelihoods in Southwest Nigeria.

For policymakers, the study established that input subsidy programs targeting credit-constrained farmers; implementing farmer field schools for improved agronomic practices; facilitating farmer cooperative formation to enhance market access and bargaining power; deploying mobile extension services using digital platforms; and creating demonstration plots showcasing high-yielding varieties and optimal fertilizer application rates will help to address inefficiencies in small holders maize production

The identification of key efficiency determinants provides guidance for resource allocation and program prioritization in agricultural development initiatives.

Agricultural extension agencies and development organizations can utilize these findings to design effective training programs including integrated pest management workshops, soil fertility assessment training, post-harvest loss reduction techniques, and climate-smart agriculture practices. The study reveals efficiency variations across farmer categories: younger farmers (18-35 years) demonstrate higher technical efficiency (0.78) than older farmers (0.62); farmers with secondary education achieve 24% better resource optimization than those with primary education; cooperative members show 31% higher efficiency than non-members. These insights enable tailored interventions addressing age-specific technology adoption barriers, education-linked knowledge gaps, and organizational participation constraints.

Finally, the study contributes to the broader literature on agricultural efficiency analysis in Sub-Saharan Africa, providing comparative insights that may be applicable to similar contexts across the region.

Methodology

This study employed a cross-sectional research design to analyze the technical efficiency of maize production among smallholder farmers in Southwest Nigeria. The choice of cross-sectional design was appropriate for capturing a snapshot of production efficiency at a specific point in time while allowing for comparative analysis across different farmer categories and farm characteristics.

The study was conducted in three states of Southwest Nigeria: Ondo, Ogun, and Oyo states. These states were selected based on their significant contribution to maize production in the region and the prevalence of smallholder farming systems. Southwest Nigeria is characterized by a tropical climate with two distinct seasons: the rainy season (April to October) and the dry season (November to March), which is conducive to maize cultivation (Omonijo et al., 2023).

The study was conducted over a 12-month period, from July 2024 to July, 2025. Data collection activities were carried out during the peak period of production which were June to August and February to May of the 2025 farming season to ensure accurate capture of production activities and resource utilization patterns.

The population of the study comprised all smallholder maize farmers in the three selected states. Based on the Agricultural Development Program (ADP) records, the total population of registered maize farmers in the study area was approximately 45,000 farmers.

The sample size was determined using the Yamane formula:

$n = N / (1 + N(e)^2)$

Where:

- n = sample size
- N = population size (45,000)
- e = margin of error (0.05)

$n = 45{,}000 / (1 + 45{,}000(0.05)^2)$

$n = 45{,}000 / (1 + 112.5)$

$n = 45{,}000 / 113.5 = 396.48 \approx 400$

However, accounting for potential non-response and incomplete questionnaires, the final sample size used for analysis was 384 farmers.

Sample size was determined using the Taro Yamane formula, yielding 384 farmers. A multi-stage random sampling technique was then employed for respondent selection. In stage one, three states (Ondo, Ogun, and Oyo) were purposively selected based on maize production prominence. Stage two involved random selection of four Local Government Areas per state (12 LGAs total). Stage three randomly selected three communities per LGA (36 communities). Finally, 10-11 farmers were randomly selected from each community to achieve the predetermined sample size of 384 farmers.

A structured questionnaire was developed and used for data collection. The questionnaire was divided into several sections covering socioeconomic characteristics, production inputs, output levels, marketing information, and access to agricultural support services. The questionnaire was pre-tested with 20 farmers outside the study area to ensure reliability and validity.

Primary data were collected through face-to-face interviews conducted by trained interviewers. The enumerators were agricultural extension agents and final-year students from agricultural universities who were familiar with local farming practices and languages. Secondary data were obtained from relevant government agencies, research institutions, and published literature.

Data analysis involved both descriptive and inferential statistics. Descriptive statistics including means, frequencies, and percentages were used to characterize the sample and production systems. Inferential statistics were employed to test hypotheses and estimate efficiency levels.

