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Comparative Gender Differences in Profitability and Technical Efficiency of Rice Production among Smallholder Farmers in North Central Nigeria

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ABSTRACT: This study analyzed comparative gender differences in profitability and technical efficiency of rice production among smallholder rice farmers in the North Central Nigeria. Multistage sampling technique was employed. Data were collected through the use of well-structured questionnaires from 1200 male smallholder rice farmers and also 1200 female sampled small scale rice farmers making a total of 2400 rice farmers. The following statistical and econometrics tools were used to achieve the specific objectives; descriptive statistics, budgetary technique, stochastic production frontier. The results show that the average age of the sampled male rice farmers was 37 years, while female rice farmers was 48 years. About 63.2% of the male farmers had formal education and also about 79.6% of the female farmers also had formal education. The results further show that rice production was profitable for both male and female small-scale rice farmers. The estimated mean value of technical efficiency attained by small scale male farmers was 85.3%, while female rice farmers was 62.7. The statistically significant factors influencing rice production for male small-scale farmers were: land size (P<0.01), labour (P<0.05), rice seed (P<0.05), fertilizer (P<0.01) and agrochemical (P<0.01), while the statistically significant factors influencing rice production for female rice farmers were: land size P<0.01, labour (P<0.01) rice seed (P<0.01) and agrochemical (P<0.05). The statistically significant factors influencing technical inefficiency of the male rice farmers were education (P<0.1), age (P<0.1), land size (P<0.05), experience (P<0.01), household size (P<0.05) extension contact (P<0.1) and cooperatives (P<0.01). The statistically significant factors influencing technical inefficiency for female farmers were: education (P<0.10), land size (P<0.05), experience (P<0.05), household size (P<0.05) and cooperatives (P<0.1). The major constraints faced by male small scale rice farmers were: poor access to credit facilities, shortage of farm input, poor soil fertility, inadequate rainfall, and high cost of farm input. The female small scale rice farmers were also faced with the following constraints: poor soil fertility, problems of land ownership/discrimination, poor credit facility, high cost of labour, inadequate rainfall. Therefore, this study recommends that: Farm inputs like improved seed varieties, fertilizer inputs and agro-chemical inputs should be provided to both male and female smallholder rice farmers by Nigerian government and Non-Governmental Organizations at affordable rate and at curate timely, extension n services should also be made available to small-scale rice farmers on the modern rice Production, male and female farmers should be encouraged to participate in cooperative societies so as to access loan to be able to use technologies in rice production which will further increase their production capacity that might lead into increase in income, improve their livelihood and food security.

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INTRODUCTION

Rice (*Oryza sativa)* is a very significant and respected food crop in Nigeria and it is most liked by majority of Nigerian populace, rice is one among the available cereal staple crops and a strategic agricultural commodity to Nigeria's economy at large. The Nigeria's demand of rice quantity is approximately 7.9 mm tons per annum out of which almost 2 mm tons is imported into the country which cost Nigeria ranging from $500 million and $1 Billion for importing rice per year since 2002 (Lawal et al. 2023).

About 6 million hectares of land are available which can be utilized for rice production, only 3.2 million hectares of farm land were in used for rice production, producing a total yield of about 3.7 million tons of rice per year (USDA, 2018) and (Lawal et al. 2023). Also, the total yield of rice per hectare is about 2 metric tonnes compared to global average of 6.0 metric tonne (Alabi et al. (2023) and Lawal et al. 2023). As a result of poor seed quality, inadequate soil fertility, improper use of fertilizer, iron toxicity, non-adoption of new innovation and modern technology, in addition to pests and diseases were the major problems of rice production in Nigeria (Adesina,2012). Consumers of rice in Nigeria generally perceived that local rice is very poor in quality which contain stone particles and other debris. Therefore, to achieve the self-sufficiency in rice production goal. The government needs to change the level of rice production, method of processing and marketing of rice in order to meet the grade and quality demand of local rice consumers. Rice production plays a vital role in Nigeria's agricultural sector, especially in the North Central region of the country, where smallholder farmers constitute a major and significant component of the total number of farmers (FAO, 2020).

Gender can be defined as the social roles, identities, and responsibilities that is associated with being a male or a female. It widely varies from one culture to another and can change over time dramatically (FAO (2011). As asserted by Kilic et al. (2015), gender differences in agricultural productivity in rice sector all over Sub-Saharan Africa (SSA) is widely ranges between 4% to 40% and the major reasons for this identified gender gap is because of the differences in having access to productive, the utilization of agricultural inputs; land tenure security and subjection of female farmers to be under male farmers.

