



Gender Differentials in Production Function Parameters, Elasticity of Production and Returns to Scale among Rice Farmers in Enugu State, Nigeria

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ABSTRACT

Despite the central role of rice production in food security, gender disparities in production efficiency remain poorly understood. This study estimated Gender differentials in production function parameters, elasticity of production, and returns to scale among Rice Farmers in Enugu State, Nigeria. A multistage sampling technique was used to select 120 rice farmers. A total of 60 male and 60 female rice farmers were included in the study. Data were collected using questionnaire and analyzed using descriptive statistics and Ordinary Least Square regression (OLS). The empirical results showed that rice farmers were predominantly middle-aged, married, moderately experienced, formally educated and had access to credit. The double-log functional form was the lead equation for both male and female rice farmers. For female rice farmers, farm size ($p < 0.05$), labour ($p < 0.05$), and planting materials ($p < 0.01$) were determinants of output, all positively related to production. For male farmers, farm size ($p < 0.05$), labour ($p < 0.05$), and fertilizer ($p < 0.01$) were the significant variables influencing output, also positively signed. The elasticity of production results showed that male rice farmers had a total elasticity coefficient of 1.078 ($E_p > 1$). In contrast, female farmers recorded a total elasticity coefficient of 0.727. The study concludes that there is clear gender-based differences in production efficiency and resource responsiveness among rice farmers in South East Nigeria. It recommends improved access to farmland, fertilizer, improved seeds, and targeted agricultural support systems to enhance productivity, especially among female farmers.

Keywords: Gender, production function parameters, elasticity, returns to scale and rice farmers

INTRODUCTION

The Nigerian economy has undergone several years of vicissitudes, particularly within the agricultural sector where the rice subsector, though steadily growing, continues to face a wide range of constraints. These constraints include biotic factors such as pests and diseases, abiotic factors such as climate variability and soil degradation, and more critically, socioeconomic limitations such as inadequate access to credit, land, and improved technologies (Abdul-Gafar *et al.*, 2016). Among these, socioeconomic constraints have exerted the most persistent pressure on rice production systems, thereby limiting

productivity and competitiveness of local rice farmers. Rice remains one of the most important agricultural commodities globally due to its central role in food security and dietary energy supply. It is consumed by billions of people worldwide and represents a major staple crop in many developing countries, including Nigeria (Surakiat *et al.*, 2017; Muthayya *et al.*, 2014). In West Africa, rice is considered a strategic food crop because of its contribution to household food security and national economic stability (Seck *et al.*, 2013; FAO, 2013). However, despite its importance, rice yields in many African

countries remain below the global average, largely due to inefficient resource use, weak extension services, and poor farm management practices (Abdul-Gafar *et al.*, 2017).

Agriculture in Nigeria is predominantly characterized by smallholder farmers who account for over 85 percent of domestic agricultural output (Obike *et al.*, 2017; Ikassim and Olayinka, 2012). These farmers rely heavily on human labour as the major input in production systems. Labour remains one of the most critical factors of production, especially in traditional and semi-mechanized farming systems, where over 90 percent of agricultural operations depend on human effort (Olayide, 2002; Shaib *et al.*, 1997). Hired labour contributes significantly to farm operations, accounting for about 88 percent of total labour use in some farming systems (Olukunle, 2013). In addition, family labour constitutes a dominant share of farm labour input, while exchange labour also plays an important role in rural agricultural production systems. However, seasonal variations in labour demand and rising labour costs continue to constrain efficient labour utilization and timely execution of farm operations (Obike *et al.*, 2017).

Economic theory identifies land, labour, and capital as the fundamental factors of production that determine sustainable agricultural development outcomes (Longpichai *et al.*, 2012). Among these, labour remains particularly important in developing economies due to limited mechanization and high reliance on manual farming systems. Labour not only serves as a key input in production but also as a primary source of livelihood for millions of rural households. In Nigeria, agriculture is highly labour-intensive, with both mechanized and non-mechanized systems depending substantially on human effort for production efficiency and output growth (Schneider, 2005). Thus, improvements in labour productivity are essential for enhancing agricultural performance and ensuring food security in the country.

Gender is an important analytical dimension in understanding agricultural production systems,

particularly in rural economies where labour allocation and resource access are influenced by social norms and cultural structures. Gender refers not merely to biological differences but to socially constructed roles, responsibilities, and expectations assigned to men and women in society (Doku, 1990; Aina, 2002). These socially defined roles shape access to productive resources such as land, credit, extension services, and technology. In many rural farming communities, women are often marginalized despite their significant contribution to agricultural production. Gender inequality in agriculture is reinforced by traditional institutions and cultural practices that influence labour division and decision-making processes within households (Akanji, 1997).

Globally, women constitute a significant proportion of the agricultural workforce, with estimates indicating that they are responsible for over half of food production, particularly in developing countries where they contribute between 60–80 percent of staple crop production (United Nations, 2006; Ajani, 2008). However, despite their contribution, women face limited access to productive resources and are often excluded from agricultural development interventions, including extension services and modern technologies (ILO, 1984; Kinkingninhou-Medagbe *et al.*, 2008). The West Africa Rice Development Authority (WARDA), now AfricaRice (2003), further notes that many agricultural innovations have historically bypassed women farmers, thereby limiting their productivity and efficiency.

Despite numerous studies on agricultural productivity and labour use in Nigeria, there remains a gap in empirical literature regarding gender-based differences in production efficiency, particularly in rice farming systems. Existing studies have often focused on aggregate productivity without adequately disaggregating outcomes by gender, thereby limiting understanding of differential efficiency levels between male and female farmers. Given that men and women perform different roles in agricultural production systems and have unequal access to productive

resources, it is essential to examine how these differences influence production outcomes (Carr, 2008). In view of the above, this study focuses on the estimation of the production function and gender-based analysis of elasticity of production and returns to scale among rice farmers in Abia State, Nigeria. The specific objectives were to:

- i. examine the socio-economic characteristics of the male and female rice famers;
- ii. estimate the production function and derive the elasticity of production and returns to scale for the farmers and female rice farmers;
- iii. describe the various constraints faced by male and female rice farmers in the study area.