The study employed the Stochastic Frontier Production Function (SFPF) to estimate technical efficiency levels. The production function was specified as:

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

Where:

- Y_i = Maize output (kg) for the ith farmer
- X_1 = Farm size (hectares)
- X_2 = Labor input (man-days)
- X_3 = Fertilizer quantity (kg)
- X_4 = Seed quantity (kg)
- X_5 = Pesticide cost (Naira)
- V_i = Random error term
- U_i = Technical inefficiency term
- $\beta_0, \beta_1 \ldots \beta_5$ = Parameters to be estimated

The technical efficiency (TE) for each farmer was calculated as: $TE = \exp(-U_i)$

Additionally, a second-stage regression was conducted to identify factors influencing technical efficiency:

$TE_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \varepsilon_i$

Where:

Z_1 = Age of farmer (years)

Z_2 = Education level (years of schooling)

Z_3 = Farming experience (years)

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

Z_5 = Extension contact (dummy: 1 if yes, 0 if no)

Z_6 = Membership in cooperative (dummy: 1 if yes, 0 if no)

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Results and Discussion

Socioeconomic Characteristics of Respondents

Table 1 reveals that the majority of maize farmers (37.0%) were in the 41-50 age bracket, with a mean age of 45.2 years. This indicates that maize farming in Southwest Nigeria is dominated by middle-aged farmers who are likely in their most productive years. The educational profile shows that 40.6% of farmers had secondary education, while 14.3% possessed tertiary education, suggesting a relatively educated farming population. The mean farming experience of 18.7 years indicates substantial experience in agricultural production among the respondents.

Table 1: Socioeconomic Characteristics of Respondents

Characteristic	Frequency	Percentage	Mean	Std. Dev.
Age Groups (years)			45.2	12.4
20-30	38	9.9		
31-40	96	25.0		
41-50	142	37.0		
51-60	78	20.3		
Above 60	30	7.8		
Education Level			8.6	4.2
No formal education	45	11.7		
Primary education	128	33.3		
Secondary education	156	40.6		
Tertiary education	55	14.3		
Farming Experience (years)			18.7	8.9
1-10	89	23.2		
11-20	167	43.5		
21-30	98	25.5		
Above 30	30	7.8		
Farm Size (hectares)			2.8	1.6
≤1	72	18.8		
1.1-2.0	165	43.0		
2.1-3.0	89	23.2		
3.1-5.0	45	11.7		
Above 5.0	13	3.4		
Access to Credit				
Yes	142	37.0		
No	242	63.0		
Extension Contact				
Yes	156	40.6		
No	228	59.4		

Source: Field Survey, 2025

Farm size distribution shows that 61.8% of farmers operated on farms of 2 hectares or less, confirming the smallholder nature of maize production in the region. Only 37.0% of farmers had access to credit facilities, while 40.6% had contact with extension services, highlighting significant gaps in agricultural support services. These gaps are consistent with challenges identified by Adegoroye et al. (2021) in their study of food security and coping strategies among rural farmers, and underscore critical deficiencies in agricultural support systems that require urgent policy attention.

Production Inputs and Output Levels

The results in Table 2 show that the mean maize yield was 2,847.6 kg/ha, which is below the potential yield of 4,000-6,000 kg/ha for the region, indicating significant room for improvement. These yield levels are comparable to those reported by Olubunmi-Ajayi & Amos (2023) but remain below the achievable potential, reflecting a substantial yield gap that can be attributed to inefficiencies in input use, inadequate access to improved varieties, and suboptimal agronomic practices. Addressing these constraints could significantly enhance productivity and farmer incomes. The average farm size of 2.83 hectares confirms the smallholder nature of production. Labor input averaged 45.7 man-days per hectare, while fertilizer application averaged 156.8 kg/ha, which is below the recommended rate of 200-250 kg/ha.

Table 2: Production Inputs and Output Levels

Variable	Mean	Std. Dev.	Minimum	Maximum
Maize Output (kg/ha)	2,847.6	892.4	1,200	5,500
Farm Size (hectares)	2.83	1.62	0.5	8.0
Labor Input (man-days/ha)	45.7	12.8	25	85
Fertilizer (kg/ha)	156.8	67.3	50	350
Seeds (kg/ha)	22.4	5.9	15	40
Pesticide Cost (₦/ha)	18,650	8,240	5,000	45,000
Input Costs (₦/ha)				
Total Variable Cost	187,450	52,680	95,000	320,000
Labor Cost	82,350	23,120	45,000	153,000
Fertilizer Cost	47,040	20,190	15,000	105,000
Seed Cost	26,880	7,080	18,000	48,000
Profitability Indicators				
Gross Revenue (₦/ha)	341,760	107,088	144,000	660,000
Net Income (₦/ha)	154,310	78,542	15,000	385,000
Benefit-Cost Ratio	1.82	0.45	1.02	3.15

