



## **Determinants of Output and Profitability among Lowland Rice Producers in North West, Nigeria**

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### **ABSTRACT**

This work is centered on determinants of output and profitability analysis among lowland rice producers in North West, Nigeria. A multi-stage sampling design was utilized, at the fourth-stage, a random sampling approach was utilized to select 200 lowland rice producers. Primary data of cross-sectional sources were utilized for this research, the data were estimated utilizing descriptive statistics, farm budgetary method, and stochastic production frontier version. The result shows that approximately 78% of lowland rice producers were male with mean age of 42 years. They are small-scale producers with an average farm size of 1.27 hectares. The lowland rice production is profitable with an evaluated gross margin (GM) and net farm incomes of 916219.39 and 868078.35 Naira per hectare. The



fertilizer usage, seed, farm size, agrochemicals, and labour were significant and positively affect the quantity of rice produced. The investigation recommends that credit at single interest rate should be giving to rice producers.

**Keywords:** Agrochemicals, lowland rice producers, farm budgetary technique, Nigeria, Stochastic production frontier model,

## INTRODUCTION

Rice (*Oryza sativa*) is one of the significant and importance cereal crops grown and eaten worldwide (Ojo et al., 2020). Rice rated third coming next to wheat and maize with regard to world output (Imolehin and Wada, 2000). Nigeria is one of the major rice consumers in the world and one of the major growers of rice in Africa (FAO, 2015). Nigeria has numerous abilities for enhanced output as the country is endowed with sufficient rice farming conditions (Alabi and Anekwe, 2022). Rice has retained its rank as one of the hopeful commercial crop for enhancing food security, increasing economic growth, and alleviating poverty (Houngue and Nonvide, 2020). Rice plays a significant part in household foodstuffs in developing countries and constitute the main produce in the wage against poverty, food insecurity in Africa (Seck et al., 2013). Rice productivity in sub-Saharan countries such as Nigeria is low, income of farmers is low, profitability is low, this is due to traditional methods of farming, land fragmentation, poor irrigation facilities, lack of modern farm technologies, lack of credit, and the impact of climate change (Chandio et al., 2017). Approximately, 90% of domestic rice output in Nigeria comes from feeble planned, resource poor, peasant, small-scale growers (USAID, 2009). The resource poor farmers use low input requirements, use low-input strategy, and has low productivity (IFAD, 2012). The smallholder farmers in Africa such as Nigeria are not so much productive when equate to global levels arising in lower outputs, and lower profitability (FAO, 2014). Africa has the lowest cereal crops output per hectare when compared to any other parts of the world, in some instances there has been reducing output per unit area. According to Obih and Baiyegunhi (2017) and USDA (2016) the yearly quantity of rice supplied in Nigeria was 2.7 million metric tons, the annual consumption of rice was 5 million metric tons, with the demand-supply gap of 2.3 million metric tons. Nigeria has approximately 4.6 million ha of land appropriate for rice farming, but approximately 1.8 million ha of land accounting for 39% is under rice farming (Danbata et al., 2013). Five main rice farming systems have been recognized in Nigeria, they include: upland rain-



fed, deep water, inland shallow swamp, floating lowland, and irrigation farming systems. Akpokodge at al. (2001) reported that approximately 46% of the total area devoted to rice farming in Nigeria is for irrigated and rain-fed upland rice production systems. Table 1 shows the output of rice in Nigeria and the world. Nigeria in 2021 and 2022 produced approximately 1.06 % and 1.09% of the world rice output, respectively. Similarly, Table 2 shows the rice cultivated area (hectares) in Nigeria and the world for 2021 and 2022, respectively (FAO, 2024). In Africa, rice is listed as one of the speedy emerging food crops, the demand in the area is rising by approximately 6%, but then the gap between the demand and output also continue to rise (Miassi et al.,2023). It is important to evolve agricultural strategies to increase the output of farmers for an advancement on one hand, and the other hand in the provision of rice. Smallholder rice producers in Nigeria are confronted with numerous problems such as low productivity, little-access to farm resources and assets, post-harvest losses, lack of support extension and research services, lack of market and rural infrastructures, and shortage of chance for agricultural value addition (IFAD, 2012).