However, smallholder male and female rice farmers in the North central region are facing constraints of low productivity, inadequate resources and lack of accessibility to new agricultural technologies and innovations (Adeyemo &Arokoyo, 2018). To overcome these problems, the adoption of modern technology gender equality in access to productive resources could be the potential ways that would increase the level of profitability and efficiency level of the male and female small-scale rice farming. This study aims to analyze the comparative differences in profitability and technical efficiency among male and female rice farmers in North Central Nigeria. This study intends to look into the potential benefits derived and constraints involved in rice farming sector among these categories of rice farmers for optimizing the utilization of inputs in order maximize profit as a result of increase in total output levels in accordance to any unit of production resources employed, most of the male and female small-scale rice farmers might encounter different problems due to barriers in accessing land, including limited access to production capital, inadequate of awareness regarding knowledge on improved technologies involved in rice production, and inadequate infrastructural facilities. The profitability and technical efficiency among male and female small-scale rice farmers in North Central Nigeria can be significantly different which could depend on their ability of having access to productive resources. However, there is a gap in empirical literatures in explaining the comparative performance among male and female small-scale rice farmers. This study was carried out to bridge this gap by diving into its complexity and providing answers to the following research questions:

(i) What are the socio-economic characteristics of the male and female smallholder rice farmers?
(ii) What is the comparative differences in costs, returns and profitability of male and female smallholder rice farmers?
(iii) What is the gender comparative differences in technical efficiency of small-scale rice farmers?
(iv) What are gender differences in the factors influencing technical efficiency of smallholder rice farmers?
(v) What are the constraints encountered by smallholder male and female rice farmers in the study area?

MATERIALS AND METHODS

Study Area

North Central Nigeria, which includes the states of Kwara, Kogi, Niger, Nasarawa, Plateau, and Benue, is where this study was conducted. Nasarawa State and Niger State were chosen for the research. According to the Niger State Ministry of Information and Communication (2008), Niger State is located between latitudes 30 20' and 7040' north of the equator and longitudes 80 11' and 1102' east of the Greenwich Meridian. The Federal Capital Territory, Abuja, Zamfara, and Kebbi States all border the state to the north. Additionally, Babana in the Borgu Local Government Area of Niger State shares a common boundary with the Republic of Benin. It is situated in Nigeria's Guinea Savannah agro-ecological zone, which receives 1100 mm of rainfall in the north and 1600 mm in the south per year (Niger State Ministry of information and communication, 2008). Nasarawa State is on the boundary in the North with Kaduna State, and on with Abuja Federal Capital Territory in the West, while in the South is bounded by Kogi and Benue States, towards the East is bounded by Taraba and Plateau States. The State is laying between Latitudes7° 45' and 9° 25' North of the equator and between Longitudes7° and 9° 37° East of the Greenwich meridian. The mean temperature is 28.4 °C and about 839 mm per annun. The major crops under cultivation by farmers in these all states are rice, cowpea cassava, groundnut sesame seed, sorghum etc and also rearing livestock such as poultry, goats, pigs, cattle and sheep.

Method of Data Collection

The data employed for this study weas collected from primary sources using well-structured questionnaires. The relevant primary data was obtained from male and female smallholder rice farmers in two selected states in the study area. The questionnaires used

for data collection was tested and pre-tested and administered to smallholder rice farmers by extension agents and enumerators while the researchers supervised all process involved.

Sampling Technique and Sample Size

The target populations for this study were male and female smallhholder farmers in the North Central Nigeria. Multi stage sampling technique employed for the study. Two States were randomly selected which were Niger and Nasarawa State. A primary data was collected through simple random sampling from 1200 male smllholder rice farmers. Furthermore, another set of 1200 female smallholder rice farmers were also selected as well. Constituting, a total number of 2400 smallholder rice farmer included for the study.

Method of Data Analysis

Descriptive Statistics

Descriptive statistics was employed to determine the socioeconomic characteristics of smallholder rice farmers such as frequency distribution, mean, and standard deviation was employed.

Budgetary Technique

Farm budgetary technique was utilized to calculate costs, returns and profitability ratios of male and female small-scale rice farmers. According to Olukosi and Erhabor (1988), the net farm income was calculated based on hectare basis as follows: -

$$GM = TR - TVC \ldots\ldots (1)$$

$$GM = \sum_{i=1}^{n} P_i Q_i - \sum_{i=1}^{n} P_j X_j \ldots\ldots (2)$$

$$\text{NFI} = \text{GM} - \text{TFC} \ldots\ldots (3)$$

Where

NFI= Net Farm Income;

GM = Gross Margin (₦/ha);

TR= Total Revenue Py . Y (₦);

P_i = Price Rice in (₦),

Q_i = Total quantity of rice (Kg/ha);

P_j = Price of Input (₦/Kg);

X_j = Quantity of Input Used (Kg/ha),

Py = Price per unit output (₦);

Y = Total quantity of output (Kg)/unit/Ha

TFC = Total Fixed cost per hectare (₦) (Depreciation on farm equipment was estimated based on annual basis)

Financial Analysis: According to Alabi *et al*. (2020), gross margin ratio is defined as follows:

$$\text{Gross Margin Ratio} = \frac{\text{Gross Margin}}{\text{Total Revenue}} \ldots\ldots\ldots\ldots (4)$$

According to Olukosi and Erhabor (1989), operating ratio (OR) is defined as follows:

$$\text{Operating Ratio} = \frac{\text{TVC}}{\text{GI}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Following Lawal (2008) return on Naira invested (ROI) was obtained as follows:

$$RORI = \frac{NI}{TC} \ldots\ldots\ldots (6)$$

Where,

RORI= Rate of Return per Naira Invested (Units);

NFI= Net Farm Income (Naira);

TC= Total Cost (Naira).