METHODOLOGY

Study Area

The study was carried out in Enugu State, Nigeria. Enugu State is one of the 36 states of the Federal Republic of Nigeria and is located in the South-East geopolitical zone of the country. The name “Enugu” was derived from the Igbo words *Enu Ugwu*, meaning “top of the hill.” The state was created on 27th August, 1991, and is made up of 17 Local

Government Areas (LGAs). Geographically, Enugu State lies approximately between latitude $6^{\circ}30'N$ and longitude $7^{\circ}30'E$. The state shares boundaries with Abia State and Imo State to the south, Ebonyi State to the east, Benue State to the northeast, Kogi State to the northwest, and Anambra State to the west. The state occupies a land area of about 7,161 square kilometres (National Bureau of Statistics [NBS], 2024).

According to the recent population projections by the National Bureau of Statistics (NBS, 2024), Enugu State has an estimated population of over 4 million people. The state is characterized by a tropical climate with mean annual temperatures ranging from $20^{\circ}C$ to $30^{\circ}C$ and adequate rainfall suitable for agricultural production. The vegetation and soil conditions support the cultivation of major food crops such as rice, yam, cassava, cocoyam, maize, vegetables, legumes, and fruits. Economically, the state is predominantly agrarian, with a large proportion of the rural population engaged in farming and related agricultural activities, while a smaller proportion is involved in trading, processing, and manufacturing activities concentrated mainly in Enugu urban, Oji River, and Nsukka areas (NBS, 2024).

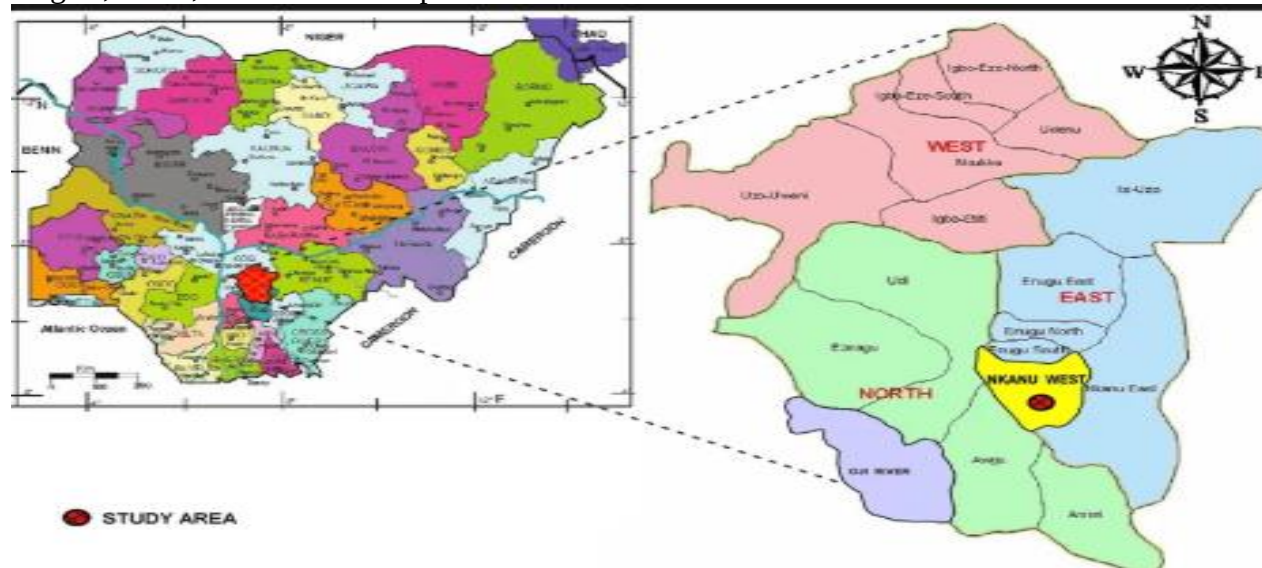


Figure 1: Map of Enugu State, Nigeria
Source: (NBS, 2024)

The study adopted a multi-stage sampling technique was adopted for this study. At the first stage, two agricultural zones out of the six were purposively selected because of the existence of rice production in these zones. These zones are Enugu and Nsukka agricultural zones. In the second stage, one local government area (LGA) was purposively selected from each of the selected agricultural zone based on the intensity of rice production. The LGAs selected were Uzo-uwani L.G.A in Nsukka and Isi-Uzo L.G.A in Enugu agricultural zone giving a total of 2 LGAs. In the third stage, three communities were randomly selected from each of the LGAs giving a sample of 6 communities. The communities selected were Adani, Ojo, Ogurugu community in Uzo-uwani L.G.A, while the communities selected in Isi-uzo L.G.A were Mbu, Umualor, Eha Amufu community. In the fourth stage 2 villages were randomly selected from each community; giving a sample of 12 villages (The villages selected in Uzo-uwani were Ajuona, Akutala, Amudala, Umueze, Onu, Odida; while for Isi-uzo the villages visited were Abbia, Ihanyi, Iken, Isieniu, Obegu, Odomogwo). In the last stage, list of rice farmers in the selected 12 villages was compiled with the help of enumerators who are natives of the villages, from this list 10 rice farmers (comprising 5 male and five females) were selected from each village, giving a sample size of 120 rice farmers for the study. Data for this study were collected from primary sources.

Model Specification

Production functions for male and female are given below:

$$Y_i = f(X_1, X_2, X_3, X_4, X_5, U) \quad 1$$

Explicitly stated as

Linear Functional form: The linear function of the OLS regression model is fitted as;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + e \quad 2$$

Exponential Function: The exponential function of the OLS regression model is fitted as;

$$\ln Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + e \quad 3$$

Cobb Douglas Function: The Cobb Douglas function of the OLS regression model otherwise known as the Double-log function is fitted as;

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + e \quad 4$$

Semi-log Function: The Semi-log function of the OLS regression model is fitted as;

$$Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + e \quad 5$$

Where:

Y_i = Output of male or female Rice farmers (kg)

X_1 = Capital (Depreciation, insurance, tax, interest and rent on land)

X_2 = Farm size (ha)

X_3 = labour (man-days)

X_4 = Cost of planting materials (N) (such as improved seeds, agrochemicals.),

X_5 = Fertilizer (kg)

U = Error term.