**Table 1. The Output of Rice in Nigeria and the World**

| Variables           | Output of Rice in Nigeria (tons) | World Output of Rice (tons) |
|---------------------|----------------------------------|-----------------------------|
| Rice Output in 2021 | 8342000                          | 789045342.64                |
| Rice Output in 2022 | 8502000                          | 776461456.61                |

**Source: FAO (2022)**

**Table 2. The Rice Cultivated Area in Nigeria and the World**

| Variables         | Area of Rice in Nigeria (hectares) | World Area of Rice (hectares) |
|-------------------|------------------------------------|-------------------------------|
| Rice Area in 2021 | 4320100                            | 166310782                     |
| Rice Area in 2022 | 4580000                            | 165038826                     |

**Source: FAO (2022)**

## MATERIALS AND METHODS

This study was conducted in North West which consists of Kano and Kaduna States, Nigeria. This work utilized the use of a multi-stage sampling design. The sample frame of lowland rice growers was 400 respondents. The total sample number of lowland rice producers was proportionately and randomly selected, which consisted of 200 respondents comprising of 100 smallholder lowland rice producers from each state, respectively. Primary data of cross-sectional sources



were used on a well-organized questionnaire that was submitted to test involving validity and reliability. This sample number was calculated based on the established formula of Yamane (1967) as follows:

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

Where,

$n$  = The representative number

$N$  = The complete number of lowland rice growers

$e$  = 5%

The data obtained were evaluated utilizing both descriptive and inferential statistics:

### Farm Budgetary Technique

The farm budgetary technique includes the gross margin (GM) analysis and net farm income. The gross margin analysis can be explained as the distinction between the gross returns (GFI) and total variable cost (TVC):

$$GM = \sum_{i=1}^n P_i Q_i - \sum_{j=1}^n P_j X_j \quad (2)$$
$$GM = TR - TVC \quad (3)$$

Where,

GM = Gross Margin (₹)

TR = Total Revenue (₹)

TVC = Total Variable Cost (₹)

NFI = Gross Margin (GM) – Total Fixed Cost (TFC)

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

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)



### Depreciation of Assets

The straight line depreciation method 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 Estimate of Farm Asset (Naira)

N= Years of the life span of the Farm Asset (Years)

### Financial Analysis

The formula of gross margin ratio (GMR) is stated as:

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

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 is defined as Rate of Return per Naira Invested (Units); NI= Net income from Rice Farming (Naira); TC= Total Cost (Naira).

### The SPEFM (Stochastic Production Efficiency Frontier Model)

This follows the work of Alabi et al. (2022), the SPEFM is expressed as:

$$Y_i = f(X_i, \beta_i) e^{v_i - u_i} \dots (9)$$

$$\ln Y_i = \ln \beta_0 + \sum_{j=1}^5 \beta_j \ln X_i + (v_i - u_i) \quad (10)$$

$$TE_i = \frac{Y_i}{Y_i^*} \dots \dots (11)$$

$$TE_{ij} = \frac{F(X_i, \beta) \exp(v_i - u_i)}{F(X_i, \beta) \exp(v_i)} \dots \dots (12)$$

$$TE_{ij} = \exp(-u_{ij}) \dots \dots (13)$$

where,

$Y_i$  = Output of Rice (Kg)

$Y_i^*$  = Unobserved Frontier Output of Rice (Kg)

$X_i$  = Inputs

$\beta_i$  = Vectors of Estimated Parameters

$V_i$  = Random Variations



$U_i$  = Error Term due to TIE (Technical Inefficiency)

$X_1$  = Fertilizer Usage (Kg)

$X_2$  = Seed in Kg

$X_3$  = Farm Size (Ha)

$X_4$  = Agrochemicals (Litre)

$X_5$  = Labour (Mandays)

## RESULTS AND DISCUSSION

### **The farm and farmers characteristics of lowland rice producers**

The farm and farmers' characteristics of lowland rice producers was presented in Table 3. Approximately 78% of lowland rice producers were male, while 22% of the growers were female. About 72% of lowland rice producers were married, while 28% of respondents were either single, or divorced. Averagely, the age of lowland rice producers were 42 years. This signifies that the producers are active and resourceful. This means that they can easily adopt ideas, innovations, farm technologies, and research findings. This result is supported with the study of Ojo et al. (2020) who obtained the mean age of household head of 47 years among rice farmers in Southwest, Nigeria. The large household size is a source of unpaid family labour for rice farming activities. The household sizes were large with mean of 12 people per household. The lowland rice producers were smallholder farmers with average farm size of 1.26 hectares of rice farms. They attended formal education and are literate, can read and write with average of 12 years (SD = 2.71) of attending school education. Approximate 81% (SD = 0.38) are members of cooperative organization. The members of cooperative organization afford the rice producers access to credit, share ideas and information, and sell their rice produce in bulk. They had about 13 years' experience in rice farming. This result is in line with outcome of Okello et al. (2019) who obtained that the mean farming experience of rice growers in Northern Uganda was 18 years.