Decision rule: ROI value should be greater than one for an enterprise to be profitable.

Stochastic Production Frontier Model

The explicit model form is presented as:

$$Y_i = f(X_i, \beta)\epsilon, i = 1, \ldots, N \ldots\ldots\ldots\ldots (7).$$

$$LnY_i = \beta_0 + \sum_{i=1}^{6} \beta_i \, LnX_i + \cdots \beta_n LnX_n + V - U_i \ldots\ldots\ldots\ldots (8)$$

$$LnY_i = \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5 + V_i - U_i. (9)$$

Where

LnY_i = Total Rice Output (Bags)

X_1= Farm size (ha)
X_2= Labour (Man days)
X_3= Quantity of Rice Seed (Kg)
X_4= Quantity of Fertilizer (Kg)
X_5= Quantity of Agro-Chemical Input (Litres)
β_0 = Constant Term
$\beta_1 - \beta_6$ = Regression Coefficients
The Technical Inefficiency Component of the Stochastic Frontier Model is stated thus:

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 \ldots\ldots (10)$$

Where,
U_i = Technical Inefficiency Component
Z_1= Level of Education (Years Schooling)
Z_2= Age of Rice Farmers (Years)
Z_3= Farm size (Hectares)
Z_4= Farming Experience (Years)
Z_5= Household Size (Number)
Z_6 = Extension services (Number of Visit)
Z_7 = Sex (1, Male; 0, Otherwise)
α_0 = Constant Term
$\alpha_1 - \alpha_7$ = Regression Parameters

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the male and Female Smallholder Rice Farmers

The results of the analysis of the socio-economic characteristics of the male and female smallholder rice farmers are shown on Table 1. The average age of the male smallholder rice farmer was 37 years while the average age of the female smallholder rice farmers was 48 years, this shows that the male and female smallholder rice farmers were still young, very strong and energetic also in their productive age bracket but male smallholder rice farmers were much more younger than the female rice farmers, there is a significant age difference of about 9 years between male farmers and female smallholder rice farmers, young farmers are more likely to adopt technology and new innovations than older farmers in rice production which could lead to increase in farm efficiency and profit maximization in rice production. This finding is consistent with the findings of Okello et al. (2019), who found and reported an average age of 38 years for rice farmers, which is in contrast to the research of Aboaba (2020), who found an average age of 54 years for rice farmers. The study also found that 50% of the sampled rice farmers were male, and another 50% were female, indicating that an equal number of male and female rice farmers were involved in the area under study.

This result is contrary with Oladele et al. (2020) who reported that the male farmers dominate agricultural production and is expected due to the great energy requirement in carrying out rice farming activities. About 70.5% of the sampled male rice farmers were married and 79.2% of the female rice farmers were also married. This implies that most of the sampled male and female rice farmers have labour supply for rice production activities in the study area. Furthermore, the results show that most of the sampled male and female rice farmers were literate, 26.3% and 33.3% of the male and female smallholder farmers had secondary school level of formal education while others have other forms of education as indicated in Table 1. Only 13.2% and 4.6% of the sampled male and female rice farmers has no formal education in the study area. The average number of persons per household of male and female rice farmers was 10 and 8 persons, respectively. On average basis male rice farmers had larger household size than female rice farmers with a difference of 2 persons per household. The mean years of rice farming experience in cultivation by male and female farmers was 11 and 14 years, respectively. There is a variance of 3 years between mean of years of farming experience among male and female smallholder rice farmers. High number of years of farming experience in rice farming production enables rice farmers to gather more experience and technical know-how regarding rice farming which could make them to utilize available resources and maximize profit. About 38.6% of the sampled male smallholder rice farmers were also a registered members of the cooperative society while majority (68.6%) of the female rice farmers were also members of the cooperative society in the study area. Membership of cooperative association could make small-s rice farmers to organize themselves which enable them to contribute their resources and pull it together that could enable them to purchase production inputs in large quantity at lower prices. The study also shows that majority 68.4% and 71.2% of the sampled male and female rice farmers had no access to formal credit facilities, respectively. The implies that most of the farmers could not purchase much quantity of farm inputs and operate on large scale basis. More so, most (62.3%) of the male rice farmers and 68.3% of the female rice farmers source their capital or finance through personal savings. Majority (67.1%) of the male rice farmers and (71.5) of the female rice farmers has land size of less than

2 ha with an average land size of 1.7 ha and 1.5 ha respectively. This is consistent with the findings of Abdul et al. (2017) who asserted that most of the smallholder farmers cultivates on farm land of less than 2 hectares.