Elasticity of production and return to scale

Elasticity of production and return to scale of the farmer was achieved using the identity used by Onyenweaku, and Nwaru, (2005)

$$\sum_{ki} = EP_{xi} = RST \quad 6$$

Where:

EP_{xi} = Elasticity of production of the ith input

RST = Return to scale (i.e sum of coefficient of elasticity of production)

K = number of parameters

The elasticity of production of the various functional form is defined below following Onyenweaku, and Nwaru, (2005)

$$\text{Linear form} = \frac{\bar{X}}{\bar{Y}} \quad 7$$

$$\text{Double log} = a_i \quad 8$$

$$\text{Semi log} = a_i / Y \quad 9$$

$$\text{Exponential} = a_i x_i \quad 10$$

Where:

a_i = regression coefficient of the ith input

$\bar{X}$ = mean value of the *i*th input

$\bar{Y}$ = mean value of output.

RESULTS AND DISCUSSION

Age Distribution of Respondents

The result in Table 1 indicates that the mean ages were 43 and 42 years for both female and males respectively which falls within an ideal age distribution in the rural societies of Africa for utilization of farm labour and this age bracket represents an active stage in life. This has direct bearing on the availability of able-bodied manpower for primary production. Moreover, age influences the ability to seek and obtain farm jobs and income, which could increase farmers'

income and ultimately their production capacity. The results are similar to a number of findings by Oluyole *et al.* (2023) who suggested that those involved in farm labour utilization are in the prime age of strength and vigour that is required to perform many of the rice farm operations. The table further reviewed that as age advance from 20 – 49 years, labour productivity of the rice also increases; hence farmers within the age bracket 40 – 49 has the highest labour productivity index for female (30.0 kg/manday) and male (32.43 kg/manday) respectively. This implies that majority of the respondents were reasonable in labour efficient.

Table 1: Distribution of Respondents based Age

Age (years)	Female			Male		
	Frequency	Percentage (%)	LP	Frequency	Percentage (%)	LP
20-29	8	13.3	6.91	14	23.3	3.27
30-39	16	26.7	13.79	10	16.7	27.08
40-49	14	23.3	30.00	16	26.7	32.43
50-59	20	33.3	19.20	18	30.0	23.91
60-69	2	3.3	13.79	2	3.3	6.17
Total	60	100.0		60	100.0	
Mean	43			42		

Source: Field Survey (2026)

Key: LP = Mean Labour productivity (Kg/man-day)

Distribution of Respondents based on Marital Status

Table 2 shows that majority of the respondents were married for both female (70%) and male (48.33%). The implication of marital status on agricultural production can be explained in terms of the utilization of agricultural family labour. The utilization of family labour was more where the household heads were married. This is in consonance with the findings of Obike *et al* (2017) were they noted that majority of farmers were married. Furthermore Nwaru (2018) stated

that the situation should create a conducive environment for good citizenship training, development of personal integrity and entrepreneurship which are very important for efficient use of farm resources. Furthermore, the result revealed that rice farmer who were married have the best labour productivity index; as female accounted for 31.88 kg/manday while male accounted 33.88 kg/manday. This implies that a greater percentage of the population who had family members have increase labour productivity.

Table 2: Distribution of Respondents based on Marital Status

Marital Status	Female			Male		
	Frequency	Percentage (%)	LP	Frequency	Percentage (%)	LP
Single	10	16.67	16.84	17	28.33	27.90
Married	42	70.00	31.88	29	48.33	33.58
Divorced	4	6.67	29.45	9	15.00	19.22
Separated	4	6.67	5.53	5	8.33	12.18
Total	60	100.0		60	100.0	

Source: Field Survey (2026)

Key: LP = Mean Labour productivity (Kg/man-day)

Distribution of Respondent based on Household Size

The Table 3 shows that mean was 7 and 6 persons for male and female respondents respectively. The economic implication is that it will provide the farmer with family labour, reduce cost of production and increase their revenue. This collaborates with Adegbite and Oluwalana (2004) who found that a relatively large household size enhances family labour utilization on farm. The table further reviewed that the mean

Labour productivity was higher for household with increase family size as the female respondent with household size between 5 – 8 person has labour productivity of 46.67/manday while male rice farmers accounted for 40.56kg kg/manday Aigbokie *et al.*(2021) made an argument that the large household have the capacity to relax the labour constraints required during introduction of new technology and increases the output of the farmers.

Table 3: Distribution of Respondent based on Household Size

Household Size	Female			Male		
	Frequency	Percentage (%)	LP	Frequency	Percentage (%)	LP
1 – 4	20	33.33	23.91	18	30.00	34.51
5 – 8	28	46.67	32.42	24	40.00	40.56
9 – 12	12	20.00	24.25	16	26.67	17.8
13 – 16	0	0.00	3.12	2	3.33	0
Total	60	100.0		60	100.0	
Mean	6			7		

Source: Field Survey (2026)

Key: LP = Mean Labour productivity (Kg/man-day)

Distribution of Respondent based on level of Education

The Table shows that majority (100%) and (88.3%) of the respondents have formal education for both female and male production. This implies that literacy level is high among the respondents and this could have implication on agricultural production as well as efficiency of labour utilization in the area. Education affects labour

productivity through a choice of better inputs and output, and through a better utilization of existing inputs. Adoption of agricultural innovations is also easier and faster among the educated farmers than the uneducated farmers as orchestrated by Nzeakor *et al.*, (2020) and thus, moves them closer to the frontier output. Also, Table 4 revealed that labour productivity was higher for farmers who completed their secondary school

education; female accounted for labour productivity index of 37.89kg/man-day while males accounted for 36.23kg/man-day. The implication is that respondents are better positioned to take advantage of new technique and innovation that could improve

agricultural labour. Improved education level brings about positive changes in the knowledge, attitude and skills through research and extension.