### **Analysis of profitability in lowland rice farming**

The analysis of profitability in lowland rice farming is displayed in Table 4. The different costs attracted and profits realized in lowland rice farming was based on the present market data. The TFC was estimated at 48141.04 Naira per hectare, and this attributed for 12.47% of TC. The total variable cost (TVC) was computed at 337878.61 Naira per hectare and this attributed for 87.53% of TC.



The TC is the sum of TVC and TFC, and this was calculated at 386019.65 Naira per hectare. The GM and NFI were computed at 916219.39 Naira and 868078.35 Naira, respectively. This signifies that lowland rice farming was profitable. The GMR and RORI were computed at 0.730 and 2.25, respectively.

**Table 3. The Farm and Farmers Characteristics among Lowland Rice Producers**

| Variables              | Unit of Measurement      | $\bar{X}_i$ | SD   |
|------------------------|--------------------------|-------------|------|
| Sex                    | 1, Male; 0, Otherwise    | 0.78        | 0.17 |
| Marital Status         | 1, Married; 0, Otherwise | 0.72        | 0.23 |
| Household Size         | Number                   | 12          | 4.47 |
| Age                    | Years                    | 42          | 7.03 |
| Farm Size              | Hectare                  | 1.27        | 0.42 |
| Member of Cooperatives | 1, Member; 0, Otherwise  | 0.81        | 0.38 |
| Formal Education       | Years                    | 12          | 2.71 |
| Farming Experience     | Years                    | 13          | 4.07 |

**Source: Field Survey (2024)**

The GMR of 0.730 reveals that for each one Naira expended in lowland rice farming, approximately 73 Kobo covered interest, profits, depreciation, and other expenses (marketing and administrative cost). This further means that the lowland rice producers retained 73% after accounting for the production cost. Furthermore, approximately 73% of each Naira earned from lowland rice farming contributes to covering other expenses and generating net profit. The RORI or return per Naira invested in lowland rice farming was computed at 2.25. This designates that for every one Naira invested into lowland rice farming, approximately 2.25 Naira is made as revenue, that is 1.25 Naira is realized as profit. This finding is supported with the outcomes of Sadiq et al. (2021) who obtained the gross margin of 543429.60 Naira among rice growers in Niger State, Nigeria.

### **The determinants of output of rice among producers**

Table 5 presented the ML estimates of the predictors influencing output among lowland rice producers using SPEFM. The values of the estimates in the TE component lies between 0 and 1, this reveals that all marginal values are positive and reducing at the mean of predictors. This aligns with a priori expectations, this



is supported by findings of Abdulai and Abdulahi (2016) who reported the significant and positive influence of frontier factors on output of maize producers in Zambia. The mean-TE of 77% indicates that the mean small-scale rice grower in the representative needs about 23% additional inputs to reach the frontier, in other terms, a small-scale rice producers lost on balance of 23% of produce due to technical inefficiency (TIE).

**Table 4. The Profitability Evaluation among Lowland Rice Producers per Hectare**

| Items                                    | Kg   | Value (Naira) | Percentage of TC |
|------------------------------------------|------|---------------|------------------|
| Quantity (1.15 tons)                     | 1150 |               |                  |
| Price per Kg                             |      | 1090.52       |                  |
| TR (Total Revenue)                       |      | 1254098       |                  |
| TVC (Total Variable Cost)                |      | 337878.61     | 87.53            |
| Depreciated Cost, Total Fixed Cost (TFC) |      | 48141.04      | 12.47            |
| TC (Total Cost)                          |      | 386019.65     | 100.00           |
| GM                                       |      | 916219.39     |                  |
| NFI                                      |      | 868078.35     |                  |
| GMR                                      |      | 0.730         |                  |
| OR                                       |      | 0.269         |                  |
| RORI                                     |      | 2.25          |                  |

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

The partial derivatives are called the marginal product or the partial elasticity. The sum of first order partial differentials of the output stimulus which is termed the return to scale or scale efficiency reveals the decreasing return to scale in the frontier model summing up to 0.9208. This designates that increasing all predictors by a certain percentage will lead to a less than comparable rise in quantity of the small-scale rice produced. The value of farm size as measured in hectares is positive (0.2902) and statistically different from zero in enhancing the output of rice at 1% alpha level. This reveals that as farm size rises by 1% while holding all other predictors constant will lead to 29.02% rise in quantity of rice produced. This is highlighted by Adenuga et al. (2013) who achieved 66.70% rise in output of tomato from 1% rise of farm size in Kwar state, Nigeria.

The values of labour as measured in man-days is positive (0.1637) and significant different from zero in enhancing the quantity of rice at 5% alpha level. This signifies that as labour rise by 1%, while holding all other predictors constant will lead to 16.37% rise in quantity of rice.



