

# GENDER DIFFERENTIALS IN FARM LEVEL EFFICIENCY IN RICE PRODUCTION AMONG SMALLHOLDER RICE FARMERS IN FEDERAL CAPITAL TERRITORY, NIGERIA

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## ABSTRACT

*Farm-level efficiency plays a crucial role in achieving the expected agricultural productivity, which can lead to sustainability and food security for Nigeria's growing population. However, smallholder rice farmers are producing at a level below their potential efficiency. This study evaluated gender differentials in farm-level efficiency in rice production among smallholder farmers in the Federal Capital Territory, Nigeria. This study employs a random sampling technique. The data were collected using well-structured questionnaires, which utilized cross-sectional data from 316 smallholder rice farmers. They were analyzed using a stochastic production frontier, stochastic cost frontier, and Tobit regression model. The results show that the statistically significant factors influencing technical efficiency, allocative efficiency and economic efficiencies of rice production for male and female smallholder rice farmers were age ( $P < 0.01$ ), sex ( $P < 0.05$ ), household size ( $P < 0.1$ ), years schooling ( $P < 0.05$ ), nonfarm income ( $P < 0.1$ ), access to credit ( $P < 0.01$ ), extension contact ( $P < 0.05$ ), unit price ( $P < 0.05$ ) and price information ( $P < 0.1$ ), respectively. The average economic efficiency score index obtained by male and female smallholder rice farmers was 51.6% and 55.5%, respectively, and the pooled index was 54.6%. The findings of this study suggest that credit facilities should be made available to farmers at single digit rate to acquire farm inputs such as seed, fertilizer and agrochemicals timely, extension services should be provided to farmers to teach them the application of farm inputs appropriately, they should also be encouraged to join cooperative associations to have access to production resources easily and market their product collectively to earn higher profit, improve their welfare and livelihood.*

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## INTRODUCTION

Rice (*Oryza sativa* L) is very important crop in Nigeria, it is used for preparation of local delicacies and dishes in our homes, and as a special food for ceremonies, and festivals contributing a significant proportion of the food requirements of Nigerians (Sanusi et al., 2022). However, the country has not been able to produce sufficient quantity to meet up with consumers' demand for the past years, the production capacity of rice is low and below the national requirements in Nigeria, though it is contributing significantly to the food security of the larger population. Smallholder rice farmers mostly produced low output and are characterize by inefficient production, aging population and low technological know-how (Aboaba, 2020). The production of rice in Nigeria rose from 3.7 million metric tons in 2017 to 4.0 million metric tons in 2018, in spite the increase in rice production only 57 percent of the 6.7 million metric tons of rice consumed in Nigeria per annum is produced locally resulting in a deficit of about 3 million metric tons, which is either smuggled or imported into the country. Also in 2020 Nigeria's rice production was 4.89 million metric tonnes and rose to 5.0 million metric tonnes in 2021. In order to stimulate and increase local production, the Government of Nigeria banned importation of rice in 2019 into the country. From (2016–2019), Nigeria's cumulative aggregate agricultural imports between 2016 and 2019 stood at N3.35 trillion, four times higher than the agricultural export of N 803 billion within the same period. The term efficiency of a firm can be defined as its ability to produce the largest possible quantity of output from a given set of inputs. The modern theory of efficiency dates back to the pioneering work, who proposed that the efficiency of a firm has two components namely:

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technical and allocative efficiency and the combination of these two components provide a measure of total economic efficiency (overall efficiency). Technical efficiency is the ability to produce a given level of output with a minimum quantity of inputs. It is measured either as input conserving oriented technical efficiency or output-expanding oriented technical efficiency (Ifeanyichukwu et al., 2018). Measurement of farm efficiency via frontier approach has been widely utilized and studied (Ifeanyichukwu et al., 2018). The term frontier involves the concept of maximization in which the function sets a limit to the range of possible observations. The observation of points below the production frontier for firms producing below the maximum possible output can occur, but there cannot be any point above the production frontier given the available technology. Deviations from the frontier are attributed to inefficiency. Despite the contribution of Agriculture to the economy, Nigeria's agricultural sector faces many challenges which impact on its productivity (Aboaba, 2020). These include; poor land tenure system, low level of irrigation farming, climate change and land degradation. Others are low technology, high production cost and poor distribution of inputs, limited financing, high post-harvest losses, poor access to markets and inadequate or low access to credit, despite the increasing importance of formal credit to farmers, rice farmers had limited access to credit facilities. Study by and Addison et al. (2016) showed that that the male and female headed households had differences in endowments (land rights, education) and differences access to technologies, factors of production, and support services. These differences in turn had implications for the productivity levels and adoption capacities of both types of farming households. Gender differentials in relation to farm productivity in subsistence farming has been of special interest from the standpoint of public policy in developing countries, as the difference is often viewed from the angle of human capital theory and measurement of discrimination. Gender differences in technical efficiency was not considered by the authors in the existing literatures in the country for male and female rice farmers, there exists a gap on differences in farm level efficiencies across male and female rice farmers. Generally female farmers access to productive resources is inadequate and limited them could not have technical training in modern technologies, credit facilities, membership of cooperatives, and markets, resulting in low productivity and income inequality between themselves and their male counterparts Addison et al. (2016). Hence, bridging these existing gaps for women or female to have access to productive and financial facilities is a critical strategy for increasing productivity in the agricultural industry including rice sector. Most studies on efficiency focus on technical efficiency (Ebukiba et al., 2020); Ifeanyichukwu et al., 2018) and profit efficiency Abdulai, Nkegbe, & Donkoh, 2018; Mabe, Donkoh, & Al-hassan, 2018). The inability of farmers to obtain the expected yields could be attributed to the low efficiency level of resource use Tasila Konja et al. (2019) which needs to be investigated. The demand for rice in Nigeria has been on increase on daily basis while the supply is low leading to perpetual increase in price which is now beyond the capacity of a common man creating demand and supply gap. This study provides valuable feedback for policy initiatives to mitigate the gender gap in agricultural productivity as reported by (Sadiq et al., 2021). Hence, this study provided useful information for policy formulation regarding gender inclusion through estimating the identified gap in existing literatures by examining the differences in farm level efficiencies in rice production among male and female smallholder rice farmers in the Federal Capital Territory, Nigeria.

The broad objective of this study is to analyze gender differential in farm level efficiencies in rice production among smallholder farmers in Federal Capital Territory, Nigeria. The specific objectives of this study is to estimate the gender differences in factors influencing technical efficiency, allocative efficiency and economic efficiency of rice production among smallholder rice farmers in the study area. The results show that factors influencing technical efficiency, allocative efficiency and economic efficiency were age of the farmers, sex, farming experience, household size, extension contact, price information and cooperative association. The results further revealed that average economic efficiency score index obtained by male and female smallholder rice farmers were 51.6% and 55.5% and pooled 54.6%, respectively. The paper has five sections section one is introduction, section two deals with literature review, section three focuses on materials and methods while section four presents the results and discussion and section five draws conclusion and suggested policy recommendations from the research.

## LITERATURE REVIEW

Gender is defined as a social construct that identifies the socially expected rights, responsibilities, privileges and obligations of males and females. Gender role refers to the socially differentiated roles assigned to males and females (Addison et al., 2016). Evaluated gender analysis of resource use and efficiency in rice production in Kogi State, Nigeria. The result of the analysis revealed that access to productive resources among men and women farmers in the study area is generally low. Yet, women access is lower compared to men. The study also, revealed that there is gap in decision making on productive resource between" men and women rice farmers: The factors that affects the technical efficiency includes sex, extension service, land capital and gender. Evaluated gender gap in agricultural productivity in Nigeria: a commodity level analysis. The mean pairwise comparisons was used to examine the extent of gender gap in agricultural productivity, access to inputs including other variables; non-parametric quantile regression technique was also applied in order to determine the relationship that exist between the use of inputs and gender gaps in total farm outputs. The finding revealed that gender there is a gap in farm output which was low with quantity harvested and quantity sold by male managed plots was marginally higher than female managed plots by 0.22% and 6.24% respectively. The gender gap in farm productivity are linked to farming experience which in longer in favour of men and there are labour market imperfection which is also biased against women farmers. A study conducted by Danso-Abbeam et al. (2020) on Gender differentials in technical efficiency of Ghanaian cocoa farms using two-stage double bootstrap data envelopment analysis (DEA) procedure in order to estimate the technical efficiency level scores for male and female cocoa farm managers. The outcome of the analysis revealed that there exists a potential for male and female cocoa farm managers to increase output without changing the quantities of farm inputs used. They further applied the Blinder-Oaxaca (B-O) extended version decomposition approach, their findings suggested that the female plot managers are on high average less technically efficient when compared with their male

counterparts. The identified gap in technical efficiency between female and male farmers could be because of disparity in their resource endowments. The findings also indicate that differences in educational level attainment, participation in non-farm activities, and farm size may contribute to the unexplained technical efficiency gap.

## MATERIALS AND METHODS

### Materials and Methods

This study was conducted in Federal Capital Territory, Nigeria. Federal Capital Territory was created and carved out in 1976 from the Kaduna, Niger, Kwara and Plateau States. Multi-stage sampling technique was adopted and employed for this study. The required sample size was determined by the formula and it is specified as follows;

$$n = \frac{Z^2 \cdot p \cdot q}{e^2} = 316 \tag{1}$$

Where;

$n$  = Sample Size,  $Z^2$  = Confidence Level ( $\alpha = 0.05$ );  $p$  = Proportion of the Population Containing the major interest (29%),  $q = 1-p = 71\%$  and  $e$  = error or Precision level. Hence,  $Z = 1.96$ ;

$$\frac{(1.96)^2 \cdot (0.29) \cdot (0.71)}{(0.05)^2} = 316 \tag{2}$$

This gives a sample size of 316 smallholder rice farmers in the study area.