Table 1: Socio-Economic Characteristics of the Sampled Small-scale Male and Female Rice Farmers in the Study area

Variables	Male Rice Farmers n =1200		Female Rice Farmers n=1200	
	Frequency	Percentage	Frequency	Percentage
Age (Years)				
21 – 30	250	20.8	150	12.5
31 – 40	681	56.8	342	28.5
41 – 50	263	21.	596	49.6
> 50	6	0.5	112	9.3
Mean	37		48	
Sex				
Male	1200	50		
Female			1200	50
Marital Status				
Single	205	17.1	231	19.3
Married	847	70.5	950	79.2
Widow	148	12.3	19	1.5
Education Level				
Quaranic	174	14.5	96	8.0
Primary	253	21.1	269	22.4
Secondary	315	26.3	400	33.3
Tertiary	189	15.8	281	23.4
Adult Education	111	9.3	96	8.0
No Formal Education	158	13.2	58	4.6
Household Size (Numbe				
1-5	474	39.5	580	48.3
6-10	505	42.1	238	19.8
11-15	221	18.4	382	31.8
Mean	10		8	
Length of Rice Cultivation				
1-5	175	14.6	304	25.3
6-10	510	42.5	400	33.3
11-15	410	34.2	54	4.5
>15	105	8.8	442	3.8
Mean	11		14	
Member Cooperative				
Members	463	38.6	823	68.6
Not Member	737	61.4	377	31.4
Access to Credit				
With access	379	31.6	346	28.8
No access	821	68.4	854	71.2
Source Finance				
Personal	747	62.3	819	68.3
Bank	32	2.6	38	3.2
Friend Relative	121	10.1	120	10.0
Cooperative	300	25.0	223	18.6
Farm Size (Ha)				
0.1-2	805	67.1	858	71.5

2.1-4	221	18.4	150	12.5
4.1-6	174	14.5	192	16.0
Mean	1.5		1.4	

Source: Field Survey Data (2024)

Differences in Costs, Returns and Profitability of Male and Female Smallholder Rice Farmers

Table 2 shows the results of costs, returns, net profit and profitability of male and female smallholder rice farmers in the study area. The results show that the estimated total variable cost for male smallholder rice farmers was ₦247,976.17 while smallholder female rice farmers incurred a total variable cost of ₦161,008.79 with cost of labour incurred accounted for the highest percent of about 80.3% for male rice farmers and 74.4% for female smallholder rice farmers. The estimated total fixed cost for male and female smallholder rice farmers was ₦48,574.28 and ₦32,427.41. The total returns or revenue estimated for male smallholder rice farmers was ₦1, 235, 244.75 and that of female smallholder rice farmers was ₦750,287.55. The estimated gross margin profit obtained by the male and female smallholder rice farmers was ₦ 974,959.65, ₦ 556,851.20, respectively and the net profit obtained by male and female rice farmers was about ₦ 926,385.37 and ₦524,423.79, respectively. This result is in consonance with the finding of Alabi et al. (2023) who asserted that rice production is yields high returns. The gross margin ratio obtained by male and female smallholder rice farmers was 0.79 and 0.74, respectively. The calculated value of the operating ratio for male and female smallholder rice was 0.21 and 0.22. The estimated value of rate of return on investment for male smallholder rice farmers was 3.00 that of the female smallholder rice farmers was found to be 2.88. These results indicated that rice production is profitable for male and female smallholder rice farmers but rice production was more profitable for male farmers. The rate of return on investment 3.0 and 2.88 obtained by male and female smallholder rice farmers implies that each one (1) naira invested in rice production, 3.0 kb and 2.88 kb was earn as profit by male and female smallholder rice farmers respectively which covers interests, commissions, fees charged and cost of capital. This result is in consonance with Lawal et al. (2023) who asserted that rice farming is a very profitable business venture that is worth venturing into for improving livelihood and welfare of rural farmers.

