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Gendered Determinants of Cost Efficiency among Smallholder Arable Crop Farmers in Abia State, Nigeria

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Abstract
This study analyzed the gendered determinants of cost efficiency among smallholder arable crop farmers in Abia State, Nigeria, using a stochastic cost frontier model. Primary data were collected from 240 farmers using a multistage sampling technique. Results revealed significant gender differences in cost efficiency: for male farmers, $\gamma = 0.8033$ indicated that 80.3% of cost variation was due to inefficiency, while for female farmers, $\gamma = 0.8760$ indicated that 87.6% was attributable to inefficiency. For male farmers, land price, labour, planting materials, and agrochemicals significantly increased production costs, while age and household size reduced inefficiency. Marital status and credit access increased inefficiency for men, likely due to resource diversion and household obligations. For female farmers, the cost of planting materials significantly increased production expenses, whereas age, farming experience, education, and credit access improved efficiency. Overall, the study showed that, male inefficiency stemmed mainly from high input and labour costs, while female inefficiency was linked to constrained access to productive resources and rising input prices. The study recommends enhanced input subsidies, gender-sensitive credit monitoring, and capacity-building programs to improve cost efficiency and profitability among smallholder arable crop farmers in Abia State.
Keywords: Gender, determinants, Economic efficiency, and Arable crop farmers

Introduction

Agriculture remains a cornerstone of economic development in many developing nations, including Nigeria, where about 35% of the population is actively engaged in the sector (World Bank, 2020). Despite Nigeria's vast oil wealth, agriculture continues to play a pivotal role in sustaining livelihoods, ensuring food security, and driving national growth, contributing approximately 25.8% to Nigeria's Gross Domestic Product (GDP) (FAO, 2022). The country possesses an estimated 70.8 million hectares of arable land, out of which 34 million hectares are used for crop cultivation—6.5 million hectares for permanent crops and 30.3 million hectares for meadows and pastures (FAO, 2021).

However, Nigeria's agricultural productivity is influenced by several socioeconomic and institutional factors, among which gender disparities play a critical role. Gender However, Nigeria's agricultural productivity is influenced by several socioeconomic and institutional factors, among which gender disparities play a critical role access to productive resources, decision-making, and income-generating opportunities in both developed and developing countries (Osondu & Simonyan, 2019). In Nigeria context, gender disparity refers to the unequal roles, responsibilities, and opportunities assigned to men and women in households and communities; differences that arise through cultural and social norms. Women contribute

significantly to food production, processing, and household sustenance; yet remain disadvantaged in access to essential agricultural resources such as land, credit, and technology. These gaps reduce women's productivity and limit household and community welfare.

The concept of economic efficiency is central to agricultural productivity, as it reflects how effectively farmers utilize available resources such as land, labour, and capital to maximize output at minimal cost (Varian, 2020). When farmers are economically efficient, they produce at the lowest possible cost given existing technology and resource constraints. Conversely, inefficiency implies underutilization or misallocation of resources, resulting in low output and income conditions that are prevalent among many smallholder farmers in Nigeria.

Arable crop farming involves the cultivation of cereals, legumes, tubers, and oilseeds, which is the key agricultural activity sustaining rural households across Nigeria (FAO, 2021). Smallholder arable crop farmers dominate the sector and play a vital role in food security; however, they face persistent challenges such as declining productivity, limited access to quality inputs, weak extension services, and widespread poverty (Olawuyi & Olagunju, 2020). Despite successive government interventions such as input subsidies, credit schemes, and training initiatives, productivity among smallholders remains low, and gender disparities further exacerbate these inefficiencies.

Studies by Agada and Igbokwe (2021) and Umeh and Ezeano (2023) show that female farmers face greater constraints than male counterparts in accessing productive resources, extension services, and modern technologies, which directly reduces their productive efficiency and income. In Abia State these challenges are particularly evident: smallholder arable crop farmers continue to operate below their production potential despite policy interventions. Limited access to quality inputs, credit, and training continues to impede progress (Eze et al., 2022). Although smallholder arable crop farmers play a significant role in Abia State's food security and economic development, low productivity and economic inefficiency persist. Gender disparities in access to productive resources, land ownership, and technology constrain female farmers' performance relative to male counterparts. Empirical evidence on how gender affects economic efficiency among smallholder arable crop farmers in the state remains limited. The broad objective of this study is to analyze how gender influences the economic efficiency of arable crop farmers in Abia State, Nigeria.