Table 4 Distribution of Respondent based on level of Education

Level of Education	Female Frequency	Percentage (%)	LP	Male Frequency	Percentage (%)	LP
No formal	0	0.00	0	7	11.67	13.24
Primary	19	31.67	33.74	14	23.33	24.18
Secondary	31	51.67	37.89	36	60.00	36.25
Tertiary	10	16.67	12.07	3	5.00	19.2
Total	60	100.0		60	100.0	

Source: Field Survey (2026)

Key: LP = Mean Labour productivity (Kg/man-day)

Distribution of Respondent based on Farming Experience

The Table 5 shows that on average the rice farmers has spent about 14 and 15 years in farming for both male and female respectively with labour productivity at its peak for rice farmers between 11 – 20 years farming experience. Nwaru (2018), noted

that the number of years a farmer spent in farming business is an indication of the practical knowledge he has acquired on how to overcome certain inherent farm production problems. Farmers would count more on their farming experiences for improved output rather than educational attainment.

Table 5: Distribution of Respondent based on Farming Experience

Farming Experience	Female Frequency	Percentage (%)	LP	Male Frequency	Percentage (%)	LP
1-10	20	13.3	20	20	33.33	22.12
11-20	28	26.7	37.89	24	40.00	47.45
21-30	12	23.3	25.81	16	26.67	23.3
Total	60	100.0		60	100.0	
Mean	14			15		

Source: Field Survey (2026)

Key: LP = Mean Labour productivity (Kg/man-day)

Distribution Respondent based on contact with extension Agent Result in Tabe 6 revealed that majority of the female (63.33%) and male (60.0%) rice farmers had contact with the extension agents. The table further reviewed that the rice farmers with extension constant had greater labour productivity. (with female and male having

58.29% and 60.25kg/manday respectively)). This implies that greater numbers of the sampled population had contact with extension visitors. Ukoha *et al.* (2013) reported that better education through improve extension service would lead to improve access to knowledge on improves

farm technologies, farm tools which in turn increase labour productivity.

Table 6: Distribution Respondent based on contact with extension Agent

Extension visit	Female			Male		
	Frequency	Percentage (%)	LP	Frequency	Percentage (%)	LP
Had contact	22	36.67	25.41	24	40.00	32.62
Had no contact	38	63.33	58.29	36	60.00	60.25
Total	60	100.0		60	100.0	

Source: Field Survey (2026)

Key: LP = Mean Labour productivity (Kg/man-day)

Distribution of Respondent based on Farm Size

The mean hectare cultivated was 2.18 and 2.62 for female and male farmers respectively, this shows that male rice farmers have greater farm size than female, this further indicate that a greater percentage of the respondents in the study area had farm size between 1.0 – 2.0 hectare of land under cultivation. This thus pose a great challenge to the much-desired agricultural modernization/mechanization and commercialization in Nigeria need urgent land reform policies and programmes that would give farmers access to more

contiguous land holdings for increased agricultural production. The result supports the assertion made by Issaac et al. (2021), that under inheritance, the whole heirs of every family have their shares of land no matter how fragmented and small their sizes area. The result further revealed that labour productivity decreases as the rice farmers cultivate more hectare of land, this might be due to inefficiency in the use of labour and poor yield. This lays credence to the subsistence farming characteristic in the area.

Table 7: Distribution of Respondent based on Farm Size

Farm size	Female			Male		
	Frequency	Percentage (%)	LP	Frequency	Percentage (%)	LP
0.1-1.0	15	25.00	16.59	10	16.67	14.54
1.1-2.0	18	30.00	35.93	17	28.33	33.11
2.1-3.0	12	20.00	11.59	13	21.67	11.28
3.1-4.0	7	11.67	7.60	8	13.33	19.21
4.1-5.0	5	8.33	6.48	5	8.33	5.11
5.1-6.0	3	5.00	5.51	5	8.33	4.94
6.1- 7.0	0	0.00	0.00	2	3.33	4.68
Total	60	100.0		60	100.0	
Mean	2.18			2.62		

Source: Field Survey (2026)

Key: LP = Mean Labour productivity (Kg/man-day)

Distribution of the Respondents Based on Membership of Farmers' Association

Table 8 showed that majority (53.33%) and (83.3%) of the female and male farmers were member of farmers association. Membership of association satisfies the social needs of farmers in additions to serving as an avenue for access to information on agricultural technology. Also labour productivity of farmers with who belong to association was

higher than farmers who were not members of association this is because farmers by virtue of their membership discern the obvious advantages of labour utilization, access to agricultural technology as well as clarify their misconception of technology and increase their output. However, the farmers do not belong to association may have been ignorant of the obvious gains through membership-the however calls for

conceited extension campaigns for farmers member of co-operative society and

combined (Simonyan *et al.*, 2011).

Table 8: Distribution of the Respondents Based on Membership of Farmers' Association

Association	Female			Male		
	Frequency	Percentage (%)	LP	Frequency	Percentage (%)	LP
Member	49	81.7	64.74	50	83.3	64.97
Non member	11	18.3	18.96	10	16.7	27.90
Total	60	100.0		60	100.0	

Source: Field Survey (2026)

Key: LP = Mean Labour productivity (Kg/man-day)

Distribution of the Respondents Based on Access to Credit

The result in Table 9 indicated that majority (53.3%) and (63.3%) of the female and male farmers were member of farmers association. Also labour productivity of farmers with who have access to credit was higher than farmers who did not have access to credit this is because access to credit increases the income of the farmers, expands farms and enables farmers to acquire technologies; it

also enables farmers to procure farm inputs and hire labour for enhanced labour productivity and income (Idu *et al.*, 2016).The implication of lack of adequate access to credit is in turn believed to have significant negative consequences for aggregate level outcomes, such as technology adoption, agricultural productivity, food security, nutrition, health, and overall farmers welfare

Table 9: Distribution of the Respondents Based on Access to Credit

Access	Female			Male		
	Frequency	Percentage (%)	LP	Frequency	Percentage (%)	LP
Yes	32	53.3	43.91	38	63.3	55.79
No	28	46.7	39.79	22	36.7	37.08
Total	60	100.0		60	100.0	

Source: Field Survey (2026)

Key: LP = Mean Labour productivity (Kg/man-day)

Estimated Production Functions of the Female Farmers

The result in Table 10 revealed that the double-log functional form was selected as the lead equation for female rice farmers based on key econometric and theoretical criteria, including the number of statistically significant variables, the magnitude and stability of the coefficient of multiple determination (R^2), conformity of coefficient signs with a priori expectations, and the overall significance of the F-ratio. The R^2 value of 0.724 indicates that about 72.4% of the variation in output among female rice farmers was jointly explained by the explanatory variables that were included in the production function.