Table 2 Differences in Average Costs, Returns and Profitability Per Hectare of Rice Producers with and in the Study Area

Variables	**Male Rice farmers**			**Female Rice farmers**		
	Average Value (₦)/ha	**Financial Ratios**	**Proportion (%)**	**Average Value (₦)**	**Financial Ratios**	**Proportion (%)**
Variable Cost						
Seed	31,080.82		10.1	21,459.02		11.1
Fertilizer	48,000.00		15.5	35,000.00		18.1
Manure	12,345.54		4.7	7,857.14		4.1
Herbicide	19,236.30		7.4	9,830.34		5.1
Pesticides	3,926.80		1.5	2,643.50		1.4
Cost of Labour						
Land preparation	24,732.41			14,123.33		
Planting cost	15,213.73			10,581.72		
First weeding	20,653.80			10,500.00		
Second weeding	13,279.63			18,124.39		
Fertilizer Application	17,721.34			9,831.71		
Harvesting	26,513.39			11,762.07		
Threshing/winnowing	15,272.41			11,012.05		
Total	**247,976.17**		80.3	**151,713.22**		74.4
Transportation	12,308.93			9,295.57		
Total Variable Cost	**260,285.10**		84.3	**161,008.79**		83.2
Fixed Cost						
Depreciation on Farm Implement	17,574.28			14,427.41		
Interest on capital	31.000			18,000		
Total Fixed Cost	**48, 574.28**		15.7	**32,427.41**		16.8
Total Cost	**308,859.38**			**193,436.20**		
Total Revenue	**1, 235, 244.75**			**750,287.55**		

Gross Margin	974,959.65		556,851.20	
Net Profit	926,385.37		524,423.79	
Gross Margin Ratio		**0.79**		**0.74**
Operating Ratio		**0.21**		**0.22**
RORI		**3.00**		**2.88**

Source: Field Survey Data (2023)

Distribution of Technically Efficiency Scores among Male and Female Rice Farmers

Table 3 indicates the results of statistical summary of the distribution of technical efficiency scores of male and female smallholder rice farmers. The findings show, there is a variance in technical efficiencies among male and female smallholder rice farmers. This result further shows that about 43.5% of the male smallholder rice farmers obtained technical efficiency level scores ranging from 0.81-1.0 only about 9.3% of the female rice farmers has the ability to attain 0.81-1.0 level of technical efficiency scores. Majority 66.7% of the female smallholder rice farmers were able to attained 0.41-0.6 score level of the obtainable technical efficiency. The minimum level technical efficiency obtained by male and female rice farmers were 0.1221 and 0.111. The highest level of technical efficiency attained by male and female rice farmers was 1.00 and 0.983, respectively. The mean technical efficiency value of 85.2% and 62.7% were obtained by male and female smallholder rice farmers, in the study area. This result shows that male rice farmers were technically more efficient than their female counterpart. This finding conforms to the findings of Lawal et al. (2023) who discovered technical efficiency score of about 78% and corroborates that smallholder rice farmers mostly obtained technical efficiencies that is less than 100% in most of the sub-Saharan countries in Africa. Other studies like Ahmed and Melesse (2018) Aboba (2020) and Biara et al. (2023) also found similar results in their studies.

Table 3 Distribution of Technically Efficiency Scores Among Male and Female Rice Farmers

Technical Efficiency Score	**Male Rice Farmers**		**Female Rice Farmers**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
0-0- 0.20	18	1.5	58	4.8
0.21-0.4	300	25	134	11.2
0.41-0.6	295	24.6	800	66.7
0.61-0.8	83	6.9	112	9.3
0.81-1.00	522	43.5	96	8.0
Minimum	0.1221		0.111	
Maximum	1.00		0.983	
Mean TE	0.8529	100	0.6270	100

Source: Field Survey Data (2024)

Estimates of the Factors Influencing Technical Efficiency of Rice Production among Male and Female Smallholder Rice Farmers

Table 4 presents the results output of the stochastic frontier using Maximum Likelihood Estimates to determine the factors that affects technical inefficiencies of the male and female smallholder rice farmers. The model comprises of two stages, in the first stage the determinants of total output of rice production that were significant for male small-holder rice farmers were: land size, labour input, rice seed input, fertilizer input, and agrochemical input. More so, the statistically significant determinants that influences total output of rice production for female smallholder rice farmers were: land size, labour, rice seed, fertilizer and agrochemicals. This finding is in line with the finding of Lawal et al (2023) Amaechina and Eboh, (2017) who asserted that fertilizer, land size, and had positive and significant relationship with rice productivity in Anambara State, Nigeria. For both male and female small-scale rice farmers, the size of the land size coefficient has a favorable impact on the overall output of rice production, and it was statistically significant at $P<0.01$ and $P<0.05$, respectively. Male and female small-scale rice producers had corresponding coefficients of land size of 0.2176 and 0.4277. This suggests that for both male and female smallholder rice producers, a percentage increase in land area will result in a notable rise in the overall output of rice production by 20.8% and 31.8%, respectively. The findings of Amaechina & Eboh (2017) and Abdulai et al. (2018), who found that farm size positively affects the overall output of rice production in their respective research areas, are in line with this result.