### Method of Data Analysis

Descriptive statistics and Inferential statistics were used for analyzing the collected data from the field. The following analytical tools were employed and used to achieve the stated objectives of the study:

### Stochastic Frontier Production Function Model

This study applied stochastic frontier production function model developed by Aigner *et al.* (1977) which is stated as follows

$$Y_i = f(X_i, \beta)\epsilon, i = 1, \dots, N \tag{3}$$

Where

$$\epsilon = v_i - u_i \tag{4}$$

The Stochastic Frontier Model is stated thus:

$$Y_i = F(X_i, \beta) + \epsilon_i \tag{5}$$

$$Y_i = f(X_1, X_2, X_3, X_4, X_5, X_6, V - U_i) \tag{6}$$

$$\ln Y_i = \beta_0 + \sum_{i=1}^6 \beta_i \ln X_i + \dots \beta_n \ln X_n + V - U_i \tag{7}$$

The explicit function is stated thus:

$$Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + V_i - U_i \tag{8}$$

Where,

$Y_i$  = Total Output of Rice (Kg)

$X_1$  = Seed Input (Kg)

$X_2$  = Farm Size (Hectares)

$X_3$  = Quantity of Organic Fertilizer (Kg)

$X_4$  = Quantity of Inorganic Fertilizer (Kg)

$X_5$  = Agro-Chemical Input (Litres)

$X_6$  = Labour Input (Mandays)

$\beta_0$  = Constant Term

$\beta_1 - \beta_6$  = Regression Coefficients

The Technical Inefficiency Component of the Stochastic Frontier Model is stated thus:

$$U_i = \alpha_0 - \alpha_1 Z_1 - \alpha_2 Z_2 - \alpha_3 Z_3 - \alpha_4 Z_4 - \alpha_5 Z_5 - \alpha_6 Z_6 - \alpha_7 Z_7 - \alpha_8 Z_8 - \alpha_9 Z_9 - \alpha_{10} Z_{10} - \alpha_{11} Z_{11} \tag{9}$$

Where,

$U_i$  = Technical Inefficiency Component

$Z_1$  = Sex (1, Male; 0, Otherwise)

$Z_2$  = Age of rice Farmers (Years)

$Z_3$  = Education Level of the rice Farmers (Years Spent Schooling)

$Z_4$  = Non-Farm Income (Naira)

$Z_5$  = Access to Credit (1, Access; 0, Otherwise)

$Z_6$  = Extension Contact (Number of Contact per Month)

$Z_7$  = Farming Experience (Years)

$Z_8$  = Unit Price of Rice Per Bag

$Z_9$  = Price Information Dummy (1, Access; 0, Otherwise)

$Z_{10}$  = Household Size (Number)

$Z_{11}$  = Cooperative Association (1, Access; 0, Otherwise)

$\alpha_0$  = Constant Term

$\alpha_1 - \alpha_{11}$  = Regression Coefficients

$V_i$  = Error Term

$U_i$  = Measure of Inefficiency

**Stochastic Cost Frontier Function**

$$C_i = f(P_i, \gamma) \exp(V_i + U_i); i = 1, 2, \dots, n \tag{10}$$

$$\ln C_i = \gamma_0 + \sum_{i=1}^6 \gamma_i \ln P_i + \dots \gamma_n \ln P_n + V + U_i \tag{11}$$

The explicit form of the stochastic cost frontier function is specified as:

$$\ln C_i = \gamma_0 + \gamma_1 \ln P_1 + \gamma_2 \ln P_2 + \gamma_3 \ln P_3 + \gamma_4 \ln P_4 + \gamma_5 \ln P_5 + \gamma_6 \ln P_6 + \gamma_7 \ln P_7 + V_i + U_i \tag{12}$$

Where,

$\ln$  = Natural Logarithm

$C_i$  = Total Cost of Rice Production

$\gamma_0$  = Intercept term

$\gamma_1 - \gamma_6$  = Partial Regression Coefficients (Elasticities of Production)

$P_1$  = Cost of Seed

$P_2$  = Cost of Land (Rent)

$P_3$  = Cost of Organic Fertilizer Cow Dung

$P_4$  = Cost of Inorganic Fertilizer NPK

$P_5$  = Cost of Agro-chemical Input

$P_6$  = Cost of Labour Input

$V_i$  = Two-sided Idiosyncratic Error Term

$U_i$  = Non-negative error term (Measure of Inefficiency) assumed to be truncated below by zero.

The Allocative efficiency of individual farmers is defined in terms of the ratio of the predicted minimum cost ( $C_i^*$ ) to observed cost ( $C_i$ ). Allocative efficiency (AE) of farm-level is computed and obtained by using the relationship:

$$AE = \frac{C_i^*}{C_i} = \exp(\mu_i) \tag{13}$$

Therefore, Allocative efficiency is an inverse function of cost efficiency  $\frac{1}{CE}$  and so ranges between 0 and 1 as used by Okello *et al.*, (2019).

The Allocative Inefficiency Model is Stated as Follows:

$$U_i = \alpha_0 - \alpha_1 \delta_1 - \alpha_2 \delta_2 - \alpha_3 \delta_3 - \alpha_4 \delta_4 - \alpha_5 \delta_5 - \alpha_6 \delta_6 - \alpha_7 \delta_7 - \alpha_8 \delta_8 - \alpha_9 \delta_9 - \alpha_{10} \delta_{10} - \alpha_{11} \delta_{11} \tag{14}$$

**Where:**

$U_i$  = Allocative Inefficiency Component

$\delta_1$  = Sex of Farmers Dummy Variable (1=Male and 0 = Female)

$\delta_2$  = Age of Farmers (Years)

$\delta_3$  = Educational Level (Number of Years of Formal Education)

$\delta_4$  = Non-farm Income (Naira)

$\delta_5$  = Access to Credit (Amount Borrowed in Naira)

$\delta_6$  = Extension Visit (Number of Visit Per Year)

$\delta_7$  = Farming Experience (Years)

$\delta_8$  = Unit Price Per Bag (Naira)

$\delta_9$  = Price Information (Dummy 1, Yes; 0, Otherwise)

$\delta_{10}$  = Household Size (Number of Persons)

$\delta_{11}$  = Co-operative Association (1, Access; 0, Otherwise)

$\alpha_0$  = Intercept

$\alpha_1 - \alpha_{11}$  = Parameters to be Estimated

**Economic Efficiency Model**

Following Haruna *et al.* (2021) the overall economic efficiency was estimated as:

$$EE_n = TE_n \times AE_n \tag{15}$$

Where,

EE = Economic Efficiency (Units)

TE = Technical Efficiency (Units)

AE = Allocative Efficiency (Units)

When EE=1, the firm is economically efficient and EE<1 means the firm is economically inefficient.

**Tobit Regression Model (ML)**

The Tobit regression model was used to evaluate the socioeconomic factors influencing economic efficiency among

smallholder rice farmers in the study area. Following as also used by (Aboaba, 2020; Okello et al., 2019; Danso-Abbeam et al., 2020; Kamau, 2019).

The Tobit model is specified as:

$$y_i = y^* = X_i + \varphi_i + \varepsilon_i$$

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The observed  $y_i$  can be defined as:

$$y_i = \begin{cases} y^* & \text{if } y^* \geq \tau \\ \tau & \text{if } y^* < \tau \end{cases}$$

$$i = 1, 2, 3, 4 \dots n$$

**Where:**

$y_i$  = Refers to the observable which is a censored variable that measure economic efficiency among the smallholder rice farmers

$y^*$  = This is the latent variable which indicates that economic efficiency may be directly observable or it may not be directly observable.

Therefore, Economic efficiency was observed if  $y^* \geq \tau$  and unobservable if  $y^* < \tau$

$X_i$  = These are the explanatory variables that are in the inefficiency model

$\varphi_i$  = These are parameters which was estimated

$\varepsilon_i$  = Stochastic, error or disturbance term

The formula becomes

$$y_i = \begin{cases} 1 & \text{if } y^* \geq 1 \\ y^* & \text{if } 0 < y^* < 1 \\ 0 & \text{if } y^* \leq 0 \end{cases}$$

The values were only observed when they fall within the range of 0 and 1. Any value below 0 and above 1 were termed as an unobserved latent or hidden variable.

The Tobit regression model is explicitly specified as follows:

$$\begin{aligned} \ln Y_i &= \gamma_0 + \sum_{i=1}^{11} \varphi_i X_i + \dots + \varphi_n X_n + \varepsilon_i & 17 \\ Y_i &= \varphi_0 + \varphi_1 X_1 + \varphi_2 X_2 + \varphi_3 X_3 + \varphi_4 X_4 + \varphi_5 X_5 + \varphi_6 X_6 + \varphi_7 X_7 + \varphi_8 X_8 + \varphi_9 X_9 + \varphi_{10} X_{10} \\ &+ \varphi_{11} X_{11} \varepsilon_i & 18 \end{aligned}$$

**Where**

$Y_i = (y^* > 0$  if a farmer is economically efficient and if  $y^* \leq 0$  if a farmer is economically not efficient)

$\varphi_1$  = Sex of the Household Head Dummy (1, Male; 0, otherwise)

$\varphi_2$  = Age of the Farming Household Head (Years)

$\varphi_3$  = Education Level (Number of Years in School)

$\varphi_4$  = Non-Farm Income Level of the Household Head (Naira)

$\varphi_5$  = Access to Credit Dummy (1, Yes; 0, otherwise)

$\varphi_6$  = Extension Services (Number of Contact)

$\varphi_7$  = Farming Experience (Years)

$\varphi_8$  = Unit Price Per bag (Naira)

$\varphi_9$  = Price Information (1, Yes; 0, Otherwise)

$\varphi_{10}$  = Household Size (Number)

$\varphi_{11}$  = Cooperative Association (1, Yes; 0, Otherwise)