This is similar with the study of Ojo et al. (2020) who noted a 5% rise in quantity of rice from a 1% rise in labour in Southwest, Nigeria. In the diagnostic information section, the measure of variance ratio( $\gamma$ ) also termed gamma is 0.7021, this reveals that 70.21% of changes in the quantity of rice were as a result of differences in TE.

**Table 5. The Determinants of Output of Rice among Producers using SPEFM**

| Variables                    | Coefficient   | Std. Error. | P-value |
|------------------------------|---------------|-------------|---------|
| Fertilizer Usage             | 0.2341**      | 0.0975      | 0.021   |
| Seed                         | 0.1009**      | 0.0458      | 0.028   |
| Farm Size                    | 0.2902***     | 0.0784      | 0.000   |
| Agrochemicals                | 0.1319***     | 0.0366      | 0.000   |
| Labour                       | 0.1637**      | 0.0711      | 0.043   |
| Constant                     | 2.319***      | 0.5946      | 0.000   |
| <b>RTS</b>                   | <b>0.9208</b> |             |         |
| <b>Diagnostic Statistics</b> |               |             |         |
| $\delta^2$                   | 2.3461***     |             |         |
| Gamma                        | 0.7021        |             |         |
| Log-Likelihood Function      | -527.46       |             |         |
| Mean Efficiency Score        | 0.77          |             |         |

**Source: Field Survey (2024)**

\*Significant at ( $P < 0.10$ )., \*\*Significant at ( $P < 0.05$ ), \*\*\*Significant at ( $P < 0.01$ ).

In addition, this signifies that 70.21% of random differences in the quantity of the rice produced were as a result of the growers' inefficiency. Therefore, decreasing the action of gamma or variance ratio will raise the quantity of rice and greatly boost the TE of the growers. The values of total variance ( $\sigma^2$ ) also called the sigma square is 2.3461, which is statistically different from zero at 1% alpha level. This reveals that the model utilized and data gotten were well specified. The LLF (Log-Likelihood function) is -527.46. The study is supported with results of Adenuga et al. (2013) who noted that farm size, seeds, labour, and herbicides had positive values and were significant predictors affecting the quantity of tomato produced in Nigeria. This study is in line with the work of Okello et al. (2019) who noted that rice seeds, land area, were significant predictors influencing quantity of rice in Northern Uganda.

## CONCLUSION

The average age of rice growers was 42 years. This signifies that they are young, active, and energetic. They can easily adopt research findings, innovations, and



new technologies. The number expressing central value of farm size was 1.27 ha of rice farms. This means that they are smallholder farmers because they had less than 5 hectares of rice farms. This result is supported with the study of Okello et al. (2019) who noted an average age of 37 years for rice growers in Uganda. Also, this work is similar to the findings of Ogundari (2008) who documented an average farm size of 1.23 hectares among rain-fed rice farmers in Nigeria.

The lowland rice farming is profitable. The gross margin and net farm income was computed at 916219.39 and 868078.35 Naira per hectare. This result is in conformity with the findings of Yusuf (2022) who observed that rice production was a profitable enterprise in Kwara State, Nigeria. This study is in line with the outcomes of Alabi et al. (2023) and Nwahia (2021) who reported that rice production is a profitable enterprise and could enhance the livelihood of resource poor farmers.

The fertilizer usage, seeds, farm size, agrochemicals, and labour were significant and positively affect the quantity of rice among growers. The partial elasticities or marginal products were computed at 0.2341, 0.1009, 0.2902, 0.1319, and 0.1637 for fertilizer usage, seed, farm size, agrochemicals, and labour. The sum of the partial elasticities gives a return to scale of approximately 0.9208. This designates a decrease return to scale, this signifies that a rise in the variable inputs by a certain percentage will lead to less than increase in output or rice. According to Onuk et al. (2012) who reported that to achieve optimal resource output of variable inputs, policies and programmes should be directed to rice producers in order to increase the level of use of these inputs.

## SUGGESTIONS

- (i) The fertilizers, seeds, agrochemicals, and other farm inputs should be made available to rice farmers to increase output.
- (ii) Government and private organizations should provide credit at single digit interest rates to rice producers devoid of cumbersome administrative procedures. That will enable the rice producers to procure farm inputs at appropriate time and required quantity.
- (iii) Land policy should be amended to provide easy access to land for rice farming by both male and female farmers.
- (iv) Extension service delivery should be strengthened to disseminate research results, innovations, new farm technologies to rice growers.



(v) Farm technologies, machines, and labour saving machines should be made available to rice producers to increase output.

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