Empirically, farm size, labour, and planting materials emerged as the significant determinants of output among female rice farmers. The coefficient of farm size was positive and statistically significant at the 5% level, implying that increases in cultivated land led to higher output levels. This result is consistent with the findings Aigbokie *et al.* (2024), who observed that limited access to farmland remains one of the most critical constraints to rice production in South East Nigeria, thereby reinforcing the importance of land availability in determining output levels. However, their broader discussion also suggests that productivity may not always increase proportionally with farm

size due to differences in input intensity and resource efficiency across farms.

Labour was also positively signed and statistically significant at the 5% level, indicating that increases in labour use significantly raise output among female rice farmers. This finding reflects the highly labour-intensive nature of rice production in Nigeria, where most farm operations still depend on manual effort due to limited mechanization. Aigbokie *et al.* (2023) emphasized that efficient labour utilization plays a crucial role in improving agricultural productivity, although inefficiencies in labour allocation may reduce marginal returns in some production systems. Similarly, Mbam and Edeh reported that labour can either enhance or reduce output depending on how effectively it is combined with other inputs, highlighting the importance of optimal resource use in farm production systems.

Furthermore, planting materials (improved seeds) were positively signed and highly significant at the 1% level, indicating that improved seed usage significantly enhances rice output. This finding underscores the critical role of technological inputs in raising agricultural productivity, particularly in smallholder systems where yield gaps remain substantial. Aigbokie *et al.* (2025) noted that access to improved inputs and modern production technologies significantly improves farm efficiency and output performance among agricultural households. In a related perspective, Idu *et al.* (2025) observed that access to productive resources, including improved inputs and financial services, strongly influences production decisions and efficiency among rural farmers. This reinforces the view that improved planting materials are essential for enhancing productivity and ensuring sustainable increases in rice output.

Table 10: Estimated Production Functions of the Female Farmers

Variables	Linear	Exponential	Double log+	Semi log
Intercept	142752.966 (2.741)***	12.172 (78.223)***	6.736 (7.801)***	-3234958.285 (-6.069)***
Capital (X_1)	0.220 (0.138)	2.356E-6 (0.624)	-0.005 (-0.303)	-1300.695 (-.138)
Farm size (X_2)	5428.236 (1.717)*	0.014 (1.447)	0.054 (2.177)**	29743.968 (1.960)*
Labour (X_3)	9657.241 (1.392)	0.012 (0.558)	0.074 (2.216)**	44719.341 (2.168)**
Cost of material (X_4)	7.273 (8.478)***	1.766E-5 (6.889)***	0.576 (7.203)***	340908.123 (6.902)***
Fertilizer (X_5)	10.733 (0.387)	2.078E-6 (0.025)	0.028 (0.724)	9692.470 (0.410)
R^2	0.711	0.612	0.724	0.691
R^2	0.683	0.576	0.698	0.661
F-ratio	25.083***	17.015***	28.333***	22.808***

Source: Field survey (2026)

Key: + = lead equation, *** = Significant at 1%, ** = Significant at 5% and * = significant at 10%

Estimated Production Functions of the male Farmers

The result in Table 11 revealed that the double-log functional form was selected as the lead equation for female rice farmers based on key econometric criteria, including the number of statistically significant variables, the magnitude and stability of the coefficient of multiple determination (R^2), conformity of coefficient signs with a priori

expectations, and the overall significance of the F-ratio. The R^2 value of 0.885 indicates that approximately 88.3% of the variation in output among the farmers was jointly explained by the included explanatory variables, reflecting a strong explanatory power of the model in capturing the determinants of rice production.

Results further show that farm size, labour, and fertilizer were the significant variables

influencing the output of female rice farmers. The coefficient of farm size was positive and statistically significant at the 5% level, indicating that increases in cultivated land led to higher output levels. This implies that expansion in farm size enhances production capacity by allowing farmers to scale up operations. Aigbokie *et al.* (2025) similarly observed that increased hectare cultivated is associated with higher output levels among rice farmers, although they noted that the efficiency of other complementary inputs also determines the extent of productivity gains from land expansion.

Labour was also found to be positive and statistically significant at the 5% level, implying that an increase in labour usage leads to higher output among female rice farmers. This result reflects the labour-intensive nature of agricultural production in Nigeria, where human labour remains a critical input due to limited mechanisation. This finding is consistent with Obike *et al.* (2016), who established that labour

significantly influences farm output among smallholder farmers, and Obike *et al.* (2019), who further highlighted that household resource allocation decisions, including labour and investment patterns, play a major role in determining farm performance and productivity outcomes.

Fertilizer use was statistically significant at the 1% level and positively related to output, indicating that higher fertilizer application significantly increases rice production. This suggests that improved soil nutrient management through fertilizer application enhances crop yield and overall productivity. This result is consistent with the broader agricultural evidence that input intensification improves farm performance and efficiency. Obike *et al.* (2019) also noted that access to productive resources such as credit significantly influences farmers' ability to invest in yield-enhancing inputs like fertilizer, thereby improving farm output.