**RESULTS**

Gender Differences in Estimates of the Factors Influencing Technical Efficiency of Rice Production among Male and Female Smallholder Farmers. Table 1 presents the results of the estimates of the parameters included in the stochastic frontier production function using maximum likelihood method of estimation. In the technical efficiency component, six (6) variables were included in the model, four (4) variables were statistically significant for male smallholder rice farmers they are: seed input, farm size, inorganic fertilizer and labour input. Four variables were also significant for female rice farmers they were: seed input, farm size, inorganic fertilizer and labour input. The pooled data show that about four (4) variables were statistically significant which includes: farm size, inorganic fertilizer, agrochemical and labour input. The estimated coefficient of seed input influence total output of rice production for male smallholder farmers positively and it was statistically significant at (P<0.05). Seed input was also significant for female smallholder rice farmers (P<0.01). The coefficient of seed input for male smallholder rice farmers was (0.1266), for female rice farmers (0.1626). This implies that a percentage change in the quantity of seed input planted as results of more usage holding other variables constant will result in the increase in the total output of rice for male and female smallholder farmers by 12.6% and 16.3%, respectively. Farmers with access to improved seed varieties stand a chance of having optimum yield per hectare. This result is consistent with the findings of Aboaba (2020); Okello et al. (2019) who reported positive relationships between the quantities of seed planted and the total output of rice. Farm size influences the total output of rice for male and female smallholder farmers

positively and was statistically significant at ( $P < 0.01$ ). The pooled data show that farm size was also statistically significant at ( $P < 0.01$ ) probability level. The coefficient of farm size for male rice farmers (0.4561), for female rice farmers (0.3698) and for the pooled data (0.4393) signifies that percentage change in farm size due to farm expansion will lead to 45.2% and 36.9% increase in total output of rice for male and female smallholder rice farmers and 43.9% increase in the total output of rice for the pooled sampled smallholder farmers respectively in the study area. This is because land is the primary factor for rice production, as land size increases output of rice will also increase in conformity with predicted a priori expectation. This is in line with the findings of Yusuf (2022) who reported positive relationship between farm size and output of rice in Kwara State, Nigeria. Addison et al. (2016) also reported positive association between output of rice with the farm size and suggested that farmers' yield is sensitive to farm size in Ahafo Ano North District in Ashanti Region of Ghana. Inorganic fertilizer influences total output of rice for male and female smallholder farmers positively, the pooled sample further show that inorganic fertilizer has a positive influence on the total output of rice among smallholder farmers. The coefficient of inorganic fertilizer for male rice farmers (0.1148), and for female rice farmers (0.2345) and for pooled data (0.2152) were statistically significant at ( $P < 0.10$ ) for smallholder male rice farmers, ( $P < 0.05$ ) for female smallholder rice farmers, and ( $P < 0.01$ ) for pooled sampled respondents, respectively. This implies that a percentage change in the quantity of inorganic fertilizer applied to the rice farm by smallholder farmers will result in the increase in total output of rice by 11.5% for male smallholder farmers, 23.4% increase in the total output for female farmers and 21.5% for pooled sampled smallholder rice farmers respectively. Inorganic fertilizer increases yield potential of rice when it is applied timely and appropriately as a result of additional nutrient added to the soil that could increase rice yield. This result corroborates with positive influence between inorganic fertilizer (chemical fertilizer) and output of rice. Agrochemical influence total output of rice positively for male and negatively for female farmers, but it was not statistically significant. The pooled data shows that agrochemical influence total output of rice negatively among smallholder rice farmers and it was statistically significant at ( $P < 0.05$ ) probability level. The coefficient of agrochemical for pooled sample data (-0.1581) implies that a percentage change in the quantity of agrochemical applied to rice farm will result in the decrease in the total output of rice by 15.8%. This could be as a result of improper application of agrochemical due to lack of technical know-how which could not give an effective result in controlling weeds, pests and diseases. This result is in consonance with Yusuf (2022) who posited that there is a negative relationship between agrochemical and output of rice in Kwara State Nigeria. The results are contrary to the findings of Gela et al. (2019) and Aboaba (2020) who asserted that agrochemicals had positive and significant influence on total output of rice production in West Gondar Zone of Ethiopia and Ogun State, Nigeria respectively. The result is also in conformity. Labour input influence total output of rice for male and female farmers positively and it was statistically significant at ( $P < 0.01$ ). The pooled sample also show that labour input had positive influence on total output of rice among sampled smallholder rice farmers and it was statistically significant at ( $P < 0.01$ ) probability level. The coefficient of labour input for male was (0.4322), for female (0.3526), and for pooled sample (0.2654), this indicates that a percentage change in the labour input supply for rice production will result in the increase in total output of rice by 43.3% for male rice farmers, 35.3% for female rice farmers and 26.5% for pooled sample respectively. This is consistent with Amaechina and Eboh (2017) who reported that labour had positive influence on rice output in Anambara State, Nigeria. The results are also in line with findings of Yusuf (2022) who found positive relationship between labour and output of rice. The technical inefficiency component revealed that out of eleven (11) variables that was included in the inefficiency model, eight (8) variables were statistically significant in influencing technical efficiency for male smallholder rice farmers, while seven (7) variables were statistically significant for female smallholder rice farmers, the pooled data show that eight (8) variables were statistically significant in influencing technical efficiency of rice production. The negative sign of the coefficients of the variables implies a decrease in the technical inefficiency or increase in technical efficiency of rice production among smallholder rice farmers in the study area. Gender of the smallholder rice farmers influence technical inefficiency of rice production negatively and it was statistically significant at ( $P < 0.01$ ) probability level, the coefficient of the pooled data (-0.1472) signifies that a unit change in sex meaning a possibility of farmer being a male rice farmer will result in the increase in technical efficiency by 14.7% for male sampled smallholder rice farmers in the study area. This is in line with who reported that male farmers are more efficient than female counterparts. Age of the sampled smallholder rice farmers influence technical inefficiency positively for male farmers and negatively for female farmers and was statistically significant at ( $P < 0.01$ ) respectively. The pooled data revealed that age of the sampled smallholder rice farmers influence technical efficiency positively implying that a unit change in the age of female farmer will result in increase in the level of technical efficiency in rice production positively. The magnitude of the coefficient of the age of male farmers (1.3201), and female farmers (-0.01317) and for pooled data (0.0137) implies that a unit change in the age of the farmers will result in decrease in technical efficiency for male smallholder rice farmers by 132%, and increase in technical efficiency for female rice farmers by 1.3% and increase in technical efficiency by 1.4% for pooled data. This could occur as the male farmers become older they don't take risk and adopt new innovation and technology thereby rendering them technically inefficient, this result show that younger farmers were more efficient because younger farmers adopt new technology and innovation easily. This conforms to the findings of Yoezer (2023) who reported that younger farmers are more receptive, better knowledge and have management skills compared to the older rice farmers. This result is also in line with the findings of Wijaya et al. (2022) who reported that age has negative influence on technical efficiency of rice production in East Java just as in the case of female rice farmers, this could be so because as farmers grow older they accumulate experience and enables them to be familiar with soil management practices and appropriate resource allocation. Years of schooling influence technical inefficiency for male and female smallholder rice farmers negatively, and it was statistically significant at ( $P < 0.10$ ) and ( $P < 0.01$ ) respectively. The pooled data also revealed that number of years schooling influence technical inefficiency negatively and it was statistically significant at ( $P < 0.01$ ) probability level. The magnitude of the coefficient of years schooling for smallholder male rice farmers (-0.0245), female rice farmers (-0.0505) and for pooled data (-0.1052). This

indicated that a unit change in the years of schooling for smallholder rice farmers will result in the increase in the technical inefficiency by 2.5% for male rice farmers, 5.1% for female rice farmers, and 10.5% for the pooled data. Years schooling indicate more knowledge as years spent in school increases knowledge will also increase and the knowledgeable farmers adopt new innovation, takes more risks and also enables them to source for information regarding rice production which could make them technically efficient. This is in line with Tasila Konja et al. (2019) and Aboaba (2020) who reported negative association of education with technical inefficiency meaning educated farmers are technically more efficient than those without education. Access to credit influence technical inefficiency of rice production among smallholder farmers negatively for male and female farmers and likewise pooled data and it was statistically significant at ( $P < 0.05$ ) probability level for male rice farmers, and ( $P < 0.01$ ) for female farmers and also ( $P < 0.01$ ) for pooled sample respectively. The magnitude of the coefficient of access to credit for male rice farmers (-0.0548), for female rice farmers (-1.2832) and for pooled data (-0.1026). This implies that a unit change in access to credit facilities by smallholder rice farmers will result in 5.5% increase in technical efficiency for male farmers, and 128.3% increase in technical efficiency for female rice farmers, while for pooled sample it leads to 10.25% increase in technical efficiency among the sampled smallholder farmers in the study area. This finding show that access to credit plays an important role in rice production, amount of credit access will enable the smallholder rice farmers to purchase farm inputs and all the necessary equipment required to improve rice production, which could increase technical efficiency among smallholder farmers. The results of this study is in consonance with Ebukiba et al. (2020) and Wijaya et al. (2022) who posited that as farmers has more access to credit will lead to accessibility of input easily which could increase output of rice thereby increasing technical efficiency among small scale farmers. Extension contact influence technical inefficiency for male smallholder rice farmers negatively and was statistically significant at ( $P < 0.01$ ) but not significant for female rice farmers, extension contact was statistically significant ( $P < 0.01$ ) for pooled sample data. The magnitude of the coefficient of the extension contact for male smallholder rice farmers was (-0.4369) and for pooled sample (-0.1052), this implies that a unit change in extension contact will result in the increase in technical efficiency by 43.7% for male farmers, and 10.5% increase in technical efficiency for pooled sample in the study area. Access to extension services equips smallholder rice farmers with knowledge on farm management practices that could lead to increase in their technical efficiency. This is in consonance with the findings of Ismail and Mahmud (2023) who asserted that farmers with access to extension services stand a chance of having higher technical efficiency than those without access to extension services in rice production. Farming experience influence technical inefficiency for male and female smallholder rice farmers negatively and it was statistically significant at ( $P < 0.01$ ) and ( $P < 0.05$ ) respectively. The pooled sampled data also revealed that farming experience negatively influence technical efficiency and it was statistically significant at ( $P < 0.05$ ) probability level. The magnitude of the coefficient of farming experience for male and female farmers was (-0.0620) and (-0.5361) respectively and for pooled data (-0.0041), signifies that a unit change in the years of farming experience will result in 6.2% and 53.6% increase in technical efficiency or decrease in technical inefficiency for male and female smallholder rice farmers respectively in the study area. The pooled data show that a unit increase years of farming experience will lead to 0.4% increase in technical efficiency among smallholder rice farmers. Experience in rice farming enables farmers to accumulate knowledge on how to manage their rice farms well and also equips rice farmers with technical know-how on how to use the available resources effectively. This result is in conformity who reported that farmers with accumulated experience of rice farming tends to be more technically efficient than those farmers that has less farming experience in rice production Unit price influence technical inefficiency among smallholder rice farmers negatively for both male and female rice farmers and was statistically significant at ( $P < 0.01$ ) respectively. The pooled sample data show that unit price of rice was also statistically significant at ( $P < 0.05$ ) probability level. The magnitude of the coefficient of unit price for sampled smallholder rice farmers was for male rice farmers (-0.5766), for female rice farmers (-0.0132), and for pooled sample was (-0.0686). This implies that a unit change in the unit price of rice per bag will result in the increase in the technical efficiency of rice production for male rice farmers by 57.7% and 1.3% for female rice farmers, and also the pooled sample show 6.9% increase in technical efficiency among smallholder rice farmers respectively. Increase in unit price may increases farmers' income, this could give them ability to have enough money or capital and capacity to purchase farm inputs like fertilizer, improve seed varieties, agrochemicals and even purchase farm machineries that could lead to increase in technical efficiency and maximize profit. Unit price has influence on rice productivity in Federal Capital Territory, Nigeria. Household size influence technical inefficiency of rice production negatively for male and female smallholder rice farmers and was statistically significant at ( $P < 0.01$ ) and ( $P < 0.10$ ) probability levels respectively. The pooled data show that household size also influences technical inefficiency negatively and was statistically significant at ( $P < 0.01$ ). The magnitude of the coefficient of the household size for the sampled smallholder rice farmers were for male rice farmers (-0.4546), while for female rice farmers (-0.0048) and for the pooled sample data was (-0.3361). The implication of these is that a unit change in the number of household size will result in the increase in technical efficiency for male rice farmers by 45.5% and 0.5% for female rice farmers and 33.6% increase in technical efficiency for sampled pooled data. Household with large number of persons has more supply of labour which reduce cost of hiring labour and have a chance of expanding their production capacity that could lead to increase in technical efficiency. This result is in conformity with the findings of Yoezer (2023) and Ebukiba et al. (2020) who found negative relationships between household size and technical efficiency, this could be due to fact that household with larger family size has the capacity to supply more resources in terms of household labour for rice output production. Cooperative association influence technical inefficiency negatively in the study area but wasn't significant for male rice farmers but it was statistically significant for female smallholder farmers at ( $P < 0.01$ ) probability level. The pooled sample also show that cooperative association was statistically significant at ( $P < 0.01$ ). The magnitude of the coefficient of cooperative association for female rice farmers was (-0.2351), while for pooled sample was (-0.1883), this implies that a unit change for being a member of cooperative association by female smallholder rice farmer will result in increase in technical efficiency in rice production by 23.5% and increase in technical efficiency for pooled sample by 18.8%