Methodology

The study was conducted in Abia State, Nigeria. A multistage sampling technique combining purposive and random methods was adopted. In the first stage, two Local Government Areas (LGAs) were purposively selected from each of the three agricultural zones based on the intensity of arable farming: Ikwuano and Umuahia South (Umuahia Zone); Isiukwuato and Bende (Ohafia Zone); and Isiala Ngwa North and South (Aba Zone). In the second stage, one community was randomly selected from each LGA, giving six communities in total. In the third stage, four villages were randomly selected from each community, resulting in 24 villages. Lists of smallholder arable crop farmers, obtained with assistance from extension agents and village heads, served as the sampling frame. In the final stage, 10 farmers (5 males and 5 females) were randomly selected from each village, yielding 240 respondents (120 male and 120 female farmers). Primary data were collected using a well-structured questionnaire. and analyzed using the stochastic frontier production function model, specified as follows:

$I_n C_{1,2,3}=C_{0+}InY_5 + C_1InE_1+C_2InE_2 +C_3InE_3 +C_4InE_4+ +C_5\ InY_5+V_i+U_i$…..1

Where,

$C_{1,2,3}$ =total cost of production for male, female and pooled arable crop farmers.

Y = Output of ith measured in grain equivalent (Yield of each crop in kg multiplied by conversion factor for each crop)

E_1 = price of cultivated land (Naira/ha)

E_2 = price of planting materials (seeds, seedlings and cuttings) used (Naira)

E_3 = price of labour used (Naira)

E_4 = price of other agro chemicals used (Naira /litre)

C_0 = intercept
$C_{1-}C_5$ =coefficients estimated.
V_i = Random variables in the production that lead to error which is beyond the farmers control such as heavy rainfall, pest and disease infestation, etc
U_i = non negative random error which leads to inefficiency in production.
To determine the factors contributing to economic inefficiency of the arable crop farmers' equation 2 was jointly estimated with equation 1 by Maximum Likelihood Estimation using software. The model is stated as:

$$EE_{1,2,3} = F_0 + F_1G_1 + F_2G_2 + F_3G_3 + F_4G_4 + F_5G_5 + F_6G_6 \ldots .2$$

Where,
$EE_{1,2,3}$ = Economic efficiency of arable crop farmers (1 for male, 2 for female and 3 for pooled)
F_0 = intercept,
F_1 -F_6 = parameters estimated
G_1 = is the farmers age in years
G_2 = farmers level of education in years
G_3 = farm size in hectares
G_4 = farmers household size in number
G_5 =farmer's farming experience in years
G_6 = credit amount (Naira)

Results and Discussion

Determinants of economic efficiency of male arable crop producers

The Maximum likelihood estimates of stochastic frontier model for male arable crop farmers is summarized and presented in Table 1:

Table 1: Economic efficiency estimates of male arable crop farmers

Variables	Coefficient	Standard error	t-ratio
Economic efficiency			
Constant	10.9346	3.4101	3.21***
Price of cultivated land	0.4042	0.1088	3.72***
Price of labour	0.3988	0.1111	3.59***
Price of planting materials	0.3741	0.1140	3.28***
Price of other agrochemicals	0.2826	0.1766	1.60*
Economic inefficiency			
Age of respondent	-0.2006	0.1244	-1.61*
Household size	-0.1367	0.0142	-9.63***
Experience	-0.1273	0.1668	-0.76
Formal education	0.2172	0.4283	0.51
Marital status	0.1926	0.0806	2.39**
access to credit	0.2208	0.1353	1.63*
Sigma squared(δ)	0.9049	0.1286	7.04***
Gamma(γ)	0.8033		
Log likelihood function	93.8933		
LR test	108.4578***		

Source: Field Survey, (2025) *, * Significant at 1% and 10%, respectively**

The estimated sigma-squared (σ^2) value of 0.9049, significant at the 1% level, confirms the reliability and appropriateness of the model. The estimated gamma (γ) coefficient of 0.8033 indicates that approximately 80.3% of the variation in total production costs among male farmers is due to cost inefficiency, while only 19.7% is attributed to random shocks beyond their control. The log-likelihood value (93.89) and the likelihood ratio (LR) statistic (108.46) further validate the model's goodness-of-fit and its statistical

significance at the 1% level. Consequently, the null hypothesis of no inefficiency effects ($\gamma = 0$) is rejected, confirming that cost inefficiency significantly influences arable crop production costs in the study area. Among the explanatory variables, the price of cultivated land, labour, planting materials and other agrochemicals were found to have positive and significant effect on the total production cost of male arable crop farmers.