Table 11: Estimated Production Functions of the Farmers

Variables	Linear	Exponential	Double log+	Semi log
Intercept	47825.106 (0.708)	11.907 (66.399)***	3.733 (5.991)***	-2814500.122 (-7.329)***
Capital (X ₁)	1.197 (0.794)	4.719E-6 (1.178)	0.005 (0.423)	-3021.561 (-.394)
Farm size (X ₂)	3958.320 (1.144)	0.019 (2.069)**	0.064 (2.287)**	1574.774 (0.091)
Labour (X ₃)	26554.385 (2.714)***	0.060 (2.318)**	0.158 (2.118)**	107016.371 (2.326)**
Cost of material (X ₄)	7.408 (9.069)	1.701E-5 (7.839)***	0.836 (14.884)***	292885.117 (8.461)***
Fertilizer (X ₅)	17.489 (0.647)	3.353E-5 (0.467)	0.015 (0.440)	18479.232 (0.880)
R ²	0.746	0.675	0.883	0.754
R ⁻²	0.722	0.645	0.872	0.731
F-ratio	31.678***	22.431***	81.198***	33.087***

Source: Field Survey (2026)

Key: + = lead equation, *** = Significant at 1%, ** = Significant at 5% and * = Significant at 10%

Elasticity of Production for Male and female Rice Farmers

Result in Table 12 reveals clear gender differences in returns to scale among rice farmers in the study area. For the male farmers, the returns to scale coefficient are 1.078, indicating increasing returns to scale.

This implies that a proportional increase in all inputs leads to a more than proportionate increase in output. In practical terms, it shows that male farmers are operating in Stage I of the production surface, where resources are still underutilized and there is substantial room for expansion in input use.

At this stage, production has not reached optimal efficiency, as additional inputs continue to generate increasing marginal gains, reflecting significant untapped productive capacity within the farming system.

In contrast, the female farmers recorded a return to scale coefficient of 0.725, indicating decreasing returns to scale. This suggests that a proportional increase in all inputs results in a less than proportionate

increase in output. Practically, it implies that female farmers are operating in Stage II of the production surface, which is considered the rational stage of production where inputs are still productive but begin to exhibit diminishing efficiency. At this stage, output can still be increased through additional inputs, but at a decreasing rate, reflecting diminishing marginal returns consistent with classical production theory.

Table 12: Overall Elasticity of Production for Male and female Rice Farmers

Resources	Male ai	Implications	female ai	Implications
Farm size	0.005		-0.005	
Labour	0.064		0.054	
Planting materials	0.158		0.074	
Fertilizer	0.836		0.576	
Capital	0.015		0.028	
Summation of ai	1.078	Ep>1 (Increasing returns to scale)	0.727	Ep<1 (decreasing returns to scale)

Source: Field Survey Data, 2026

Constraints in rice production rice farmers

The results presented in Table 13 reveal clear gender-based differences in the constraints affecting rice production among farmers in Enugu State. Using a 5-point Likert scale, constraints with mean scores of 3.0 and above were regarded as serious, while those below 3.0 were considered less serious. Among male rice farmers, the most severe constraint was high incidence of pests ($\bar{X} = 4.05$, 1st), indicating that pest infestation significantly threatens rice productivity. This aligns with the well-established evidence that pests account for substantial global crop losses and remain a major threat to food security and farm productivity. This was followed closely by high interest rate on loans ($\bar{X} = 4.00$, 2nd) and lack of collateral required to secure loans ($\bar{X} = 4.00$, 2nd), both

of which highlight serious financial access limitations. Similar evidence from Obike *et al.* (2019) shows that limited access to credit significantly constrains farm investment decisions and reduces farmers' ability to adopt improved technologies. Scarcity of farmland ($\bar{X} = 3.19$, 3rd) also ranked high, reflecting increasing pressure on land availability for rice cultivation in densely populated farming communities. This agrees with Aigbokie *et al.* (2024), who identified land scarcity as a major structural constraint limiting rice production in South East Nigeria. Other important constraints included high cost of inorganic fertilizer ($\bar{X} = 3.16$, 4th), high cost of improved varieties ($\bar{X} = 3.16$, 4th), and lack of market, roads and social facilities ($\bar{X} = 3.16$, 4th), all of which reflect input and infrastructural bottlenecks that reduce production efficiency.

Table 13: Constraints in rice production rice farmers

Constraint	Male Mean score	Ranking	Female Mean score	Ranking
High cost of inorganic fertilizer	3.16	4 th	2.81	9 th
Scarcity of farm land	3.19	3 rd	3.55	3 rd
Instability in government policy	2.98	6 th	3.46	4 th
Poor access to good road	2.96	7 th	3.32	5 th
Lack of technical knowledge	2.91	8 th	3.58	2 nd
High interest rate on loan	4.00	2 nd	2.18	10 th
High cost of improved varieties	3.16	4 th	3.71	1 st
Poor extension agent farmers contact	2.41	9 th	3.58	2 nd
Lack of market, roads and social facilities	3.16	4 th	3.71	6 th
High cost of agrochemicals	3.00	5 th	3.32	5 th
Unavailability of labour	2.98	6 th	2.89	8 th
High incidence of pests	4.05	1 st	3.00	7 th
Lack of collateral required to secure loan	4.00	2 nd	3.71	1 st

Source: Field Survey (2026)

For female rice farmers, the most serious constraint was high cost of improved varieties ($\bar{X}$ = 3.71, 1st), indicating limited access to productivity-enhancing technologies. This is consistent with the findings of Idu *et al.* (2025), who noted that access to productive resources such as improved inputs strongly influences production outcomes among rural farmers. This was followed by lack of technical knowledge (mean = 3.58, 2nd) and poor extension agent–farmer contact ($\bar{X}$ = 3.58, 2nd), both of which reflect weak agricultural knowledge dissemination systems. This supports the argument of Aigbokie *et al.* (2023) that inadequate extension services remain a major barrier to agricultural productivity improvements in South East Nigeria. Scarcity of farmland ($\bar{X}$ = 3.55, 3rd) also emerged as a major constraint, indicating that women face structural barriers in accessing productive land resources. Instability in government policy ($\bar{X}$ = 3.46, 4th) and poor access to good roads ($\bar{X}$ = 3.32, 5th) further demonstrate institutional and infrastructural limitations affecting production efficiency. Comparatively, the results show that while both male and female farmers face common constraints such as land scarcity, poor infrastructure, and high input costs, the severity and nature differ by

gender. Male farmers are more affected by financial barriers and production risks such as pest infestation and high borrowing costs, while female farmers are more constrained by limited access to technical knowledge, extension services, and improved inputs.