Labour influences rice total output positively for male and female smallholder rice farmers and it has a significant effect at $P<0.05$) and ($P<0.1$) probability level. The magnitude of the regression coefficients of labour for male smallholder rice farmers (0.6949) and (0.2176) for female smallholder rice farmers. This signifies that percentage change in labour provided by families for rice production activities will result in the increment in total yield of rice total output by 69.5% and 21.7%, respectively. Rice seed influence rice

production and it was positively significant for male and negatively for female smallholder farmers, respectively and was statistically significant at (P<0.05) and (P<0.01), respectively. The coefficient of rice seed for male and female smallholder rice farmers was (0.1861) and (-0.2530). This indicates that percentage increase in rice seed used by small-scale male and female rice farmers will lead to increment in the total output of rice produced by 18.6% for male rice farmers and 25.3% reduction in the quantity of rice for female smallholder farmers. Having access to modern seed varieties might be the major reason that led to increase in total output of rice production among the male farmers while female smallholder farmers experiences decrease in total output due to inability to acquire improved seed varieties or non-adoption of new technology.

Fertilizer influences quantity of rice output among male smallholder farmers positively while for female rice farmers it influences quantity of rice production negatively and it was statistically significant at (P<0.01) and (P<0.1), for male and female smallholder rice farmers. The magnitude of the coefficient of fertilizer input for male and female smallholder rice farmers was (0.3109) and (-0.1703), respectively. This signifies that a one percentage change in the quantity of fertilizer utilized on rice farm by male and female smallholder rice farmers will lead to increase in the total quantity of rice output by 31.1% while the female farmers experienced a decrease in total out of rice by17%. This finding corroborates the findings of Lawal et al, (2023) who asserted that adequate application of fertilizer led to positive influence on total quantity of rice output in North central, Nigeria. The result also agreed with the finding of Amaechina & Eboh (2017) and Mabe et al. (2018) who reported positive influence of fertilizer on rice production in Anambara State, Nigeria. This result contradicts the results of Abdulai et al. (2018) who discovered inverse effects of fertilizer on total output of rice in Northern Ghana. But conforms to the results of the female smallholder rice farmers sampled for this study. Agrochemical influence total output of rice production for both male and female smallholder rice farmers positively and it was statistically significant at (P<0.01) and (P<0.05), respectively. The magnitude of the coefficient of agrochemical for male and female rice farmers was (0.3053) and (0.4355), respectively. Implying that a one percent increase in the quantity of agrochemical applied by male and female smallholder rice farmers will lead to increment in the total quantity of rice output produced by male and female rice farmers by 30.5% and43.6%, respectively.

The second stage of the production function, the technical inefficiency component of the stochastic production frontier, reveals that the following statistically significant factors affect technical inefficiency for both male and female smallholder rice farmers: farmers' age, education level, land size, farming experience, household size, extension services, and cooperative association (Table 4). Education has a statistically significant detrimental and positive impact on the technical efficiency of smallholder male and female rice producers, respectively (P<0.01). For both male and female rice farmers, the calculated coefficient of education was -0.3024 and 0.1212, respectively. Male smallholder rice farmers' technical inefficiency is negatively impacted by their education, but female smallholder farmers' technical inefficiency is positively impacted by their education. This result shows that a unit increase in the education level of small-scale rice farmers will result in the decrease in technical inefficiency for male small-scale rice farmers 30.2% and increase in technical efficiency for female rice famers by 12.1%. The implies that the positive sign for female rice farmers could be that they didn't don't have technical know nor adopt modern technology in rice production which could increase their level of productivity, they might have rather prefer to embrace traditional way of rice production, thereby leading to technical inefficiency. This outcome is in line with research by Dominic et al. (2019), which found a negative correlation between rice farmers' educational attainment and technical production inefficiencies. The results of this study also support those of Danso-Abbeam et al. (2015), who claimed that technological inefficiency is negatively impacted by educational access. Male and female smallholder producers' estimated age coefficients were (-0.1175) and (0.0717), respectively. According to this, the technical inefficiency of male smallholder rice farmers will drop by 11.8% for every unit rise in age, whereas the technical inefficiency of female rice farmers will increase by 7.2%. Because younger farmers are more likely to take risks and readily adopt new innovations than older farmers, the results suggest that younger farmers are more technically efficient than older farmers. This result supports that of Ishiaku et al. (2017), who claimed that younger farmers are more adaptable than older farmers when it comes to embracing innovation. Land size had a statistically significant negative impact on technical inefficiency for both male and female smallholder rice growers (P<0.05). Male and female smallholder rice growers had corresponding coefficients of land size of 0.4330 and 0.2553. This suggests that the technical efficiency of rice production among male and female smallholder rice farmers will increase by 43.3% and 25.5%, respectively, for every unit increment in land size. For smallholder male rice farmers, experience has a negative and statistically significant impact on technical inefficiency of rice production (P<0.01), whereas for female farmers, it has a favorable effect. Male and female smallholder rice farmers had agricultural experience coefficients of -1824 and 0.0493, respectively. This suggests that for male small-scale rice farmers, a unit change in years of experience in rice farming will result in an 18.2% reduction in technical inefficiency, but for female rice farmers, it will result in a 4.9% drop in technical efficiency. The findings of Nwahia et al. (2020), who proposed that small-scale farmers with more years of rice farming experience typically achieve higher technical efficiency than those with less farming experience, are supported by this study.