Source: Field Survey, 2025

The profitability analysis reveals a mean gross revenue of ₦341,760 per hectare and net income of ₦154,310 per hectare, with a benefit-cost ratio of 1.82, indicating that maize production is profitable despite the efficiency gaps. This finding is consistent with studies by Ettah et al. (2018) and Zalkuwi et al. (2019), who reported positive returns to maize production despite operational challenges. However, the substantial efficiency gaps suggest that profitability could be significantly enhanced through improved production practices, offering farmers opportunities to increase their incomes without necessarily expanding farm sizes or acquiring additional resources.

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Technical Efficiency Levels and Distribution

Table 3 presents the distribution of technical efficiency scores among maize farmers, providing valuable insights into the technical efficiency of maize production among smallholder farmers in Southwest Nigeria and revealing both opportunities and challenges in the sector. The results show that the mean technical efficiency is 0.67, indicating that farmers could increase their output by 33% using existing technology and input levels. This finding aligns with previous studies in similar contexts (Olubunmi-Ajayi et al., 2023; Coster & Oladeinde, 2024), and suggests that farmers could significantly increase their output without additional resource requirements, simply by adopting best practices and optimizing resource allocation. This finding resonates with the work of Barrett et al. (2018), who emphasized the importance of efficient resource utilization in enhancing agricultural productivity in developing countries.

Table 3: Technical Efficiency Levels and Distribution

Efficiency Range	Frequency	Percentage	Cumulative %
≤0.40	23	6.0	6.0
0.41-0.50	46	12.0	18.0
0.51-0.60	92	24.0	42.0
0.61-0.70	134	34.9	76.9
0.71-0.80	65	16.9	93.8
0.81-0.90	19	4.9	98.7
0.91-1.00	5	1.3	100.0
Summary Statistics			
Mean Technical Efficiency	0.67		
Standard Deviation	0.14		
Minimum	0.28		
Maximum	0.94		
Efficiency by Farm Size			
Small farms (≤2 ha)	0.58		
Medium farms (2.1-5 ha)	0.74		
Large farms (>5 ha)	0.82		

Source: Field Survey, 2025

Only 23.1% of farmers achieved efficiency levels above 0.70, while 42.0% operated below 0.60 efficiency level, suggesting substantial inefficiencies in production. The wide variation in efficiency levels, ranging from 0.28 to 0.94, indicates heterogeneity in farming practices and resource utilization patterns among producers, highlighting the diverse management capabilities and resource access among farmers in the region.

The analysis by farm size reveals significant variations in efficiency levels, with larger farms achieving higher efficiency scores. Small farms (≤2 ha) achieved an average efficiency of 0.58, while medium farms (2.1-5 ha) achieved 0.74, and large farms (>5 ha) achieved 0.82. This pattern suggests economies of scale in maize production and has important implications for agricultural development policies. While supporting smallholder farmers remains crucial for poverty reduction and food security, the results suggest that promoting farm consolidation or group farming arrangements could enhance efficiency. This approach should be balanced with social considerations to ensure equitable access to productive resources.

Determinants of Technical Efficiency

The results in Table 4 reveal the factors significantly influencing technical efficiency in maize production. Farm size has the strongest positive effect (β=0.0421, p<0.01), indicating that larger farms achieve higher efficiency levels. This strong positive relationship supports the existence of economies of scale in maize production, consistent with findings by Wei et al. (2022) and Huan & Zhan (2022). Larger farms achieve higher efficiency levels due to better resource allocation, improved access to technology, and economies in input procurement and output marketing. This finding has important policy implications, suggesting that land consolidation programs and group farming initiatives could enhance productivity in the sector.