CONCLUSION

The study estimated the production function and examined gender-based differences in elasticity of production and returns to scale among rice farmers in Enugu State, Nigeria. The findings revealed that the double-log functional form provided the best fit for both male and female rice farmers. The study further showed that farm size and labour significantly influenced rice output for both genders, while planting materials were more important for female farmers and fertilizer was more influential among male farmers. The elasticity analysis indicated that male rice farmers operated under increasing returns to scale, suggesting that inputs were still underutilized and that output could be increased with additional resource use. Female rice farmers, however, operated under decreasing returns to scale, indicating that production was already in the rational stage of production where additional inputs yield diminishing returns. The study therefore established that significant gender-

based differences exist in production efficiency, resource utilization, and responsiveness to production inputs among rice farmers in the study area.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:

- i. Government and agricultural development agencies should improve farmers' access to farmland through land reform policies and gender-inclusive land allocation systems.
- ii. Subsidized and timely distribution of fertilizer and improved rice seeds should be provided to farmers to enhance productivity.
- iii. Female rice farmers should be given targeted support such as credit facilities, input subsidies, extension services, and training programmes to improve their production efficiency.
- iv. Farmers should be encouraged to adopt labour-saving technologies and improved farm management practices to increase labour efficiency and reduce production costs.
- v. Agricultural extension agents should intensify training on efficient resource allocation and modern rice production techniques for both male and female farmers.

REFERENCES

- Abdul-Gafar Ahmed, Shiwei Xu, Wen Yu, and Yu Wang (2017), "Comparative Study on Factors Influencing Rice Yield in Niger State of Nigeria and Hainan of China. *International Journal of Agricultural and Food Research [IJAFR]* ISSN 1929-0969 Vol. 6 No. 1, pp. 15-25.
- Abdul-Gafar, A., Xu, S. W., & Yu, W. (2016). Perceptions of rice farmers towards production constraints: Case study of Niger State of Nigeria and Hainan of China. *Journal of Agricultural Chemistry and Environment*, 5, 20–30.
- Adegbite D.A. and Oluwalana E.O (2004). "Revolving loan Scheme as a Poverty Alleviation Strategy: A case Study of Women Groups in UNAAB Extension Villages" *FAMAN Journal*, Vol. 7 (2), 2004, Pp18-32.
- Aigbokie, S. O., Ibe, G. I. C., Inyang, N. N., Eze, A. A., Bassey, I., Uchendu, C. O. and Umeadi, S. C. (2021). Gender differentials in labour source and utilization among rural Rice farmers In Enugu State, Nigeria. *Nigerian Agricultural Journal*. Volume 52 Number 1 April 2021 Pg. 181-187.
- Aina, O. I. (2002). General overview of the status of women in Nigeria. In A. Akiyode-Afolabi (Ed.), *Gender gaps in the 1999 Constitution of Nigeria* (pp. 9–41). Lagos, Nigeria: Women Advocates Research and Documentation Centre (WARDC).
- Ajani, O. I. Y. (2008). Gender dimensions of agriculture, poverty, nutrition and food security in Nigeria. Abuja, Nigeria: Nigeria Strategy Support Programme (NSSP), IFPRI.
- Akanji, B. (1997). The gender implications of structural adjustment for women farmers and their households. In P. K. Garba, B. Akanji, & I. Isiugo-Abanihe (Eds.), *Women and economic reforms in Nigeria* (pp. 127–131). Ibadan, Nigeria: WORDOC.
- Carr, E. R. (2008). Men's crops and women's crops: The importance of gender to the understanding of agricultural and development

- outcomes in Ghana's Central Region. *World Development*, 36(5), 900–915.
- Doku, E. B. (1990). A framework for integrating gender interest in development programme in Ghana. In *Proceedings of the UNDP International Conference on Planning for Growth and Development in Africa*. University of Ghana, Legon.
- Food and Agriculture Organization of the United Nations (FAO). (2013). *Rice Market Monitor*. Rome, Italy: Food and Agriculture Organization of the United Nations. Retrieved on 11 June 2026.
- Federal Republic of Nigeria. (2007). *Official Gazette*. Abuja, Nigeria.
- Food and Agriculture Organization of the United Nations (FAO). (2013). *Rice Market Monitor*. FAO. Retrieved on 11 June 2026.
- Global Development Research Centre (2002). *GDRC Special Focus on Gender Analysis Framework*. Available at <http://www.gdrc.org/gender/framework/g-framework.html> Retrieved on 11 June 2026.
- Idu M.A and Aigbokie S.O (2021). Expository Analysis of Labour Utilization and Cost Efficiency of Food Crop Credit Beneficiaries in Abia State, Nigeria. In: Onwumere J.C., Ogbonna M.C&Obasi I.O (Eds) repositioning agriculture for economic development in Nigeria. *Book of readings in Honour of Professor Remmy Onyekachi Mejeha*. Academic Researcher Committee of friends of Professor Remmy Onyekachi Mejeha. 128 – 133
- IFAD (International Fund for Agricultural Development). (2008). *Improving access to land and tenure security*. Accra, Ghana: IFAD. Retrieved on 11 June 2026.
- Ikassim, A., & Olayinka, O. (2012). Study on agricultural output contribution of smallholder farmers in Nigeria (details not fully available). Retrieved on 11 June 2026.
- International Labour Organization (ILO). (1984). *Rural women and agricultural production*. Geneva, Switzerland: ILO. Retrieved on 11 June 2026.
- Issaac, C. R. and Aigbokie S. O. (2021). Determinants of Food Crop Farmers Preference for Risks and Coping Strategies in Abia State, Nigeria. *International Journal of Applied Research and Technology*. 10(10): 3 – 9.
- Job N and Adebola A (2015) 2-4 February 2015- Istanbul, Turkey Proceedings of INTCESS15- 2nd International Conference on Education and Social Sciences 311 ISBN: 978-605-64453-2-3
- Kinkingninhoun-Medagbé, F. M., Diagne, A., Simtowe, F., Agboh-Noameshie, A. R., & Adégbola, P. (2008). Gender discrimination and its impact on income, productivity and technical efficiency: Evidence from Benin. *Agriculture and Human Values*, 25(4), 515–523.
- Longpichai, O., Perret, S. R., & Shivakoti, G. P. (2012). Role of livelihood capital in shaping farming strategies of smallholder rubber producers in