Household size has a positive influence on technical efficiency for male small-scale rice farmers and negative effect for female farmers and it was statistically significant at (P<0.05). The coefficient of household size for male and female small-scale rice farmers was (0.2682) and (–0.0628), respectively. This implies that a unit or percentage increase in the number of members per each

household for male rice farmers will lead to increment in the technical efficiency of rice production by 26.8% for male farmers and reduction in technical efficiency for female farmers by 6.3% in the study area. Household size provides labour supply for rice production by the families which might result in the reduction of cost of production and as a result could lead to increase in profit maximization while for female small-scale rice farmers larger number of family members in a household could lead to negative effects on technical efficiency due to the fact that the scarce available resources could be channeled for solving family challenges such as feeding, payment of children school fees and hospital bills instead of using it for farm productivity which could lead to decline in technical efficiency and profit level among female farmers. This result is in line with that of Okello et al. (2019), who claimed that larger households may result in a decrease in the technical efficiency of rice production. Male small-scale rice farmers' technical efficiency is negatively impacted by extension services, and this effect was statistically significant at the (P<0.1) probability level. A unit increase in access to extension services will result in a 3.1% rise in the technical efficiency of rice production, according to the coefficient of extension services for male rice farmers, which was 0.0307. This result showed that men rice farmers are more technically efficient than their female counterparts when they have access to extension services. The results of this study are consistent with those of Abdulai et al. (2018), Dominic et al. (2019), and Danso-Abbeam et al. (2015), who found that access to extension services helps rice farmers learn more about productivity growth. For both male and female smallholder rice farmers, cooperative associations have a detrimental impact on technical efficiency; this effect was statistically significant at P<0.01 and P<0.05, respectively. The coefficient of cooperative association was -0.4051 for male smallholder rice producers and -0.2574 for female rice farmers. This suggests that the technical efficiency of rice production among male and female smallholder rice farmers will rise by 40.5% and 25.7%, respectively, for every unit increase in the likelihood that a farmer will be a member of a cooperative association. This result is in line with the findings of Alabi et al. (2023) and Lawal et al. (2023), who proposed that smallholder rice farmers could have access to and obtain farm inputs at a reduced cost by joining a cooperative association. This is because they could buy the production inputs in bulk at a discounted price, increasing their productivity, enabling them to be technically efficient, and maximizing profit, all of which could improve their welfare and standard of living.

Table 4: Maximum Likelihood Estimates of the Stochastic Frontier of Rice Production Function for Male and Female Rice Producers

Variable	Male Rice Farmers			Female Rice Farmers		
	Coefficients	**Std Error**	**Z-Score**	**Coefficients**	**Std Error**	**Z-Score**
Land Size	0.2176***	0.0456	4.77	0.4277*	0.2221	1.93
Labour	0.6949**	0.2839	2.44	0.2176*	0.1128	1.93
Rice Seed	0.4034**	0.1861	2.16	-0.2530*	0.0861	-2.92
Fertilizer	0.3109***	0.3012	10.32	-0.1703*	0.1001	-1.70
Agrochemical	0.3052***	0.092	3.35	-0.4355**	0.2018	2.16
Constant	4.0994	2.895	1.41	0.3712	0.6759	0.55
Inefficiency Model						
Education	-0.3024***	0.0724	-4.17	0.1212***	0.0432	2.81
Age	-.1175***	0.0186	-6.31	0.0717**	0.0721	2.64
Land Size	-0.4330**	0.2100	-2.06	-0.6248**	0.2553	-2.45
Experience	-0.1824***	0.0481	-4.44	0.0493**	0.0206	2.39
Household Size	0.2682**	0.1273	2.11	-0.0628**	0.0294	-2.13
Extension Contact	0.0307*	0.0159	1.93	-0.0663*	0.0495	-1.34
Cooperatives	-0.4051***	0.1381	-2.93	-0.2574**	0.1298	-1.98
Sex	0.0038	0.0244	0,16	-0.1281	0.1783	-1.58
Diagnostic Statistics						
Log likelihood	-85.8000			34.7855		
Sigma square	91.5117			0.0565		
Gama	0.8441			0.6218		

Source: Field Survey Data (2023)

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

Constraints Faced by Male Smallholder Rice Farmers

The limitations that the male smallholder rice producers in the sample face are shown in Table 5. The majority of male rice farmers (97.8%) reported that the main obstacle to rice production was limited access to finance facilities, and this was ranked 1st according to the opinions of the greatest number of rice farmers.