Table 1 shows that the price of cultivated land is positively and significantly associated with production costs at the 1% level. The result implies that as land prices rise, total production costs for male arable crop farmers increase because land is a primary input in crop cultivation. Hence, higher land costs raise the overall expenditure of cultivation and reduce profit margins. This denotes that high land prices are a major constraint on cost efficiency among male farmers, particularly where land scarcity or tenure restrictions exist. This finding is consistent with Egbetokun et al. (2023), who reported that land costs significantly affect production efficiency among smallholder crop farmers in southwestern Nigeria.

Similarly, labour prices have a positive and significant effect on production costs at the 1% level. This indicates that higher labour costs substantially increase total production expenses. Labour remains a critical input in smallholder arable farming, and fluctuations in labour costs directly reduce profitability. High dependence on manual labour and the seasonal scarcity of farmhands also contribute significantly to rising production costs in the study area. This result is consistent with Adeleke and Olanrewaju (2023), who found that rising labour costs were a major determinant of inefficiency among cassava farmers in Oyo State.

The price of planting materials also showed a positive and significant effect at the 1% level. This means that increases in the cost of inputs such as seeds and cuttings translate directly into higher production costs. The result indicates that the cost of acquiring quality planting materials remains a key factor affecting the overall cost structure of arable crop farming. Farmers with limited financial resources may therefore opt for low-quality input, which could affect yield and efficiency. This result aligns with Onwuka et al. (2024), who observed that input costs, particularly planting materials, significantly determine the cost and output efficiency of arable crop farmers in southeastern Nigeria.

Furthermore, the price of agrochemicals was positive and significant at the 10% level, indicating that as the prices of pesticides and herbicides increase, the total production cost also rises. Agrochemicals are essential for pest and disease control; however, their rising prices strain farmers' budgets and may reduce the frequency or effectiveness of their application. This finding aligns with Olagunju et al. (2024), who reported that high agrochemical prices adversely affect efficiency and yield among maize and cassava producers in Nigeria.

The estimated coefficients for age and household size were negative, while those for marital status and access to credit were positive. The negative coefficients indicate a reduction in cost inefficiency (that is, an improvement in efficiency), whereas the positive coefficients indicate increased inefficiency.

The negative and significant coefficient of age (10%) indicates that older farmers are less inefficient, implying that efficiency improves with age. This suggests that experience, accumulated skills, and better decision-making contribute to more effective resource use among older farmers. Similar findings were reported by Okoye et al. (2023), who noted that farming experience and age positively influenced efficiency among yam farmers in Anambra State.

The negative and significant effect of household size (1%) shows that larger households enhance efficiency, likely because more family members provide labour and reduce dependence on costly hired workers. This underscores the role of household labour in improving resource use and lowering production costs. Comparable evidence from Nwachukwu and Okoli (2022) showed that household labour availability significantly reduces production costs among arable crop farmers in Abia State.

Conversely, marital status had a positive and significant relationship with inefficiency (5%), meaning that married farmers were less efficient than their unmarried counterparts. Although marriage is expected to increase family labour supply, household consumption pressures and competing domestic responsibilities may divert resources away from productive farm activities. This suggests that marital obligations can impose financial and labour constraints that reduce efficiency. This observation corroborates Oladejo and Bello (2023), who found that marital responsibilities limited efficiency among married smallholder farmers due to higher household expenditure and reduced on-farm participation.

Similarly, access to credit had a positive and significant effect on inefficiency (10%), showing that farmers with credit access were less efficient. This suggests that loans were often diverted to non-farm uses due to poor monitoring, high interest rates, and low financial literacy. Strengthening credit supervision and financial training could help ensure that borrowed funds improve productivity and efficiency (Edaba et al., 2023; Obafemi & Olatidoye, 2019).

