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Research article

Analysis of profitability among rain-fed upland rice producers, north west, Nigeria[a]

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ABSTRACT

This study analyzes profitability among rain-fed upland rice producers in North West, Nigeria. Uisng a multi-stage sampling technique, 200 respondents were selected for the study. Primary data were analyzed using descriptive statistics, farm budgeting techniques, and multiple regression analysis. Results showed that approximately 89% of rain-fed upland rice producers were male, with the average age of 46 years. The household sizes were large with an average of 10 people per household. The respondents are small-scale farmers with an average rice farm of 1.47 hectares. Approximate 85% of rain-fed upland rice farmers belong to membership of cooperative organization. The farmers had 14 years' experience in upland rice farming. The gross margin and net farm income in rice production were estimated at 780879.28, and 701627.13 Naira per hectare, respectively. This shows that upland rice production was profitable. The seed, farm size, fertilizer, agrochemicals, and hired labour were significantly different from zero in influencing the net farm income of rain-fed upland rice farmers. The coefficient multiple determinations of 0.91, implies that 91% of variations in the net farm income of rain-fed upland rice farmers were explained by the independent variables included in the multiple

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regression model. The study recommends that the government through credit policy should provide credit facilities to rain-fed upland rice farmers at a single digit interest rate, this will enable them to purchase necessary farm input.

Keywords: Profitability Analysis, Rain-Fed Upland Rice Producers, Farm Budgeting Technique, Multiple Regression Analysis, Nigeria

Introduction

Rice (Oryza sativa) is one of the most important cereal crops consumed and cultivated all over the world (Ojo et al., 2020). Rice plays a significant role in household diets in Africa and represents a major produce in the fight against food insecurity in the developing countries (Seck et al., 2013). Rice is counted among the fastest growing food crop, the demand in the region is increasing by around 6% per year but the gap between demand and output also continues to grow (Miassi et al., 2023). In Nigeria, rice is the fourth major cereal crop and sixth major crop after sorghum, millet, cowpea, cassava and yam (USAID, 2009). In Nigeria, more than 90% of rice is produced by resource-poor and small-scale farmers (Adeyemi et al., 2017). Approximately 95% of rice processors are of small-scale who use low capacity and outdated mills (Olaniyi, 2011). Rice provides 20% of calorie consumed and is the second highest production worldwide after maize (Kenmore, 2003; Mohanty et al.,2013). Nigeria is one of the largest rice importer in the world, and simultaneously, Nigeria is one of the leading consumer of rice in Africa. Nigeria is the largest producer of rice in West Africa producing over 40% of the regions' total production (FAOSTAT, 2007). Similarly, Nigeria is one of the largest producers of rice in Africa. Rice productivity and profitability in Nigeria is low due to traditional methods of farming, land fragmentation, poor irrigation facilities, non-availability of credit, mis-use of modern agricultural technology, and impact of climate change (Chandio et al., 2017). Africa has the lowest cereal crops productivity per hectare than any other regions in the world (Okello et al. 2019). The smallholder farmers in Africa are less productive compared to world standard resulting in lower yields (FAO, 2014). Nigeria in 2021 and 2022 produced approximate 8342000 tons and 8502000 tons of rice, which represents 1.06 % and 1.09% of world output, respectively (Figure 1). Similarly, in Nigeria, the rice area in 2021 and 2022 approximates 4320100 hectares and 4580000 hectares, respectively (Figure 2). The world output of rice in 2021 and 2022 approximates 789045342.64 tons and 776461456.61 tons, respectively (Figure 1). The world area of rice in 2021 and 2022 approximates 166310782 hectares and 165038826 hectares, respectively (Figure 2) (FAO, 2024).