Also, majority (96.1%) of the male rice farmers encountered shortage of farm input and poor soil fertility as a constraint. Additionally, the majority of male rice farmers (96.1%) ranked poor soil fertility and a lack of farm inputs as constraints, pl acing them second and third, respectively, while 94.8% and 93.8 percent of male rice farmers ranked insufficient rainfall and high farm input costs as constraints, placing them third and fourth, respectively.

As a major constraint affecting rice production in the study area, the results also showed that 88.2% of the sampled smallholder male rice farmers faced planting calendar instability, ranking it fifth in terms of severity among smallholder male rice farmers. This outcome is consistent with the findings of Parveen et al. (2016), Cooker et al. (2018), Alabi et al. (2023), and Lawal et al. (2023), who all identified similar obstacles impeding farmers' ability to produce rice in their various fields of research.

Table 5: Constraint Faced by Male Rice Producers in the Study Area

Constraints	Frequency	Percentage	Rank
Poor access to credit facilities	1174	97.8	1st
Shortage of farm inputs	1153	96.1	2nd
Poor soil fertility	1153	96.1	2nd
Inadequate rainfall	1137	94.8	3rd
High cost of farm input	1125	93.8	5th
Instability in planting calendar	1058	88.2	6th
High cost of labour	1074	85.6	7th
Problem of land ownership	1026	85.5	8th
Farmer/herder clashes	947	78.9	9th
Inadequate extension contact	958	79.7	10th
Total	1200	100	

Source: Field Survey (2024)

Constraints Faced by Smallholder Female Rice Producers

Table 6 shows the constraints encountered by female smallholder rice farmers, the results show that majority (96.8%) of the smallholder female rice farmers identified poor soil fertility and inadequate infrastructure and were both ranked 1st while 92.9% of the female rice farmers ranked the problem of land ownership/discrimination as 2nd, high cost of labour 3rd, poor access to credit facilities 4th and inadequate rain fall season 5th, respectively. These were the most important constraints faced by the female farmers in rice production in the order of its severity. This finding is consistent with the report of Lawal et al. (2023) who reported similar challenges faced by farmers.

Table 6: Constraints Faced by Female Rice Producers in the Study Area

Constraints Faced by Female Rice Farmers	Frequency	Percentage	Rank
Poor soil fertility	1162	96.8	1st
Inadequate infrastructure	1162	96.8	1st
Problem of land ownership/Discrimination	1115	92.9	2nd
High cost of labour	1127	93.9	33rd
Poor access to credit facilities	1118	93.2	4th
Inadequate rain fall season	1115	92.9	5th
Small Farm Size	1085	90.4	6th
High cost of farm inputs	1034	86.2	7th
Instability in planting calendar	865	72.1	8th
Poor access to market centers due to bad roads	769	64.1	9th
Inadequate extension services	711	59.3	10th
Total	1200	100	

Source: Field Survey Data (2024)

CONCLUSION AND POLICY RECOMMENDATIONS

The generally, this study conclude that rice production was profit for male and female smallholder rice farmers. Male rice farmers obtained return on each Naira investment greater than the female smallholder rice farmers and technical efficiency much more than female smallholder farmers. The mean technical efficiency obtained by male smallholder farmers was 81.1% while female smallholder rice farmers obtained 52.7% which indicated that male small-scale rice farmers attained high level of technical

efficiency than the female rice farmers. The study found that labor, rice seed, fertilizer, agrochemicals, and land area were the main factors influencing the overall rice production of both male and female rice producers. The study also found that household size, education, age, land size, experience, extension services, and cooperative organizations were statistically significant factors impacting technical inefficiency for male rice farmers. Education, land size, experience, household size, and cooperatives were the statistically significant factors impacting technical inefficiency among female small-scale rice producers.

The major constraints encountered by male and female smalls-cale rice farmers were poor access to credit facilities, inadequate infrastructures, Problem of land ownership/Discrimination, high cost of labour, shortage of farm input, high cost of farm input, and inadequate rainfall. Therefore, the study recommends that, there is need to provide modernized technologies to all male and female small-scale rice farmers in order to enable them produce on large scale basis to maximize profit. Small-scale rice farmers should have access to tractors and other farm equipment so they can engage in mechanized farming. They should also be given better seed varieties, fertilizer inputs, and agrochemical inputs. The Nigerian government or non-governmental organizations should promptly and at a subsidized rate supply these inputs to farmers. Small-scale rice farmers should receive assistance from extension agents on how to use new technologies and innovations related to precision planting for rice production. In order for both male and female farmers to have access to credit facilities to increase their capacity to produce rice and adopt new innovations and technologies that will increase their output yield and income, which could improve their welfare and livelihood and increase their food security, it is recommended that they join cooperative societies.

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