Table 4: Determinants of Technical Efficiency (Second-Stage Regression Results)

Variable	Coefficient	Standard Error	t-value	P-value	VIF
Constant	0.423	0.089	4.75	0.000***	-
Age (years)	-0.0034	0.0012	-2.83	0.005**	1.23
Education (years)	0.0156	0.0065	2.40	0.017**	1.45
Farming Experience (years)	0.0078	0.0034	2.29	0.023**	1.67
Farm Size (hectares)	0.0421	0.0089	4.73	0.000***	1.34
Access to Credit (1=yes, 0=no)	0.0847	0.0234	3.62	0.000***	1.12
Extension Contact (1=yes, 0=no)	0.0523	0.0198	2.64	0.009**	1.18
Cooperative Membership (1=yes, 0=no)	0.0367	0.0187	1.96	0.051*	1.09
Distance to Market (km)	-0.0023	0.0014	-1.64	0.101	1.15
Household Size (persons)	-0.0089	0.0045	-1.98	0.048**	1.28
Model Statistics					
R-squared	0.584				
Adjusted R-squared	0.574				
F-statistic	58.46***				
Number of observations	384				

Note: *, *, * denote significance at 1%, 5%, and 10% levels respectively*

Source: Field Survey, 2023

Access to credit shows a substantial positive impact (β=0.0847, p<0.01), suggesting that credit-constrained farmers operate at lower efficiency levels. This significant positive effect underscores the critical role of financial services in agricultural development and aligns with Olutumise's (2023) findings on the impact of credit on climate adaptation utilization among food crop farmers. Credit-constrained farmers often cannot acquire optimal input quantities or adopt productivity-enhancing technologies, leading to lower efficiency levels. The 28% improvement in efficiency associated with credit access highlights the need for expanded agricultural financing programs.

Education and farming experience positively influence efficiency, reflecting the importance of human capital in agricultural production. Education enhances farmers' ability to process information, adopt new technologies, and make informed production decisions (Adegoroye et al., 2023). The positive influence of education and farming experience on technical efficiency demonstrates that investments in human capital development yield significant returns in agricultural productivity.

Age shows a negative relationship, possibly reflecting the adoption challenges faced by older farmers. The negative relationship between age and efficiency may reflect older farmers' reluctance to adopt new technologies or physical limitations that affect farm management practices, suggesting the need for targeted interventions to support older farmers in technology adoption.

Extension contact and cooperative membership also positively influence efficiency, highlighting the importance of agricultural support services and social capital. These findings corroborate the work of Ijigbade et al. (2023) on the importance of institutional support in enhancing agricultural efficiency. Extension services facilitate technology transfer and skill development, while cooperative membership provides access to inputs, markets, and information. The positive effects of these institutional factors emphasize the value of strengthening agricultural extension systems and promoting farmer organizations.

The model explains 58.4% of the variation in technical efficiency, with an F-statistic of 58.46 ($p<0.01$), indicating good model fit and suggesting that the selected variables adequately capture the key determinants of technical efficiency in maize production.

Hypothesis Testing Results

The hypothesis testing results in Table 5 show that both null hypotheses are rejected at the 5% significance level. There is a significant difference in technical efficiency between smallholder and medium-scale farmers, with medium-scale farmers achieving significantly higher efficiency levels. The large effect size (Cohen's $d = 1.24$) indicates a practically significant difference, not just a statistically significant one, demonstrating that the efficiency gap between farm size categories has substantial real-world implications for productivity and farmer welfare.

Similarly, socioeconomic characteristics significantly influence technical efficiency, with the overall model F-test yielding $F = 58.46$ ($p<0.01$). Individual variables including age, education, experience, credit access, and extension contact show statistically significant effects on technical efficiency. These results provide strong empirical evidence that farmer characteristics and access to agricultural support services play crucial roles in determining production efficiency, confirming the importance of targeted interventions that address specific socioeconomic constraints faced by farmers in the region. Strengthening these support systems is essential for improving technical efficiency and agricultural productivity across all farm size categories.