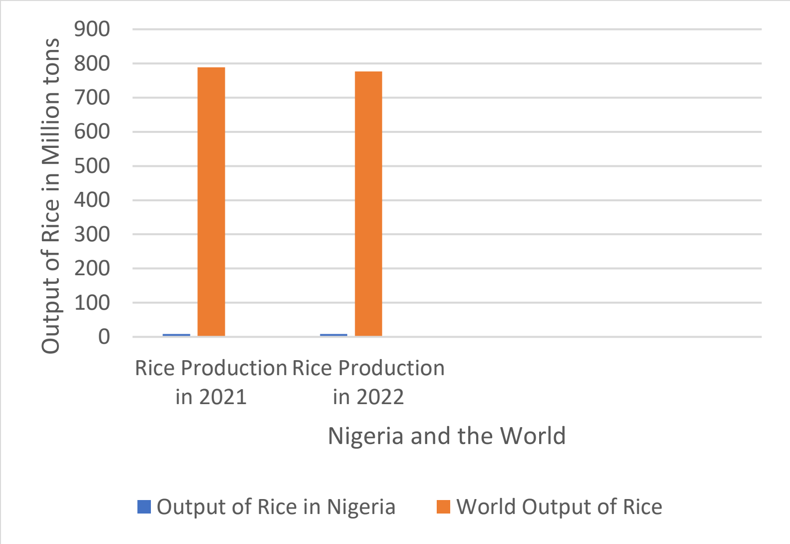

Figure 1: Comparison of rice production in Nigeria and globally (2021-2022)

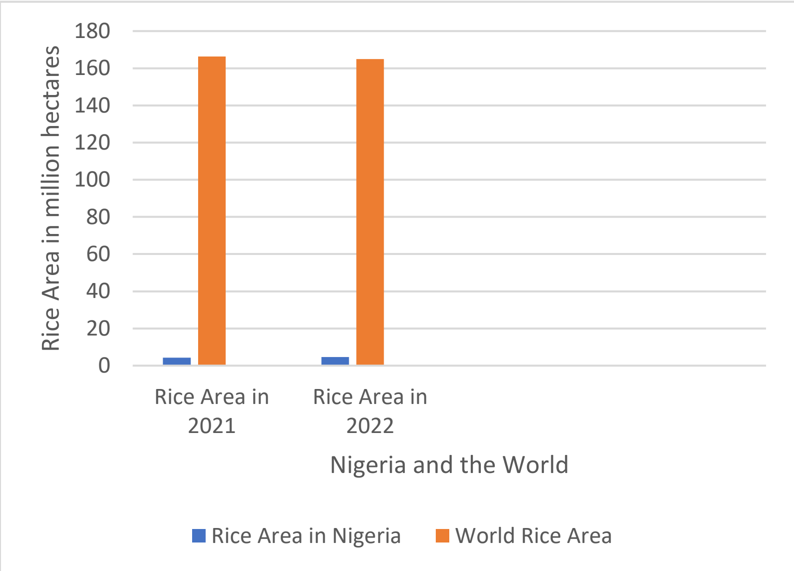

Figure 2: Cultivated rice area in Nigeria and globally (2021-2022)

USDA (2016) documented that annual rice consumption in Nigeria was evaluated at 5 million metric tonnes, while the quantity of rice supplied was estimated at 2.7 million metric tonnes, giving a demand and supply gap of about 2.3 million metric tonnes, which is completed by rice importation (Obih and Baiyegunhi, 2017). According to the Central Bank of Nigeria (CBN) (2019), approximate 57% of the 6.7 million metric tons of rice consumed is produced locally; the 43% supply imbalance was filled in by imports. To make up for this gap, around 3 million tonnes of rice worth US$480 million are imported each year (Kamai et al., 2020).