among the sampled rice farmers. Cooperative association helps farmers to come together and market their farm produce, pull their resources together and purchase farm inputs in bulk at lower price rate. This result is consistent with the findings of Wijaya et al. (2022) who reported that being a member of cooperative association will enable farmers to have access to price information and farm inputs at a lower cost because the farmers might purchase their inputs in bulk at a low price rate which could enable them to save cost and in turn make them technically efficient and maximize profit that could improve their welfare and livelihood.

Table 1. Results of the Maximum Likelihood Estimates of the Stochastic Frontier Production Function of Rice Farmers in the Study Area

Variable	Male Farmers			Female Farmers			Pooled Sample		
	Coefficients	Std Error	Z-Score	Coefficients	Std Error	Z-Score	Coefficient	Std Error	Z-Score
Total Output									
Seed Inputs	0.1266**	0.0625	2.03	0.1626***	0.0159	10.25	-0.1119	0.0840	-1.33
Farm Size	0.4516***	0.0889	5.09	0.3698***	0.1318	2.81	0.4393***	0.0779	5.64
Organic Fertilizer	0.0505	0.0763	0.66	-0.0243	0.1509	-0.16	-0.0202	0.0681	-0.30
Inorganic Fertilizer	0.1148*	0.0627	1.83	0.2345**	0.1137	2.06	0.2152***	0.0631	3.41
Agro-Chemical	0.0322	0.0904	0.36	-0.1742	0.1073	-1.62	-0.1582**	0.0710	-2.23
Labour	0.4327***	0.0812	5.33	0.3526***	0.1167	3.02	0.2654***	0.0455	5.83
Constant	3.3108	0.5579	5.93	2.7570***	0.7566	3.64	2.7104	0.4501	6.02
Technical Inefficiency Model									
Gender	-----	-----	-----	-----	-----	---	-.1472***	0.0451	-3.26
Age	1.3201***	0.3793	3.48	-0.0132***	0.0053	-2.49	-	0.0035	-3.85
							0.0137***		
Years Schooling	-0.0245*	0.0129	-1.90	-0.0505***	0.0151	-3.33	-0.1052***	0.0329	-3.19
Non-farm Income	-0.0538	0.1552	-0.35	-0.0089	0.0189	-0.47	0.0064	0.0076	0.83
Access to Credit	-0.0548**	0.0234	-2.34	-1.2832***	0.4544	-2.82	-0.1025***	0.0361	-2.84
Extension Contact	-0.4369***	0.0459	-9.50	0.0019***	0.0032	0.59	-0.1052***	0.0329	-3.19
Farming Experience	-0.0620***	0.01767	-3.51	-0.5361**	0.2570	-2.09	-0.0041**	0.0016	-2.43
Unit Price	-0.5766***	0.2320	-2.49	-0.0131***	0.0053	-2.47	-0.0685**	0.0333	-2.06
Price Information	-0.0373	0.0271	-1.38	0.0151	0.0194	0.78	0.0566	0.0355	1.60
Household Size	-0.4546***	0.0282	-	-0.0048*	0.0028	-1.69	-0.3361***	0.0534	-6.29
			16.23						
Coop Association	-0.1327	0.4444	-0.29	-0.2351***	0.9527	-2.47	-0.1883***	0.0359	-5.23
Diagnostic Statistics:									
Log likelihood	5.6856			80.2339			18.8692		
Sigma square	0.1881			0.0477			0.0527		
Gama	0.4442			0.0866			0.5105		

\*Significant at 10%, \*\* Significant at 5%, \*\*\* Significant at 1% Probability Levels

Source: Computed from Field Survey Data (2023)

**Distribution of Technical Efficiency Level Differences of Male and Female Smallholder Rice Farmers**

Table 2 presents the summary statistics of technical efficiency scores of male and female smallholder rice farmers. About 19.2% of the male smallholder rice farmers, 19.4% of female smallholder rice farmers and 19.9% of the pooled sample has a technical efficiency score between 41% to 60 % efficiency levels. About 17% of the male rice farmers, 14.18% of the female rice farmers and 15.5% of the pooled sampled smallholder rice farmers attained 61% to 80% level of technical efficiency respectively. Most of the smallholder rice male farmers (48.3%), female farmers (47.76%) and pooled sample (47.15%) obtained a technical efficiency score of 81-100% respectively. This implies that most farmers were technically efficient to certain level. The minimum technical efficiency score obtained by the smallholder rice male farmer was 0.018, female smallholder rice farmer was 0.115 and the pooled sampled smallholder rice farmers was 0.0158. The mean technical efficiency obtained by smallholder rice male farmers was 70.2%, while female rice farmers obtained mean technical efficiency of 68.9% and pooled sample of 69.7% leaving a gap of 29.8% for improvement for male rice farmers, 31.1% for female rice farmers and 30.3% for pooled sample, which need to be filled with the existing technology and innovation. The best performing smallholder rice male farmer had the maximum technical efficiency of 100% which is the maximum attainable technical efficiency when resources are utilized efficiently, while female rice farmer had 98.9% and the pooled sample of 100%. The higher technical efficiency scores for smallholder rice male farmer could be attributed to their higher

labour participation in rice production and larger farm size. This result is in line with the findings of Addison et al. (2016) who reported that male farmers are more technically efficient than female rice farmers in Ashanti Region of Ghana and Ethiopia respectively. This distribution of technical efficiency among rice farmers in this study corroborates the findings of Mabe et al. (2018); Tasila Konja et al. (2019) and Abdulai et al. (2018) who reported similar finding on technical efficiency distribution.

Table 2. Distribution of Technically Efficiency Score among Male and Female Rice Farmers in the Study Area

Technical Efficiency Score	Male Farmers		Female Farmers		Pooled Sample	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0-0.2	10	5.49	8	5.97	24	7.59
0.21-0.4	18	9.9	17	12.69	31	9.81
0.41-0.6	35	19.23	26	19.40	63	19.94
0.61-0.8	31	17.03	19	14.18	49	15.51
0.81-1	88	48.35	64	47.76	149	47.15
Minimum	0.0158		0.1152		0.0158	
Maximum	1.0791		0.9891		1.0791	
Mean TE	.7024		.6894		0.6968	

Source: Computed from Field Survey Data (2023)