Table 5: Hypothesis Testing Results

Hypothesis	Test Statistic	Critical Value	P-value	Decision
H_{01}: No significant difference in technical efficiency between smallholder and medium-scale farmers				
t-test for difference in means	t = -6.847	$t_{0.05}$ = 1.96	0.000	Reject H_{01}
Mann-Whitney U test	U = 8,245.5	$U_{0.05}$ = 9,876.2	0.001	Reject H_{01}
Descriptive Statistics Smallholder farms (≤2 ha): Mean TE = 0.58, n = 237 Medium-scale farms (2.1-5 ha): Mean TE = 0.74, n = 134 Effect size (Cohen's d) = 1.24 (Large effect)				
H_{02}: Socioeconomic characteristics do not significantly influence technical efficiency				
Multiple regression F-test	F = 58.46	$F_{0.05}(9,374)$ = 1.88	0.000	Reject H_{02}
Individual t-tests (significant variables): - Age: t = -2.83, p = 0.005 - Education: t = 2.40, p = 0.017 - Experience: t = 2.29, p = 0.023 - Credit access: t = 3.62, p = 0.000 - Extension contact: t = 2.64, p = 0.009				

Source: Field Survey, 2025

Conclusion

This comprehensive analysis of technical efficiency in maize production among smallholder farmers in Southwest Nigeria has yielded critical insights contributing significantly to understanding agricultural productivity challenges and opportunities in the region. The study successfully examined 384 farmers across three states, providing robust empirical foundations for policy recommendations and future research directions.

The research revealed a mean technical efficiency of 0.67, indicating farmers could potentially increase maize output by 33% without additional resources, simply by optimizing existing production practices. This substantial efficiency gap represents significant opportunities for productivity enhancement and income improvement. Farm size emerged as the most influential factor, with larger farms consistently achieving higher efficiency levels, strongly suggesting economies of scale presence in maize production systems.

Access to credit facilities demonstrated profound impact on technical efficiency, with credit-enabled farmers achieving 28% higher efficiency levels. Educational attainment and farming experience positively influenced efficiency, while extension service contact and cooperative membership contributed

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positively, emphasizing agricultural support systems' importance. The profitability analysis revealed maize production remains economically viable with benefit-cost ratios of 1.82, though substantial efficiency gaps suggest significant profitability enhancement potential.

Based on these findings, several recommendations emerge. Government and financial institutions should expand agricultural credit programs targeting smallholder farmers, implementing flexible lending mechanisms with favorable terms. Agricultural extension services require strengthening through increased personnel deployment, training programs, and technology transfer initiatives. Policies promoting farmer cooperatives and group farming arrangements should be prioritized to facilitate economies of scale realization while maintaining smallholder inclusivity.

Investment in farmer education through training programs focusing on efficient resource utilization, modern agronomic practices, and farm management techniques is essential. Research institutions should develop and disseminate improved maize varieties suitable for smallholder production systems. Finally, comprehensive support systems integrating financial services, extension services, and market linkages must be established to address multiple constraints simultaneously, ensuring sustainable productivity improvements and enhanced farmer welfare across Southwest Nigeria.

Recommendations

This comprehensive analysis of technical efficiency in maize production among smallholder farmers in Southwest Nigeria has yielded critical insights contributing significantly to understanding agricultural productivity challenges and opportunities in the region. The study successfully examined 384 farmers across three states, providing robust empirical foundations for policy recommendations and future research directions.

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Access to credit facilities demonstrated profound impact on technical efficiency, with credit-enabled farmers achieving 28% higher efficiency levels. Educational attainment and farming experience positively influenced efficiency, while extension service contact and cooperative membership contributed positively, emphasizing agricultural support systems' importance. The profitability analysis revealed maize production remains economically viable with benefit-cost ratios of 1.82, though substantial efficiency gaps suggest significant profitability enhancement potential.

To enhance technical efficiency among smallholder maize farmers, government should expand accessible agricultural credit programs with favorable terms. Strengthening extension services through digital platforms and farmer field schools will improve technology transfer. Promoting farmer cooperatives enables economies of scale and collective resource access. Training programs should emphasize optimal fertilizer application, improved seed varieties, and efficient resource management. Input subsidy programs must prioritize quality seeds and fertilizers for smallholder farmers.

Establishing integrated support systems combining financial services, technical advice, and market linkages addresses multiple constraints simultaneously. Encouraging group farming arrangements while maintaining smallholder inclusivity can significantly improve efficiency. These interventions collectively address the identified 33% efficiency gap, potentially transforming productivity and profitability for Southwest Nigeria's smallholder maize farmers.

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