In Africa, rainfall is a crucial determinant of agricultural productivity because most crop production systems are rain-fed dependent. Rice production in Nigeria is majorly rain-fed as over 90% of rice produced in the country is through this system (Ogundari, 2008). According to Akpokodge et al. (2001) who documented that 46% of total area devoted to rice production is for rain-fed upland rice and irrigated production systems, each accounting for 30% and 16%, respectively. There is increasing dependence on rain-fed rice production as a result of nonfunctioning irrigation program in the country. Rice is grown in all the agro-ecological zones in Nigeria (Akande, 2003). According to Onyishi et al. (2010), the main farming ecologies of rice are rain-fed lowland, rain-fed upland, irrigated lowland, deep water floating, and mangrove swamp. They observed that, land area for rice farming under rain-fed upland is 25%, rain-fed lowland 50%, irrigated lowland 16%, deep water and mangrove 9%, and their share of production is 17%, 35%, 27% and 3% for rain-fed upland, rain-fed- lowland, irrigated lowland, and deep water mangrove, respectively. Nigeria has a land area of 923768 square kilometres with total of 71.2 million hectares of cultivable land, an estimated 4.6 million hectares is suitable for rice farming, but only 1.8 million hectares or 39% is currently developed for rice farming (Kadiri et al., 2014). The study conducted by Offor et al. (2020) on economic analysis of rice production in Bende local government area of Abia state, Nigeria, reported that the rice farmers realized an average revenue of 403268.22 Naira (387 USD) and recorded a net return of 183017.02 Naira (176 USD), the factors that influenced rice farming were age, farm size, planting materials, chemical fertilizer, labour input, amount of credit, and initial capital. The research conducted by Kadiri et al. (2014) on economic analysis of paddy rice production in Niger Delta region of Nigeria reported that the total operating cost of paddy production amounted to 334916.60 Naira (322 USD) or 95.18% of the total cost of production, the seed, family labour, and herbicide application were significant factors influencing paddy rice output. The major aim of the research is to analyzed the profitability among rain-fed upland rice producers in North West, Nigeria. The specific objectives were to: describe the socio-economic profiles of rice producers, analyze the profitability of rain-fed upland rice production, and evaluate the predictors influencing the net farm income among rain-fed upland rice farmers in the study area.

1.1 Hypotheses of the Study

The study was guided by the following hypotheses stated in null-forms:

H_{01}: There is no significant relationship between the predictors such as seed planted, farm size, fertilizer usage, agrochemicals, and hired labour and net farm income among rain-fed upland rice producers in the study area.

H_{02}: There is no significant difference between cost and returns among rain-fed upland rice producers in the study area

Materials and Method

This study was carried out in North West which consists of Kano and Kaduna States, Nigeria. This research employs the use of a multi-stage sampling technique. The multi-stage sampling technique was used because of cost reduction, time efficiency, increase reliability, and flexibility. For geographically dispersed respondents, a probability sample provides more reliable population parameter liestimates. You draw a sample from a population using smaller and smaller groups (unit) at each stage. In the first stage, two states were randomly selected from the north-west region based on their prominence in rain-fed upland rice farming. In the second stage, two local government areas were selected from each state. In the third stage, four villages were chosen from each local government area,yielding a total of sixteen villages. The sample frame of rain-fed rice producers approximates 400 respondents. In the fourth and final stage, the total sample number of rain-fed rice producers was randomly and proportionately selected which consists of 200 respondents comprising 100 smallholder rain-fed rice producers each from the two states, respectively. Primary sources of data were utilized based on a well-designed questionnaire that was subjected to reliability and validity test. This sample number was evaluated based on the established formula of Yamane (1967) as follows:

$$n = \frac{N}{1+N(e^2)} = \frac{400}{1+400(0.05^2)} = 200 \quad (1)$$

Where,

n = The Sample Number
N = The Total Number of Rain-Fed Rice Producers (Number for the 2 States)
e = 5%

The data obtained were analyzed using both descriptive and inferential statistics:

2.1 Farm Budgetary Technique

Gross Margin Analysis is one of the farms budgetary technique and it can be explained following Olukosi and Erhabor (2005) as the difference between the gross farm income (GFI) and total variable cost (TVC):