### Gender Differences in Factors Influencing Allocative Efficiency of Rice Production among Smallholder Rice Farmers

The results of the maximum Likelihood estimates of the parameters of the stochastic cost frontier is presented in Table 3. The cost of seed had positive coefficient and was statistically significant at ( $P < 0.01$ ) probability levels for both men and female rice farmers in influence total cost of rice production among smallholder farmers. The coefficient of cost of seed for male rice farmers was (0.2299), for female rice farmers was (0.1799) and for pooled sampled smallholder rice farmers was (0.2139). This implies that percentage change in the cost of seed input will result in the increase in the total cost of rice production among smallholder rice farmers by 22.9% for male farmers, 17.9% for female farmers and 21.4% for the pooled sample. Seed inputs is very important in rice production it determines the quality of rice yield output, an increase in quantity of seed planted increases total cost of rice production. This is line with the findings of Aboaba (2020) who reported positive influence of cost of seed on total cost of rice production in Ogun State and Abuja, Nigeria. Cost of land rent influence total cost of rice production positively for female rice farmers and for pooled sampled data and it was statistically significant at ( $P < 0.01$ ) probability level respectively. The coefficient for cost of land rent for female rice farmers was (0.2185) and for pooled sample data was (0.0711). This signifies that percentage change in the cost of land rent will result in the increase in the total cost of rice production by 21.9% for the female rice farmers, and 7.1% for the pooled sample data. This could be so because land is a vital resource that particularly used in rice production any increase in the rent of land will lead to increase in the total cost of production. This is in conformity with the findings of Aboaba (2020); Melese et al. (2019) and Gela et al. (2019) who reported positive relationship between cost of land and cost of rice production. Total output had a positive influence on the total cost of production for smallholder rice male farmer, and it was statistically significant at ( $P < 0.01$ ). The coefficient of total output was (0.3800). This implies that a percentage change in the total output of rice produced will result in the increase in total cost of rice production by for male farmers by 38%. This result is in line with who reported that as the quantity of total output increases more resources would have been purchased thereby increasing the total cost of production for male farmers in the study area. Cost of organic fertilizer influence total cost of rice production among smallholder rice farmers positively for both male and female farmers, the pooled data also revealed that cost of organic fertilizer has a positive influence on the total cost of rice production. The coefficient of the cost of organic fertilizer for male rice farmers is (0.0935), female rice farmers (0.0884) and was statistically significant at ( $P < 0.01$ ) probability levels for male, female rice farmers and pooled sampled data respectively. This implies that percentage change in the cost of organic fertilizer will result in the increase in total cost of production for male farmers by 9.4%, for female rice farmers by 8.3%, and pooled sample by 8.8% respectively. This is in support of the findings who reported positive effect of organic fertilizer on total cost of rice production in Adamawa State, Nigeria. Cost of inorganic fertilizer influence total cost of rice production for male and female smallholder rice farmers positively, and it was statistically significant at ( $P < 0.01$ ) probability levels respectively. The pooled sample data also show that cost of inorganic fertilizer influence total cost of rice production positively and was also significant at ( $P < 0.01$ ). The coefficient of the cost of inorganic fertilizer for male smallholder rice farmers was (0.2221), for female smallholder rice farmers was (0.1336) and for pooled sample data was (0.1584). This implies that percentage change in the cost of inorganic fertilizer will result in the increase in the total cost of rice production for male smallholder rice farmers by 22.2%, for smallholder female farmers by 13.3%, and for pooled sample by 15.8% respectively. Fertilizer play an important role in provision of required soil nutrient in rice production, as the quantity of fertilizer usage increases the cost will likewise increase and it will in turn result in the increase in the total cost of rice production. This result is consistent with the findings who posited that cost of inorganic fertilizer increases total cost of rice production. Cost of agrochemical influence total cost of rice production positively for male and female smallholder rice farmers and also positively for the pooled sample data and it was statistically significant at ( $P < 0.01$ ) probability level. The coefficient of the cost of agrochemical for male and female smallholder rice farmers were (0.1147) and (0.1321) respectively, and the coefficient of cost of agrochemical for the pooled sampled data was (0.1551). This implies that percentage change in the cost of agrochemical will lead to increase in the total cost of rice production among male and female farmers by 11.5% and 13.2% respectively. The result of the pooled sample data show that percentage change in the cost of agrochemical will result in 15.5% increase in the total cost of rice production among smallholder farmers. More

usage of the quantity of the agrochemical in rice farm will result in the increase in the total cost of rice production. This finding is consistent with the finding of Sadiq et al. (2021) who asserted that an increase in the cost of agrochemical variable results in the increase in the total cost of rice production. Cost of labour input influence the total cost of rice production for male and female smallholder rice farmers positively. The pooled sampled data revealed that the cost of labour input influence total cost of rice production positively. Cost of labour was statistically significant in influencing total cost of production for both male and female smallholder rice farmers and for the pooled sample data at ( $P < 0.01$ ) probability level. The coefficient of cost of labour input for male smallholder rice farmers was (0.3637), for female smallholder rice farmers (0.1345) and for the pooled sample (0.3033). This signifies that percentage change in the cost of labour input will lead to increase in the total cost of rice production for male and female smallholder rice farmers by 36.4% and 13.5% respectively. The pooled sample data show an increase in total cost of rice production by 30.3%. Employing more labour force in rice production by smallholder rice farmers will result in the increase in total cost of production. Cost of labor is the highest cost involved in rice production due to different activities that is involved in the production process. This is in consonance with the findings of Aboaba (2020) who corroborates that any increase in the cost of labour will result in the increase in the total cost of rice production in the study area. The results are in line with the findings who posited that crop production is relatively sensitive to labor as number of labor supply increases the cost will increase thereby resulting in the increase in total cost of production. The allocative inefficiency component show that sex of the female smallholder rice farmers influences allocative inefficiency negatively and it was statistically significant at ( $P < 0.05$ ), the pooled sample was also statistically significant at ( $P < 0.10$ ) probability level. The pooled sample indicated the coefficient of gender influence (i.e) farmer being a male smallholder rice farmer will result in the increase in the allocative efficiency by 15.2%. This is in line with the findings who found that male farmers were efficient in cost allocation in rice production in Gambia. Age of the sampled smallholder rice farmers influence allocative inefficiency positively for male farmers and it was statistically significant at ( $P < 0.10$ ). Age had negative coefficient for female rice farmers, the pooled sample also show that age influence allocative inefficiency positively. The coefficient of the age for male smallholder rice farmers (0.2050), for female rice farmers (-0.2102) and for pooled sampled data (0.2802), this signifies that a unit change in the age of the sampled smallholder farmers will result in the decrease in allocative efficiency for the male rice farmers by 20.5% and 21% increase in the allocative efficiency for the female smallholder rice farmers, the pooled sampled data show that age of the farmers will result in the decrease in the allocative efficiency of the smallholder rice farmer by 28.1% in the study area. This could be because the older farmer has less possibility of accepting modern approaches and adoption of technologies, young farmers are more cost efficient than older farmers because they are more knowledgeable, risk averse and more versatile in sourcing productive information regarding input prices. This is in line with who reported that an increase in age makes older farmers less cost efficient. Years schooling of the sampled smallholder rice farmers influence allocative inefficiency negatively for both male and female smallholder rice farmers and was statistically significant at ( $P < 0.05$ ). The pooled sample result show that years of schooling also influence allocative inefficiency of the smallholder rice farmers negatively meaning that a unit change in the years of schooling will result in the increase in allocative efficiency for male and female smallholder rice farmers by 7% and 26.4%, respectively. The pooled sample result also indicated that a unit change in the years of schooling will result in the increase in the allocative efficiency by 22.4%. Farmers with formal system of education are able to source, acquire, process and comprehend important productive information about input mix and production management practices which could increase their ability to make informed decisions to adopt technologies and innovations regarding rice production. This in line with Abdul et al. (2017) and Sadiq et al. (2021) who found negative relationship between years of schooling and allocative efficiency. Formal education of farmers plays critical role in influencing the efficiency of rice production. Nonfarm-income influence allocative inefficiency for male smallholder rice farmers negatively and it was statistically significant at ( $P < 0.1$ ) probability level. The pooled sample show that non-farm income also positively influence allocative inefficiency of the smallholder rice farmers and it was statistically significant at ( $P < 0.10$ ) probability level. The coefficient of the non-farm income for male smallholder rice farmers (-0.0649) and pooled (0.0555). This implies that a unit change in the non-farm income will result in the increase in the allocative efficiency for the male rice farmers by 6.5% and 5.5% decrease in the allocative efficiency for the pooled sampled farmers. Farmers who were engage in off-farm activities has the ability to earn income and improved productive efficiency. This agrees with the finding of Wakili and Isa (2015) who found non-farm income to have negative influence on allocative efficiency and posited that farmers with non-farm income are more likely to adopt new innovation and technologies like improve seeds varieties, fertilizers and agrochemical than their counterparts. Access to credit facilities influence allocative inefficiency negatively for male and female smallholder rice farmers and it was statistically significant at ( $P < 0.01$ ) probability level. The pooled sample show that access to credit facilities influence allocative inefficiency of rice production negatively and was also statistically significant at ( $P < 0.05$ ). The coefficient of access to credit for male smallholder rice farmers (-0.2142), while for female smallholder rice farmers (-0.1535) and for pooled sample (-0.1486), this signifies that a unit change in the access to credit facilities will result in the increase in the allocative efficiency for male smallholder rice farmers by 21.4% and for female farmers by 15.4% and for pooled sample by 14.9%. This could occur because access to credit facilities could enable smallholder rice farmers to purchase their farm input at appropriate time when the prices are low enabling the farmers to allocate cost efficiently. This result is consistent with the findings of Musa et al. (2015) and Haile (2015) who asserted that farmers who has access to credit for rice production can afford the improved-yielding inputs such as improved seed varieties, fertilizers and labor saving inputs like herbicides. This could increase rice yield for farmers, reduce production cost that can translate into increase in productivity and profitability. Extension contact influence allocative inefficiency for male and female smallholder rice farmers negatively and was statistically significant at ( $P < 0.05$ ) and ( $P < 0.01$ ) respectively. The pooled sample further show that extension contact had negative coefficient and was statistically significant at ( $P < 0.1$ ) probability level. The coefficient of the extension contact for smallholder male rice farmers (-0.0714), for female rice farmers (-0.5958) and for the pooled sample (-0.1223).