Determinants of economic efficiencies for female arable crop farmers

The Maximum likelihood estimates of stochastic frontier model for female arable crop farmers is summarized and presented in Table 2:

Table 2: Economic efficiency estimates for female arable crop farmers

Variables	Coefficient	Standard error	t-ratio
Economic efficiency			
Constant	6.4245	0.3977	16.15***
Price of cultivated land	0.0233	0.0308	0.76
Price of labour	0.0195	0.0168	1.16
Price of planting materials	0.2089	0.0365	5.72***
Price of other agrochemicals	0.0009	0.0019	0.47
Economic inefficiency			
Age of respondent	-1.4078	0.4716	-2.99***
Household size	0.1523	0.0988	1.54
Farming Experience	-4.5399	1.6842	-2.70***
Formal education	-13.8737	4.8578	-2.86***
Marital status	0.1515	0.6380	0.24
access to credit	0.0078	0.0038	-2.05**
Sigma squared(δ)	46.1202	15.3482	3.00***
Gamma(γ)	0.8760		
Log likelihood function	119.4867		
LR test	446.33***		

Source: Field Survey data, 2025 *, *; Significant at 1% and 10%, respectively**

The maximum likelihood estimates in Table 2 show a gamma (γ) value of 0.8760, indicating that about 87.6% of the variation in production costs is due to differences in cost efficiency among female farmers, while only 12.4% results from random factors beyond their control. The high log-likelihood value (119.49) and LR statistic (446.33), both significant at the 1% level, confirm the model's strong goodness-of-fit and the presence of significant inefficiency effects. Hence, the null hypothesis of no inefficiency effects ($\gamma = 0$) is rejected. Among the cost variables, the price of planting materials was positive and significant, implying that higher input costs directly increase production expenses for female arable crop farmers, thereby reducing cost efficiency.

Table 2 show that the cost of planting materials had a positive and significant effect (1%), indicating that higher seed and planting stock prices substantially increased production expenses for female arable crop farmers. This suggests that rising input costs constrain women's cost efficiency, as they often face limited access to credit and productive assets. The finding underscores that seed cost inflation remains a major barrier to efficient production, particularly among female smallholders who operate with tighter financial margins (Fafolarin, Mustapha, & Salihu, 2024; Ironkwe et al., 2023; Adesina., Owoo & Boakye-Yiadom, 2023).

The coefficients for age, farming experience, formal education, and access to credit were all negative and significant, implying that these factors reduce inefficiency and enhance economic efficiency among female farmers.

The negative effect of age (1%) indicates that efficiency improves as farmers grow older. Older women farmers appear to leverage accumulated skills and experience to make better production and resource-use decisions, improving overall management efficiency. However, at advanced ages, physical limitations may reduce productivity unless supported by labour-saving tools (Ironkwe et al., 2023; Mustapha & Salihu, 2022).

Similarly, farming experience had a significant negative relationship with inefficiency (1%), showing that long-term exposure to farming improves decision-making, risk management, and adaptive capacity. Experienced farmers better anticipate seasonal changes and optimize input use, resulting in lower inefficiency (Mahmud, 2022; Owoo & Boakye-Yiadom, 2021).

The negative and significant effect of formal education (1%) suggests that educated female farmers are more efficient, as education enhances understanding of extension advice, record keeping, and technology adoption. Literate farmers are better equipped to evaluate input costs and maximize returns, reflecting the efficiency benefits of human capital investment (Coster et al., 2024; Adesina et al., 2023). Finally, access to credit showed a negative and significant effect (5%), implying that credit availability enhances efficiency by easing liquidity constraints and enabling farmers to invest in quality inputs and technologies. Access to finance also allows timely farm operations and greater resilience against price fluctuations (Fafolarin et al., 2024; Coster, Fafolarin, & Olagunju 2024).

Conclusion

The study concludes that economic efficiency among smallholder arable crop farmers in Abia State is shaped by gender-specific factors and differential access to resources. For male farmers, high land, labour, and input costs drive inefficiency, while for female farmers, limited access to productive assets and rising input prices constrain efficiency. Age, education, and farming experience enhance efficiency for both genders, thereby emphasizing the critical role of human capital.

Recommendations

1. Adopt gender-sensitive policies that address gender-specific constraints by improving women's access to critical productive assets, including land, agricultural inputs, and technology.
2. Provide affordable credit and targeted input subsidies to reduce production costs and enhance efficiency for both women and men.
3. Strengthen Farmer Education. Expanding training services to build farmers' technical and managerial skills.
4. Encourage and strengthen the development of farmer cooperatives to enhance resource sharing, collective bargaining, and market access for greater productivity

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