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

$$GM = TR - TVC \quad (3)$$

Where,

GM = Gross Margin (₦)
TR = Total Revenue (₦)
TVC =Total Variable Cost (₦)
NFI = Gross Margin (GM) – Total Fixed Cost (TFC)

$$NFI = \sum_{i=1}^{n} P_i Q_i - \sum_{i=1}^{n} P_j X_j - K \quad (4)$$

Where ,

NFI = Net Farm Income (Naira)
GM= Gross Margin (Naira)
P_i = Price of Rice Output i^{th} ₦/Kg
Q_i = Quantity of Rice Output i^{th} (Kg)
P_j = Price of Input j^{th} (₦/Kg)
X_j = Quantity of Input j^{th} used (Kg)
K = Total Fixed Cost (TFC)

2.2 Depreciation of Assets

The straight line depreciation following the method of Olukosi and Erhabor (2005) is specified as:

$$D = \frac{P - S}{N} \quad (5)$$

D= Depreciation of Farm Production Assets (Naira)
P= Purchase Cost of Farm Asset (Naira)
S= Salvage Value of Farm Asset (Naira)
N= Number of Years of the life span of the Farm Asset (Years)

2.3 Financial Analysis

The formula of Gross Margin Ratio (GMR) following Alabi *et al.* (2020); Ben-Chendo *et al*. (2015) is stated as:

$$GMR = \frac{Gross\ Margin}{Total\ Revenue} = \frac{GM}{TR} \quad (6)$$

The operating ratio (OR) is stated thus:

$$OR = \frac{TVC}{GI} \quad (7)$$

Where, OR= Operating Ratio (Units); TVC= Total Variable Cost (Naira); GI= Gross Income (Naira).

The rate of return invested per naira is stated thus;

$$RORI = \frac{NI}{TC} \quad (8)$$

Where, RORI= Rate of Return per Naira Invested (Units); NI= Net income from Rice Production (Naira); TC= Total Cost (Naira).

2.4 Multiple Regression Model (MRM)

The multiple regression model (Lead Equation) following the method of Emokaro & Erhabor (2014) is stated as:

$$Y_i = \beta_0 + \sum_{i=1}^{5} \beta_i X_i + \cdots \beta_n X_n + \varepsilon_i \quad (9)$$

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon_i \quad (10)$$

Where,
Y_i = Net Farm Income (Naira)
X_1= Seed Planted (Kg)
X_2 = Farm Size (Hectares)
X_3 = Fertilizer Usage (Kg)
X_4 = Agrochemicals (Litres)
X_5 = Hired Labour (Mandays)
β_0 = Constant Term
$\beta_1 - \beta_5$ = Regression Coefficients
ε_i = Noise Term

2.5 Jarque-Bera Statistics

The Jarque-Bera (JB) statistics is used to test the normality of data. The Jarque-Bera following Hill et al. (2018) is stated as:

$$\mathrm{JB} = \frac{N}{6}\left(\frac{S^2+(K-3)^2}{4}\right) \qquad (11)$$

where,

JB = Jarque-Bera Statistics
N =Number of Observations
S = Skewness
K =Kurtosis

2.6 t-Test Statistics

The t-Test statistics following Hill et al. (2018) is stated as:

$$t = \frac{\beta}{SE} \qquad (12)$$

where,

t = t-Test Statistics
β =Regression Coefficient
SE =Standard Error

2.7 The Z-Test of Difference Between Means

The z-Test of difference between means following Hill et al. (2018) is stated as:

$$\mathrm{Z} - \mathrm{Statistics} = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{S_1^2}{n_1}+\frac{S_2^2}{n_2}}} \qquad (13)$$

where,

$\overline{X_1}$ =Mean of Returns
$\overline{X_2}$ = Mean of Cost
S_1^2 =Variance of Returns
S_2^2 = Variance of Cost
n_1 =Number of Observation of Returns
n_2 = Number of Observation of Cost