This implies that a unit change in the extension contact will result in 7.1% and 59.6% increase in the allocative efficiency for both male and female smallholder rice farmers, the pooled sample indicate 12.2% increase in the allocative efficiency for the sampled smallholder rice farmers in the study area. This could occur as a result or due to advices that the extension officers may proffer to the rice farmers on how to utilize production inputs such as inorganic fertilizer, agrochemical and improved seed varieties in order to avoid waste such that the farmers will not over utilize their available resources and as a result it may reduce cost of purchasing input among farmers and improve allocative efficiency. This result is consistent with the findings who found negative relationship between extension contact and allocative inefficiency. Farming experience influence allocative inefficiency for the smallholder female rice farmers negatively and it was statistically significant at (P<0.05) probability level. The pooled sample show that farming experience influence allocative inefficiency negatively and it was statistically significant at (P<0.05) probability level. The coefficient of the farming experience for smallholder female rice farmers (-0.1925) and for pooled sample (-0.1486), this implies that a unit increase in the years of farming experience of the smallholder female rice farmers will result in the increase in the allocative efficiency by 19.3% and 14.9% increase in the allocative efficiency for the pooled sample in the study area. Farmers who have been planting rice for so long of time will be able to predict accurately when to plant, the type of seed to plant and the amount of inputs to utilize in production season. Experience accumulated over the years equips farmers with production knowledge that could make them effective in cost allocation in rice production, they will be able to purchase their inputs accordingly and avoid waste of resources that could lead to increase in cost of production and decrease profit and efficiency level. This is in consonance with Yoezer (2023) who reported negative influence of farming experience on rice production inefficiency and explained that experienced farmers understand soil and water management and conservation practices more than farmers that are inexperienced in rice production which could lead to increase in their allocative efficiency. Unit price of rice influence allocative inefficiency negatively for both male and female smallholder rice farmers and it was statistically significant at (P<0.05) probability level. The pooled sample show that unit price had negative coefficient and was also significant at (P<0.05) probability level. The coefficient of the unit price for smallholder male rice farmers (-0.0713) and for smallholder female rice farmers (-0.1121), while for pooled sample (-0.0418), this implies that a unit increase in the unit price of rice per bag will result in the increase in the allocative efficiency of the male and female smallholder rice farmers by 7.1% and 11.2% respectively, and also 4.2% increase in allocative efficiency of smallholder rice farmers for pooled data in the study area. Price of rice produce plays a vital role in the production process and is the major determinant of revenue, as price increases farmers profit will also increase thereby enabling the farmer to have enough funds to purchase production inputs. This conforms to the findings of Khounthikoumane, Chang, and Lee (2021) who asserted that unit price or selling price has influence on revenue in rice production as the revenue increases farmers' ability to allocate cost efficiently increases. Household size influence allocative inefficiency negatively for male and female smallholder rice farmers and it was statistically significant at (P<0.01) and (P<0.10) respectively. The pooled sample smallholder rice farmers show that the household size was statistically significant at (P<0.01). The coefficient of household size for smallholder male rice farmers (-0.3846) for smallholder female rice farmers (-0.0037) and the pooled sample (-0.8362), this signifies that a unit change in the number of household size by one person will result in the increase in the allocative efficiency for smallholder male rice farmers by 38.5% and 0.4% for the smallholder female rice farmers. The pooled sample show that as household size increases by one unit it will result in the increase in the allocative efficiency of the smallholder rice farmers by 3.8%. Larger household size supplies more labour for rice production and as a result the farmers will not pay for hired labour due to availability of family labour thereby leading to increase in the allocative efficiency of the smallholder rice farmers. This supports the findings of Musa et al. (2015) who corroborates that most farmers depend on household supply of labour in order to increase rice production due to its availability, it is inexpensive and very easy to allocate for different farm activities more especially during the period of rice planting, weeding and harvesting season. Cooperative association influence allocative inefficiency negatively for smallholder female rice farmers and it was statistically significant at (P<0.1). The pooled sample show that cooperative association had negative coefficient and was statistically significant at (P<0.05) probability level. The coefficient of the cooperative association for smallholder female rice farmers was (-0.2257) and for pooled sample (0.0918), this implies that a unit change in the possibility of the smallholder female rice farmers being a member of cooperative association will result in the increase in the allocative efficiency for female rice farmers by 22.5%, while for the pooled sample will result in the increase in the allocative efficiency by 9.2%. Cooperative association helps farmers to pull their resources together in order to purchase production input in bulk at a lower price, this could lead to reduction in cost of production thereby leading to increase in allocative efficiency of the smallholder rice farmers in the study area. This result is in line with the findings of Mwangi et al. (2020) and Okello et al. (2019) who found cooperative membership to be significantly influencing allocative efficiency and posited that farmers who belong to cooperative association or farmers group can have access to production inputs, credit facilities, agricultural training and also linkage to product market and this could improve rice farmers productivity as a result of proper and efficient allocation of available resources.

Table 3. Results of the Maximum Likelihood Estimates of the Stochastic Cost Frontier Estimates of Rice Production in the Study Area

Items Variable	Male Farmers			Female Farmers			Pooled Sample		
	Coefficients	Std Error	Z-Score	Coefficients	Std Error	Z-Score	Coefficients	Std Error	Z-Score
Cost of Seed	0.2299* **	0.0258	8.91	0.1799***	0.0294	6.12	0.2138***	0.0242	8.82
Total Output	0.3800***	0.0370	10.26	0.0257	0.0280	0.92	0.1713***	0.0297	5.77

<b>Cost of Land Rent</b>	0.0069	0.0313	0.22	0.2185***	0.0267	8.18	0.0711***	0.0277	2.56
<b>Cost of Organic Fertilizer</b>	0.0934***	0.0346	2.70	0.0837***	0.0266	3.14	0.0884***	0.0284	3.11
<b>Cost of Inorganic Fertilizer</b>	0.2221* **	0.0371	5.98	0.1336***	0.0259	5.15	0.15848***	0.0272	5.81
<b>Agro-chemical</b>	0.1147***	0.0271	4.23	0.13209***	0.0195	6.77	0.1551***	0.1551	7.61
<b>Cost of Labour</b>	0.3635***	0.0306	11.85	0.1345***	0.1042	5.06	0.3303***	0.0202	16.38
Constant	0.6601	0.2892	2.28	1.3177***	0.0951	5.55	0.7138***	0.2297	3.11
Allocative Inefficiency									
<b>Sex</b>	-----	-----	----	-----	-----	-----	-0.1523***	0.0432	-3.52
<b>Age</b>	0.2050***	0.0270	7.59	-0.2101***	0.0429	4.90	0.2807***	0.1033	2.72
<b>Years</b>	-0.0708**	0.0328	-2.16	-0.2644**	0.12021	-2.20	-0.2244***	0.0452	-4.97
<b>Schooling</b>									
<b>Non-farm Income</b>	-0.0649*	0.0331	-1.96	-0.0420	0.0681	-0.62	0.0555*	0.0324	1.71
<b>Access to Credit</b>	-0.2142***	0.0314	-6.83	-0.1535***	0.0495	-3.10	-0.1486**	0.0613	-2.42
<b>Extension Contact</b>	-0.0713**	0.0313	-2.28	-0.5958***	0.1042	-5.72	-0.1224*	0.0645	-1.90
<b>Farming Experience</b>	0.0018	0.0016	1.13	-0.1925**	0.0951	-2.02	-0.1486**	0.0612	-2.42
<b>Unit Price</b>	-0.0713**	0.0313	-2.28	-0.1121**	0.0490	-2.29	-0.0918**	0.0418	-2.20
<b>Price Information</b>	-0.0163	0.0324	-0.53	-0.0614	0.0674	-0.91	0.0090	0.0224	0.40
<b>Household Size</b>	-0.3846***	0.0300	-12.81	-0.0036*	0.0021	-1.80	-0.1836***	0.0384	-4.78
<b>Coop Association</b>	-0.0155	0.0323	-0.49	-0.2257*	0.1155	-1.95	-0.0918 **	0.0417	-2.20
Diagnostic Statistics									
Log likelihood	103.57			1.4332			150.153		
Sigma square	0.0872			0.0559			0.01601		
Gama	0.0930			0.0226					

\*\*\* Significant at (P<0.01) , \*\* Significant at (P<0.05) , \* Significant at (P<0.10)  
 Source: Computed from Field Survey Data (2023)

**Differences in Allocative Efficiency Scores Index for Male and Female Smallholder Rice Farmers in the Study Area**

Table 4 shows the distribution of allocative efficiency score index for male and female smallholder rice farmers. The results show that about 32.4% of the sampled male and 14.2% of the female smallholder rice farmers attained the allocative efficiency score index between 0.41-0.60, the pooled results indicated that about 24.7% were within the ranges of 0.41-0.6. Most (52.7%) of the male and majority (67.9%) of the female smallholder rice farmers attained 0.61-0.80 allocative efficiency score index, while pooled sample results revealed 59.2% of the sampled smallholder rice farmers were able to obtain allocative efficiency score index between 0.81-1.0. The minimum allocative efficiency score attained by male and female smallholder rice farmer was 0.001 and 0.017 respectively, the minimum allocative efficiency for pooled sample was 0.00. The maximum value of the allocative efficiency score index for male and female smallholder rice farmers were 1.0791 and 0.999 respectively, while the maximum allocative efficiency score index for the pooled sample was 1.0994. This implies that male farmers obtained 0.01% above the frontier while the pooled sample show that an individual smallholder rice farmers obtained allocative efficiency of 0.99% above the frontier indicating the male rice farmers wasted about 0.017 and 0.99% for pooled of the cost in rice production respectively. This result is in line with reported cost efficiency of 1.16. The mean allocative efficiency score index for both male and female smallholder rice farmers was 0.738 (73.8) and 0.798 (79.8%), the pooled sample show that the average allocative efficiency score index attained by sampled smallholder rice farmers was 0.765 (76.5%). This study shows that female smallholder rice farmers were more efficient in cost allocation but with a shortfall or gap of 20.2% inefficiency that needed to be filled to reach maximum cost allocative efficiency and perfection while male smallholder rice farmers had about 26.2% inefficiency level that need improvement to reach maximum cost allocation efficiency while the pooled sample show that there is a gap of 23.5% allocative inefficiency to attain optimum level of cost allocation, which needed to be met through adoption of modern technology or new innovation to reach maximum allocative efficiency and achieve optimum output for profit maximization by smallholder rice farmers in the study area. This result is in line with Abdul et al. (2017); Yenihebit et al. (2020) and Aboaba (2020) who reported similar allocative efficiency. This is also in consonance with the findings of Okello et al. (2019); and Gela et al. (2019) who reported higher allocative efficiency of 86% and 75% among rice farmers in Adamawa State, Federal Capital Territory, Nigeria and Gulu and Amuru Districts of Northern Uganda.