- southern Thailand. *Outlook on Agriculture*, 41(2), 117–124.
- Mbam, B. N., & Edeh, H. O. (2011). Resource use efficiency in rice production in Nigeria. *Journal of Agricultural Science*, 3(3), 150–160.
- Muthayya, S., Sugimoto, J. D., Montgomery, S., & Maberly, G. F. (2014). An overview of global rice production, supply, trade, and consumption. *Annals of the New York Academy of Sciences*, 1324, 7–14.
- National Bureau of Statistics (NBS). (2024). *Selected Food Prices Watch Report, 2024*. Abuja, Nigeria: National Bureau of Statistics, pp. 1–180.
- Nzeakor, F.C., Aigbokie A.O & Nwabuisi J.C (2020) Determinants of participation in rice processing among rural women in Abia State. In: J.C Nwaru., C.A Okezie., M.E Njoku., K.C Igwe., O.R Iheke., B.C Okoye., I.O Obasi., T.A Amusa and L.D.N Nnadozie (Eds) repositioning agriculture for economic development in Nigeria. *Book of readings in Honour of Professor Christian Ejike Onyenweaku*. AEC-MOUAU publication, Umudike, Nigeria. Pp. 199 – 205.
- Obike, K.C., Idu, M.A and Aigbokie S.O (2016). Labour Productivity and Resource Use Efficiency Amongst Smallholder Cocoa Farmers in Abia State, Nigeria. *Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension*; Volume 15 Number 3 (September 2016) pp. 7 – 12.
- Obike, K.C., Aigbokie S.O and Adilieme C. C (2019). *Effect of agricultural credit on farm household investment in Abia state, Nigeria*. *Journal of Agricultural Economics, Extension and Social Sciences*. Vol. 2(1) 57 – 64. <http://www.unijos.edu.ng/jaeess>
- Obike, K.C., Nse-Nelson F.A., Aigbokie S.O and Emezie G. (2016). Determinant of off-farm income diversification among small scale farmers in Abia State, Nigeria. *Nigerian Southeast Journal of Agricultural Economics and Extension* 14 (1&2) 83 – 95.
- Obike. K.C, Ebe, F.E., Idu, M. A., Aigboke, S.O. and Lugard E.G, (2017) “Labour Productivity and Yield Determinants in Cocoa Farming: Evidence from Abia State, Nigeria; *Nigerian Agricultural Policy Research Journal*. Volume 2, Issue 1, 2017. <http://aprnetworkng.org> Pp114 -122.
- Okoye, B.C. (2006). Efficiency evaluation of small holder cocoyam production in Anambra State, Nigeria. An M.Sc Thesis, Department of agricultural Economics, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.
- Olayide, S. O. (2002). *Agricultural production in Nigeria: Problems and prospects*. Ibadan, Nigeria: University of Ibadan Press, pp. 1–245.
- Olukunle, O. T. (2013). Challenges and prospects of agriculture in Nigeria: The way forward. *Journal of Economics and Sustainable Development*, 4(16), 37–46.
- Oluyole, K.A., O.A. Dada, O.A. Oni, S. Adebisi, O.O. Oduwole, (2013). Farm Labour Structure and Its Determinants among Cocoa Farmers in Nigeria. *American Journal of*

- Rural Development*, 1(1):1-5.
DOI:10.12691/ajrd-1-1-1.
- Onyenweaku, C. E., & Nwaru, J. C. (2005). Application of production function in farm efficiency analysis. *Journal of Agricultural Economics*, 7(2), 77–85.
- Schneider, S. (2005). *Human capital is the key to growth: Success stories and policies for 2020*. Deutsche Bank Research Global Growth Centre. Vol. 2, Issue 1, pp. 15–47. Seck, P. A., Diagne, A., Mohanty, S., & Wopereis, M. C. S. (2013). Crops that feed the world 7: Rice. *Food Security*, 5, 7–24.
- Shaib, B., Aliyu, A., & Bakshi, J. S. (1997). *Nigeria national agricultural research strategy plan: 1996–2010*. Abuja, Nigeria: Federal Ministry of Agriculture and Natural Resources. Retrieved on 11 June 2025.
- Simonyan, J. B., Umoren, B. D. and Okoye, B. C. (2011), ‘Gender Differentials in Technical Efficiency among Maize Farmers in Essien Udim Local Government Area, Nigeria’, *International Journal of Economics and Management*, Vol. 1, No. 2, pp. 17– 23.
- Surakiat, P., Maichum, K., & Peng, K. C. (2017). Evaluating technical efficiency of rice production using a modified three-stage data envelopment analysis approach: A case study in Thailand. *International Journal of Scientific & Technology Research*, 6(1), 152–160.
- Ukoha OO, Okoye BC, Emetu J (2013). Analysis of the Determinants of total Factor Productivity among Smallholder Cassava Farmers in Ohafia LGA of Abia, *Int. J. Agric. Rural Dev.* 1(4):97-101.
- United Nations. (2006). *Final report of the Commission on Human Security*. New York, NY: United Nations. Retrieved on 15 March 2024. West Africa Rice Development Association (WARDA). (2003). *Rice in West Africa*. Bouaké, Côte d’Ivoire: WARDA. Retrieved on 22 August, 2017.