Results and Discussion

Socio-Economic Profiles of Rain-Fed Upland Rice Producers

The summary profiles of rain-fed upland rice farmers was presented in Table 1. About 90% of rain-fed upland rice producers were married. Approximate 89% of rain-fed upland rice producers were male, while 11% of the respondents were female. Averagely, the rain-fed upland rice producers were 46 years of age. This implies that they are young, energetic, strong, and resourceful. This means that they can easily adopt innovations, farm technologies, and research findings. This result is in line with findings of Ojo et al. (2020) who obtained the mean age of household head of 47 years among rice farmers in Southwest, Nigeria. The household sizes were large with average of 10 people per household. The rain-fed upland rice farmers were small-scale farmers with average farm size of 1.47 hectares of farm land. They are literate, can read and write with average of 14 years of attending school education. Approximate 85% (SD = 0.57) are members of cooperative organization, this enables them to access to credit, share ideas and information, and sell their rice produce in bulk. They had about 14 years' experience in rice farming. This result is in line with outcome of Okello et al. (2019) who obtained an average farming experience of 18 years among rice farmers in Northern Uganda.

Table 1: Socio-economic characteristics of rain-fed upland rice farmers

Variables	Unit of Measurement	$\overline{X}_i$	SD
Marital Status	1, Married; 0,Otherwise	0.90	0.51
Sex	1, Male; 0, Otherwise	0.89	0.48
Age	Years	46	10.14
Household Size	Number	10	4.23
Farm Size	Hectare	1.47	0.62
Formal Education	Years	14	3.28
Member of Cooperatives	1, Member; 0, Otherwise	0.85	0.57
Farming Experience	Years	14	5.91

Source: Field survey (2024)

3.1 Analysis of Profitability among Rain-Fed Upland Rice Farmers

Estimates of cost and returns and hence profitability in rain-fed upland rice production is presented in Table 2. The various costs incurred and revenue obtained in upland rain-fed rice production was based on the current market survey. The total variable cost (TVC) was evaluated at 341989.72 Naira (329 USD) per hectare and this accounted for 81.19% of total cost. The total variable cost includes the cost of seed (29.19%), cost of fertilizer (26.16%), cost of labour (17.81%), cost of pesticides (2.88%), cost of herbicides (2.67%), loading and offloading cost (0.74%), cost of bags and sewing (0.51%), and transportation cost (1.23%). The total fixed cost (TFC) was calculated at 79252.15 Naira (76 USD) per hectare, and this accounted for 18.81% of total cost. The total fixed cost includes land rent (13.80%), and general administrative expenses (5.01%). The total cost is the sum of total variable cost (TVC) and total fixed cost (TFC), and this was calculated at 421, 241.87 Naira (405 USD) per hectare. The gross margin and net farm income were estimated at 780, 898.28 Naira and 701627.13 Naira (675 USD), respectively.

Table 2: Profitability analysis among rain-fed upland rice production per hectare

Items	Kg	Value (Naira)	Percentage of TC
Quantity (1.1 tons)	1,100		
Price per Kg		1020.79	
Total Revenue		1122, 869	
Variable Cost			
Cost of Seed		123000.09	29.19
Cost of Fertilizer		110161.00	26.16
Cost of Labour		75000.00	17.81
Cost of Pesticides		12131.07	02.88
Cost of Herbicides		11261.21	02.67
Loading and Offloading Cost		3128.61	0.74
Cost of Bags and Sewing		2125.54	0.51
Transportation Cost		5182.20	1.23
Total Variable Cost (TVC)		341989.72	81.19
Fixed Cost (TFC)			
Land Rent		58141.01	13.80
General Administrative Expenses		21111.01	05.01
Total Fixed Cost (TFC)		79252.15	18.81
Total Cost (TFC + TVC)		421241.87	100.00
Gross Margin		780879.28	
Net Farm Income		701627.13	
Gross Margin Ratio		0.695	
Operating Ratio		0.30	
Rate of Return on Investment		1.66	