Table 4. Distribution of Allocative Efficiency Scores Among Male and Female Rice Farmers in the Study Area

Allocative Efficiency Score	Male Farmers		Female Farmers		Pooled Sample	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0-0.2	18	9.9	6	4.5	24	7.6
0.21-0.4	2	1.1	12	9.0	14	4.43
0.41-0.6	59	32.4	19	14.2	78	24.7

0.61-0.8	7	3.8	6	4.5	13	4.11
0.81-1	96	52.7	91	67.9	187	59.2
Minimum	0.001		0.017		0.001	
Maximum	1.09		0.999		1.099	
Mean AE	0.738		0.798		0.765	

Source: Computed from Field Survey Data (2021)

### Factors Influencing Economic Efficiency of Rice Production among Male and Female Smallholder Rice Farmers

The factors influencing economic efficiency using maximum likelihood estimates using tobit regression model is presented in Table 5. The factors are shown below:

Gender of the household head for sampled smallholder rice farmers had positive influence on the economic efficiency and was statistically significant for the pooled data ( $P < 0.10$ ). The marginal effect of the pooled sample was (0.1393), this implies that if a farmer happened to be male farmers, will result in the probability of increase in the economic efficiency of the smallholder rice farmers by 13.9%. This is in line with the findings of Melese et al. (2019) who reported positive influence of sex on rice production in Ethiopia.

Age of the smallholder rice farmers has a negative influence on the level of economic efficiency for male rice farmers and has a positive influence for female smallholder rice farmers, while the pooled result show that age of the sampled smallholder rice farmers influences economic efficiency positively. Age was statistically significant at ( $P < 0.05$ ) for male, and ( $P < 0.01$ ) for female rice farmers, and ( $P < 0.10$ ) for pooled sample. The marginal effect of the age for male and female smallholder rice farmers was (-0.3736), (0.1898) and pooled (0.0941) respectively. This implies that a unit change in age will result in the decrease in economic efficiency of the male smallholder rice farmers by 37.4%, and will result in the increase in the probability that the economic efficiency of the female smallholder rice farmers will increase by 18.9%, while the pooled results show that a unit change in the age of the sampled smallholder rice farmers will result in the increase in the probability that economic efficiency of the smallholder rice farmers will increase by 9.4% in the study area. The implication of this result is that younger male farmers were more economically efficient than the older male farmers, this could be because younger farmers are more energetic, risk averse and adopt new technology and innovation easily, while for female farmers the older farmers were more economically efficient than the younger ones this could happen because as they acquire more experience as a result of their age it could make them familiar with the farm management practices that might make them economically efficient than the younger female farmers, this could be so because most younger female farmers don't own their own farm. This result is line with the findings of Aboaba (2020) who asserted that age of the farmers had positive effect on economic efficiency of rice production. Years schooling influence economic efficiency for male and female smallholder rice farmers positively and was statistically significant at ( $P < 0.05$ ) for both male and female smallholder rice farmers respectively. The pooled sample show that years of schooling had positive influence on the economic efficiency of the smallholder rice farmers and was statistically significant at ( $P < 0.01$ ). The marginal effect of the years of schooling for male rice farmers (0.1533), for the female rice farmers (0.0083) and for the pooled sample was (0.1687), this implies that a unit change in the years of schooling for the smallholder rice farmers will result in the increase in the probability of economic efficiency by 15.6% for male rice farmers, 0.8% for female rice farmers, and 16.9% for pooled sample respectively. Farmers with formal education has the ability to acquire information on input mix that could increase their decision-making process on production practices, more educated farmers have the capacity to perceive, interpret and know how to respond to any new information regarding new method of production and adopt innovation and improve technologies like fertilizers, agrochemical and planting materials faster than their counterparts. This result confirms the finding of Aboaba (2020); Okello et al. (2019) and Gela et al. (2019) who reported a positive influence of years of schooling between education and economic efficiency and posited that educated farmers are more economically efficient; it enables them to adopt new innovation in rice production. Non-farm income had positive influence on economic efficiency for both male and female smallholder rice farmers, but it was only statistically significant for female smallholder rice farmers at ( $P < 0.01$ ). The estimated marginal effect for the sampled female smallholder rice farmers was (0.3268), which indicated that a unit change in the level of non-farm income will result in the likelihood of the increase in economic efficiency for the female smallholder rice farmers by 32.7%. Non-farm income enables smallholder rice farmers to organize their farming activities properly by enabling them to have the capacity to purchase farm inputs at appropriate time which could make them economically efficient and maximize profit at optimum level of productivity. This result is contrary to the findings of Melese et al. (2019) who reported that non-farm income had negative effect on economic efficiency that farmers which are engaged in non-farm income activities tends to allocate more of their time to non-farm income generating activities which could make them exhibit lower level of economic efficiency. Access to credit influence economic efficiency positively for both male and female smallholder rice farmers and was statistically significant at ( $P < 0.01$ ) and ( $P < 0.05$ ) respectively. The pooled sample result revealed that access to credit has positive influence on economic efficiency of the sampled smallholder rice farmers and it was statistically significant at ( $P < 0.10$ ) probability level. The marginal effect of the access to credit for male and female smallholder rice farmers was (0.2797) and (0.634) respectively. This signifies that a unit increase in the amount of credit accessed by the male and female smallholder rice farmers will result in the likelihood or probability of the economic efficiency for both male and female smallholder rice farmers to increase by 27.9% and 63.4% respectively. The marginal effect of access to credit for the pooled sample was (0.0829), which implies that a unit increase in the access to credit will lead to the likelihood or probability of the increase in the economic efficiency of the sampled smallholder rice farmers by 8.3%. Access to credit enables rice farmers to acquire production inputs with ease and timely which could lead to increase in their economic efficiency. This is consistent with Kamau (2019) who asserted that farmers that had access to credit for agricultural production has the ability to purchase improved yielding inputs such as improved seed varieties and agrochemicals which is labour saving like herbicides which can increase crop yield and reduce production costs that can

translate into increased productivity and profitability. Musa et al. (2015) and Haile (2015) also reported access to credit influencing economic efficiency positively.

Extension contacts influence economic efficiency of the male and female smallholder rice farmers positively and was statistically significant at ( $P < 0.01$ ) for both male and female smallholder rice farmers, while the pooled sample results show that extension contact has positive effect on the economic efficiency of the rice farmers and was statistically significant at ( $P < 0.01$ ) probability level. This result indicates that, smallholder farmers with more access to extension services during the cropping season were more economically efficient than those that had less number of extension contact during production period. The marginal effect of the extension contact for both male and female smallholder rice farmers were (0.2906) and (0.3091), while that of pooled sample was (0.1596), this implies that a unit change in the probability or likelihood of having access to extension services by smallholder rice farmers will result in the increase in economic efficiency of the male and female smallholder rice farmers by 29.1% and 30.9% respectively, while for the pooled sample will result in the increase in economic efficiency of the rice farmers by 15.9%. Access to extension contact could expose rice farmers to better training on how to use their available resources adequately and other extension services like knowledge and skills on how to use agrochemicals, improved seed varieties and fertilizer application that could lead to increase in the farmers' economic efficiency. This result is consistent with the findings of Melese et al. (2019); Mwangi et al. (2020) who reported positive influence of extension services on rice production in their respective study areas. Farming experience influence economic efficiency negatively for male and positively for female smallholder farmers and it was statistically significant at ( $P < 0.05$ ) and ( $P < 0.10$ ) probability level respectively. The marginal effect of the farming experience of the smallholder farmers for male (-0.0557), female farmers (0.3091), and the pooled result was (0.2432), this implies that a unit change in the years of farming experience of the smallholder rice farmers will result in the decrease in the likelihood or probability of the economic efficiency of the male smallholder rice farmers to decrease by 5.6%, while the economic efficiency of the female farmers will increase by 30.9%. The pooled result show that a unit change in the farming experience of the smallholder rice farmers will result in the increase in economic efficiency of the sample smallholder rice farmers by 24.3% in the study area. This could be because farmers acquire more experience over the years and could enable them to use farm inputs appropriately that might make them economically efficient. This result is in conformity with the findings of Aboaba (2020) who asserted that farming experience has negative influence on economic efficiency in Ogun State, Nigeria. The results are also in line with posited that experienced rice farmers are not economically efficient. This could be true because experienced farmers might likely depend on their ideas and knowledge rather than adopting new innovation which could improve their productivity and efficiency. As shown in Table 5 the coefficient of farming experience is positively related with economic efficiency, this confirms the finding of Haruna et al. (2021) who found positive relationship between experience and economic efficiency in rice production in Kogi State, Nigeria and asserted that generally it is expected that productivity increases with accumulated years of experience and experienced farmers master production techniques and can avoid previous mistakes and they are more likely to take informed decisions in order to improve productivity and profitability that will in turn increase economic efficiency. Unit price of rice had positive influence on economic efficiency for male and female smallholder rice farmers positively and it was statistically significant at ( $P < 0.05$ ) and ( $P < 0.01$ ) respectively. The pooled sample also revealed that a unit price of rice per bag was statistically significant at ( $P < 0.01$ ). The marginal effect of the unit price for male (0.271), and female (0.040) and pooled sample (0.0232). This implies that a unit change in the unit price will lead to increase in the likelihood or probability of the economic efficiency of rice production to increase by 27.1% and 4% for male and female smallholder rice farmers respectively, while the pooled sample indicated that it will result in the increase in economic efficiency by 2.3% among smallholder rice farmers. Price information influence economic efficiency for male smallholder rice farmers positively and it was statistically significant at ( $P < 0.10$ ) probability level. Price information was not significant for female farmers and the pooled sample. The marginal effect of the price information for sampled male smallholder rice farmers was (0.1188), which signifies that a unit change in the access to price information by smallholder rice farmers will result in the in the likelihood or probability of the economic efficiency to increase by 11.9%. Access to information enables farmers to acquire information about prices of output which could enable them to sale their product at appropriate time that could increase economic efficiency of the male smallholder rice farmers. Household size as presented in Table 5 influence economic efficiency positively for male smallholder rice farmers and negatively for female smallholder rice farmers, the pooled sample revealed that household size had positive influence on economic efficiency. The marginal effect of household size for male and female smallholder rice farmers were (0.0196) and (-0.3255) respectively. This implies that a unit change in the number of household size for male rice farmers will result in the increase in the likelihood or probability of the economic efficiency of rice production to increase by 1.9% and decrease in economic efficiency for female rice farmers by 32.6%. Male farmers with larger household size has more supply of family labour for rice production but in the case of female smallholder rice farmers, household size has negative effect on the economic efficiency, this could be that larger household size could make the available resources to be diverted for children school fees, hospital bills and feeding that may affect economic efficiency of the female smallholder rice farmers. The marginal effect for the pooled sample was 0.1462, this means a unit change in the number of household size will result in the increase in the probability of the economic efficiency to increase by 14.6%. As household size increases there will be availability of labour supply which could make farmers not to source for hired labour and as a result there will be cost savings which could lead to increase in economic efficiency. This is in line with Melese et al. (2019) who opined that a larger household size guarantees availability of family labor for farm operations to be accomplished in time in Ethiopia, the results further agrees with the findings of Okello et al. (2019) who reported that household size had negative relationship with farm efficiency level in Uganda. The result is also in consonance with Aboaba (2020) who posited that household size decreases economic efficiency of rice farmers in Ogun State, Nigeria. Cooperative association influence economic efficiency of rice production for female smallholder rice farmers positively and it was statistically significant at ( $P < 0.10$ )