Source: Field Survey (2024)   USD = 1,040 Naira

This means that rain-fed upland rice production in the area was profitable. The gross margin ratio and rate of return on investment were calculated at 0.695 and 1.66, respectively. The gross margin ratio of 0.695 signifies that for every one Naira invested in upland rice production, approximate 70 Kobo covered interest, profits, depreciation, and other expenses (marketing and administrative cost). This can be further explained to mean that the rain-fed rice farmers retained 69.5% after accounting for the production cost. That implies that 69.5% of each Naira earned contributes to covering other expenses and generating net profit. The rate of return on investment or return per Naira invested in rain-fed upland rice production was estimated at 1.66. This implies that for every one Naira invested into rain-fed rice production, approximate 1.66 Naira is made as revenue, that is 0.66 Naira is realized as profit. This finding is in line with result of Sadiq et al. (2021) who obtained the gross margin of 543 429.60 Naira (522 USD) among rice farmers in Niger State, Nigeria.

3.2 Factors Influencing Net Farm Income of Rain-Fed Upland Farmers

Table 3 presents the factors influencing net farm income of rain-fed upland rice farmers. The multiple regression analysis was used to analyzed that data, linear equation was chosen as lead equation using the 4 criteria such as the significance of the variables, the R-square value, the signs of coefficient relative to a priori expectations, and the F-value. Five (5) predictors were significantly different from zero in influencing net farm income of rain-fed upland rice farmers. The five (5) significant predictors include seed, farm size, fertilizer, agrochemicals, and hired labour. All the predictors included in the multiple regression model had positive coefficients. The coefficient of seed is 0.543 and was significantly different from zero at 5% probability level in influencing the net farm income of rain-fed upland rice farmers. A one percent increase in improved seeds usage, while keeping all other factors fixed will give rise to 54.3 % increase in net farm income of rain-fed upland rice farmers. Similarly, the coefficient of farm size was evaluated at 0.125, and was significantly different from zero at 10 % probability level in influencing the net farm income of rain-fed upland rice farmers. A one percent increase in farm size, while keeping all other factors fixed will give rise to 12.5 % increase in the net farm income of rain-fed upland rice producers. The coefficient of multiple determinations (R^2) was evaluated at 0.91, this signifies that 91% of variations in the net farm income of rain-fed upland rice farmers was explained by the independent stimuli included in the model. The F-value of 402.53 was significantly different from zero at 1 percent probability level. This means that the model is of good fit. This finding is in line with results of Okello et al. (2019) who obtained that rice seeds, land area, were significant predictors influencing output of rice in Northern Uganda. The skewness, kurtosis, and Jarque-Bera were used to test for the normality of data. A normality test is used to determine whether the sample data has been drawn from a normally distributed population. The data were considered to be from normal distribution when the skewness is between -2 to +2, the kurtosis is between -7 to +7 and the Jarque-Bera is greater than 0.05. The skewness, kurtosis and Jarque-Bera were evaluated at -0.3668, 2.4963 and 3.2318, respectively (Table 3). This signifies that the data follow a normal distribution. The variance inflation factor (VIF) was used to check whether multicollinearity exist in the data. The multicollinearity exist in the data when the VIF is > 5 – 10 and < 0.1 – 0.2, the variance inflation factor (VIF) of data between 1 – 5 mean that the variables are moderately correlated, while the variance inflation factor of 1 means that the data were not correlated. The variance inflation factor was estimated at 1.7 which mean that the multicollinearity does not exists in the data (Table 3). The Durbin –Watson (DW) is used to detect that autocorrelations in the residuals from a regression analysis. The Durbin-Watson (DW) statistics assume the value between 0 – 4, The Durbin-Watson (DW) of 2 indicate that there is no autocorrelation, 0, means stronger positive autocorrelation, while, 4, means stronger negative autocorrelations. The Durbin-Watson (DW) statistics was estimated at 2.1, which means that there is no autocorrelation in the data.

Table 3: Multiple regression results of factors influencing profitability among rain-fed upland rice farmers

Variables	Parameters	Coefficient	Standard Error	t-Value
Constant	β_0	1.601**	0.578	2.77
Seed Planted	β_1	0.543**	0.201	2.70
Farm Size	β_2	0.125*	0.063	1.98
Fertilizer Usage	β_3	0.406**	0.185	2.20
Agrochemicals	β_4	0.346**	0.148	2.34
Hired Labour	β_5	0.135*	0.069	1.97
R^2	0.91			
$Adjusted\ R^2$	0.89			
F-Value	402.53***			
Skewness	-0.3668			
Kurtosis	2.4963			
Jargue-Bera (JB)	3.2318			
Variance Inflation Factor	1.7			
Durbin-Watson	2.1			

Source: Field Survey (2024),
*Significant at ($P < 0.10$)., **Significant at ($P < 0.05$), ***Significant at ($P < 0.01$).

Conclusion

This study analyzed the profitability among rain-fed upland rice producers in North West, Nigeria. A multi-stage sampling technique was employed to select 200 rain-fed upland rice producers. The sample frame was 400 respondents. The primary data were used based on a well-designed questionnaire. The data were analyzed using descriptive statistics, farm budgeting technique, and multiple regression analysis. The following conclusions were based on the hypotheses of the study:

*H_{01}**:** There is no significant relationship between the predictors such as seed planted, farm size, fertilizer usage, agrochemicals, and hired labour and net farm income among rain-fed upland rice producers in the study area.*

The coefficient of farm size (0.125), seed (0.543), fertilizer (0.406), agrochemicals (0.346), and hired labour (0.135) were positive and significantly different from zero in influencing the net farm income of rain-fed upland rice production. This means an increase in any of these predictors will lead to increase in net farm income of rain-fed upland rice producers. This result means that there are opportunities to increase rice production in the short term by adopting better farming practices. This study agrees with the findings of Ogundari et al. (2008) who reported an increasing effect of quantities of rice planted on rice output in his study on the resource productivity, allocative efficiency and determinants of technical inefficiency of rain-fed producers in Nigeria. These results are similar to the one previously obtained by Yabi (2009) who have shown that there are opportunities to increase rice production, producers would therefore benefit more by improving the use of productive resources.

*H_{02}**:** There is no significant difference between cost and returns among rain-fed upland rice producers in the study area*

This study has established that rain-fed upland rice production was profitable. The Table 4 has confirmed that there is a significant difference between cost and returns involved in rice farming. The mean cost was estimated at 2106.20, while the return was estimated at 5614.35. The z-calculated was estimated at 641.34, while the z-table was 2.54 at 1% probability level. The z-calculated was greater than z-table, therefore the null-hypothesis (H_{02}) was rejected, while the alternative hypothesis was accepted. The total variable cost (TVC) incurred in rain-fed upland rice production was estimated at 341989.72 Naira per hectare. The total fixed cost(TFC) was evaluated at 79252.15 Naira per hectare. The gross margin and net farm income were calculated at 780879.28 Naira per hectare, and 701627.13 Naira per hectare. This result agrees with the findings of Oruonye et al. (2021) who utilized the paired t –test to show that there is a significant difference between the rice yield and income before and after IFAD-VCDP intervention among smallholder rice farmers in Taraba State, Nigeria.

Table 4: Z-Test comparison of costs and returns among rain-fed upland rice producers

Variables	Values	Z-Cal	Z-Table
Mean Costs	2106.20	641.34***	2.54
Mean Returns	5614.35		
Variance Cost	1327.00		
Variance Returns	1669.00		

Source: Field Survey (2024), ***Significant at $(P < 0.01)$.

Based on the findings of this research, the following recommendations were made:

(i) The farm inputs such as improved seeds, fertilizers, agrochemicals should be provided for rice farmers to increase productivity and profitability

(ii) Government through credit policy should provide credit facilities to rain-fed upland rice farmers at a single digit interest rate to purchase necessary farm input.

(iii)The upland rice farmers should join cooperative organization, this will enable them to share ideas, information and for easy access of credit facilities.

(iv)Extension officers should be employed to disseminate research findings, innovations to rice farmers.

(v) Government should make farm land available for youth, women and men for rice farming.

Conflict of Interest

No known or potential conflict of interest exist for any author.

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