probability level. The pooled sample results also show that cooperative association had positive influence on economic efficiency of rice production among smallholder rice farmers. The marginal effect of the cooperative association for female smallholder rice farmers and pooled results was 0.0826 and 0.1248 respectively. This connotes that a unit change in the possibility of the female rice farmers and pooled sample being a member of cooperative association will result in the increase in the likelihood or probability of the economic efficiency to increase by 8.3% and 12.5% in the study area. This is in line with the findings of Yusuf (2022) who asserted that membership of farmers' cooperative association has positive influence on rice production efficiency in Patigi Local Government Area of Kwara State Nigeria.

Table 5. Maximum Likelihood Estimates of the Tobit Regression Model of the Factors Influencing Economic Efficiency of Rice Production in the Study Area

Variable Economic Efficiency	Male Farmers				Female Farmers				Pooled Sample			
	Coefficients	Std Error	t-value	ME	Coefficients	Std Error	t-value	ME	Coefficients	Std Error	t-value	ME
Sex	-----	-----	-----	-----	-----	-----	-----	-----	0.1122*	0.0665	1.69	0.1393
Age	-0.0050**	0.0022	-2.26	-0.3736	0.0787***	0.0302	2.61	0.1898	-0.0233*	0.0124	-1.88	0.0941
Years of Schooling	0.5626**	0.2817	2.00	0.1533	1.1862**	0.5576	2.13	0.0083	0.3545***	0.0609	5.82	0.1687
Non-Farm Income	0.0127	0.0149	0.84	0.4131	1.0302***	0.2738	3.76	0.3268	8.60e-0	7.22e-7	1.19	0.0126
Access to Credit	0.2797	0.1005	2.78	0.2797	1.1448**	0.4915	2.33	0.0160	0.1906*	0.1141	1.67	0.0829
Extension Contact	0.0043*	0.0023	1.82	0.2906	0.6949*	0.3843	1.81	0.1634	0.1462***	0.0332	4.40	0.1596
Farming Experience	-0.2556**	0.1208	-2.12	0.0557	2.8334*	1.6149	1.75	0.3091	0.0608*	0.0320	1.90	0.2432
Unit Price	0.1953**	0.0949	2.06	0.2713	0.0528***	0.0178	2.96	0.0404	0.6433***	0.1778	3.62	0.0232
Price Information	0.2906*	0.1674	1.74	0.1188	-0.1193	0.2468	-0.48	0.0276	0.0170	0.1251	0.14	-0.1906
Household Size	0.4131***	0.1316	3.14	0.0196	-0.0083*	0.0049	-1.68	-0.3255	0.3140***	0.0645	4.87	0.1462
Coop Association	0.0267	0.0474	0.56	0.0979	0.3229*	0.1722	1.88	0.0826	0.1879***	0.0669	2.81	0.1248
<b>Sigma</b>	0.2403				0.8692				0.890			
<b>Log likelihood</b>	-38.138				-138.568				-328.88			
<b>Prob &gt;ch<sup>2</sup></b>	0.240				0.831				0.859			

\*Significant at 10%, \*\* Significant at 5%, \*\*\* Significant at 1% Probability Levels  
Source: Computed from Field Survey Data (2023)

**Distribution of Economic Efficiency Scores Among Male and Female Rice Farmers**

The distribution of economic efficiency score level for male and female smallholder rice farmers is presented in Table 6. The results also show that 14.8% of the male smallholder farmers and 20.9% of the female rice farmers had an economic efficiency between the ranges of 0.21-40, while 17.4% of the pooled sampled smallholder rice farmers were within the range of 0.21-0.40. About 37.9% of the sampled male smallholder rice farmers and 30.6% of the female smallholder rice farmers attained economic efficiency level of 0.4-0.60. About 34.8% of the pooled sampled smallholder rice farmers had economic efficiency within the ranges of 0.41-0.60 in the study area. The results further show that about 25.3%, 31.3% of the sampled male and female smallholder rice farmers attained economic efficiency score between 0.81-10, while the pooled sample revealed that 27.9% of the smallholder rice farmers had an economic efficiency within the ranges of 0.81-10. The maximum economic efficiency score attained by male and female rice farmers was 1.04 and 0.987 respectively and the pooled was 1.003. This implies that the best performing male rice farmer obtained economic efficiency 100.4% and the best performing female rice farmer attained economic efficiency of 98.7%, while pooled sample show that the best performing smallholder rice farmer attained 100%. The average economic efficiency level attained by the sampled smallholder rice farmers were male (0.516) 51.6%, female (0.555) 55.5%, and the pooled sample was (0.545) 54.5% in the study area. There exists an economic inefficiency gap of 49.5% for male rice farmers, 45.5% for female rice farmers, and 46.5% for pooled sample that need improvement to be filled up with existing technology to attain perfection in the level of economic efficiency among sampled smallholder rice farmers. This result is in line with the findings of Okello et al. (2019) who reported 75% economic efficiency among rice farmers in Gulu and Amuru districts of northern Uganda and Haruna et al. (2021) who reported economic efficiency of 66% for male and 56% for female rice farmers in Kogi State, Nigeria and the results is contrary to the findings of Aboaba (2020) who reported higher average economic efficiency of 94% for rice farmers in Ogun state, Nigeria.

Table 6. Distribution of Economic Efficiency Scores Among Male and Female Rice Farmers in the Study Area

Economic Efficiency Score	Male Farmers		Female Farmers		Pooled Sample	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0-0.20	40	22.0	23	17.16	63	19.9

0.21-0.40	27	14.8	28	20.9	55	17.4
0.41-0.60	44	24.2	21	15.7	65	20.6
0.61-0.80	25	13.7	20	14.9	45	14.2
0.81-1.00	46	25.3	42	31.3	88	27.9
Minimum	0.001		0.008		0.008	
Maximum	1.041		0.987		1.003	
Mean EE	0.516		0.555		0.545	

Source: Computed from Field Survey Data (2023)

## CONCLUSIONS

This study evaluated gender differences in farm level efficiencies in rice production among smallholder rice farmers in Federal Capital Territory, Nigeria. Generally, the farmers were efficient to certain level but there was a shortfall in obtaining the maximum farm level efficiency for both male and female rice farmers, male farmers were more efficient in technical efficiency while female farmers were more efficient in both allocative and economic efficiency. The study shows that the seed inputs, farm size, inorganic fertilizer, and labour input had relationship with technical efficiency. The mean technical efficiency score obtained by the male and female smallholder rice farmers was 70.2%, and 69.7% respectively. The socio-economic factors that had significant relationship with technical inefficiencies for male and female smallholder farmers were: sex, age, years schooling, and access to credit, extension contact, farming experience, unit price, cooperative association and household size. The study further revealed that the significant factors influencing total cost of rice production for male smallholder farmers were: cost of seed, total output, cost of organic fertilizer, cost of inorganic fertilizer, cost of agrochemical, cost of land rent and cost of labour, the average allocative efficiency score obtained by smallholder rice farmers were 73.8% and 79.8% respectively. The socioeconomic factors influencing allocative efficiency for male and female smallholder rice farmers were sex, age, years schooling, access to credit, extension contact, farming experience, unit price, household size and cooperative association. The significant factors influencing economic efficiencies of the male and female smallholder rice farmers were: age, years schooling, access to credit, extension contact, farming experience, unit price, price information, nonfarm income, household size and cooperative association. The average economic efficiency score index obtained by male smallholder rice farmers was 51.6% while female smallholder farmers obtained 55.5%.

There exists an economic inefficiency gap of 49.5% for male rice farmers, 45.5% for female rice farmers, and 46.5% for pooled sample that need improvement to be filled up with existing technology to attain perfection in the level of economic efficiency among sampled male and female smallholder rice farmers. Theoretically, this study agreed with the theory of production which implies that more usage of farm inputs led to increase in total out of rice and generally leads to increase in farm level efficiency, efficient management of production resources could result to maximum profit. Therefore, the study made the following policy recommendations: Production inputs like improved seed varieties, inorganic fertilizer and agrochemical should be provided to male and female rice farmers by government of Nigeria or Non-Governmental Organizations at affordable price or subsidized rate and timely to increase productivity and minimize cost among rice producers that will enable them to maximize profit. Credit facilities should be provided at single digit by government and financial institutions in order to enable farmers to purchase inputs at affordable price to earn more profit and improve their welfare and livelihood. Extension services should be made available to farmers to teach them about the application of farm inputs appropriately and they should also be encouraged to join cooperative membership to have access to resources easily. Training on additional source of non-farm income should be provided to female rice farmers to enable them to be financially independent to make them fully engaged in rice farming. In the course of this research work the researcher encountered difficulties in collecting data from the respondent due higher level of illiteracy among the smallholder farmers and lack of availability of research funds. Further research should be conducted on resource use efficiency among smallholder farmers, how farm level efficiency affects family food security and livelihood.

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