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Optimizing the output of rice farmers in Niger and Nasarawa states, Nigeria

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ABSTRACT

This research study focused on optimizing the output of rice farmers in Niger and Nasarawa States, Nigeria. The study collected primary data from 180 rice farmers utilizing structured questionnaires. The specific objectives of the study were to describe the farm specific and farmers features of rice production, optimize and determine the input factors (farm size, labour, fertilizer, agrochemicals, seeds) affecting output of rice producers, evaluate the socio-economic factors affecting the technical inefficiency of rice producers and determine the technical efficiency scores of rice producers. The analytical tools used to achieve the objectives were stochastic production efficiency frontier model (SPEFM), return to scale (RTS), elasticity of production model (EP) and t-Test of difference between means. The findings revealed that rice production generates profits and demonstrated a substantial financial difference between cost and returns. Production elasticity showed a positive result for all farm inputs including farm size, labour, fertilizers, agrochemicals and seeds and as a result, these inputs boost output levels. A proportional increase in input resources results in more than a proportional increase in output at a return to scale ratio of 1.020 in the rice farming operation. The analysis reveals that farm size with combined seeds and fertilizers stands as the significant and primary production factors for rice but actual production efficiency depends mainly on the education level, farm experience and cooperative standing of the producers. Rice productivity will increase through better access to productive inputs combined with available land improvements and financial assistance. The paper suggests policy solutions which support both efficient resource management and technical training initiatives to enhance farmers' output levels.

Nijerya'nın Nijer ve Nasarawa eyaletlerindeki pirinç çiftçilerinin üretiminin optimize edilmesi

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ÖZET

Bu araştırma çalışması, Nijerya'nın Nijer ve Nassarawa eyaletlerindeki pirinç çiftçilerinin çıktılarını optimize etmeye odaklanmıştır. Çalışma, yapılandırılmış anketler kullanarak 180 pirinç çiftçisinden birincil veri toplamıştır. Çalışmanın özel hedefleri, pirinç üretiminin çiftliklere özgü ve çiftçilere özgü özelliklerini tanımlamak, pirinç üreticilerinin çıktısını etkileyen girdi faktörlerini (çiftlik büyüklüğü, emek, gübre, tarım kimyasalları, tohumlar) optimize etmek ve belirlemek, pirinç üreticilerinin teknik yetersizliğini etkileyen sosyo-ekonomik faktörleri değerlendirmek ve pirinç üreticilerinin teknik verimlilik puanlarını belirlemekti. Amaçlara ulaşmak için kullanılan analitik araçlar, stokastik üretim verimliliği sınır modeli (SPEFM), ölçeğe göre getiri (RTS), üretim modelinin esnekliği (EP) ve ortalamalar arasındaki farkın t-Testi idi. Bulgular, pirinç üretiminin kar getirdiğini ve maliyet ile getiriler arasında önemli bir finansal fark olduğunu ortaya koydu. Üretim esnekliği, çiftlik büyüklüğü, emek, gübre, tarım kimyasalları ve tohumlar dahil olmak üzere tüm çiftlik girdileri için pozitif bir sonuç gösterdi ve sonuç olarak bu girdiler çıktı seviyelerini artırdı. Pirinç çiftçiliği işletmesinde girdi kaynaklarındaki orantılı bir artış, 1,020'lik ölçek getirisi oranında çıktıda orantılıdan daha fazla bir artışla sonuçlanmaktadır. Analiz, kombine tohum ve gübrelerle çiftlik boyutunun pirinç için önemli ve birincil üretim faktörleri olduğunu ancak gerçek üretim verimliliğinin esas olarak eğitim düzeyine, çiftlik deneyimine ve üreticilerin kooperatif statüsüne bağlı olduğunu ortaya koymaktadır. Pirinç verimliliği, mevcut arazi iyileştirmeleri ve mali yardımla birleştirilmiş üretken girdilere daha iyi erişim yoluyla artacaktır. Makale, çiftçilerin çıktı seviyelerini artırmak için hem verimli kaynak yönetimini hem de teknik eğitim girişimlerini destekleyen politika çözümleri önermektedir.

1.Introduction

Rice (*Oryza sativa L.*) is a fundamental food in Nigeria. Its production massively supports national food security, while creating jobs and facilitating economic advancement (FAO, 2022). Rice is one of the dominant staple foods in Nigeria and the nationwide demand has surged because of fast population expansion and changing dietary choices and the effects of urban development (Mohammed et al. 2019). Despite its position as a leading rice producer across Africa local supply has failed to meet consumption needs, so the nation imports rice extensively at high prices (Abbas et al., 2018). Enhancing rice production in domestic operations has become essential for Niger and Nasarawa and other major producing states. These states maintain beneficial rice cultivation environments yet their agricultural efficiency remains low along with unacceptable yield (Merem et al., 2017).

The Nigerian government keeps advancing programs such as the Anchor Borrowers' Program (ABP) together with the Presidential Fertilizer Initiative (PFI) as well as import restrictions to enhance rice production (CBN, 2021). Rice production has received minor improvements from government initiatives but numerous farmers maintain ineffective resource use and poor output combined with performance barriers (Okodua, 2017). These interventions succeed according to the extent farmers can enhance their input optimization and increase productivity efficiency. The main obstacle for rice farmers involves suboptimal utilization of farm size, labor force and fertilizers, agrochemicals and seeds. The effective use of farming inputs by farmers directly affects both their output production levels and their profitability. Rice farmers who operate small agricultural farms in Nigeria struggle to access contemporary agricultural tools and quality agricultural products, while lacking sufficient funds which decreases their ability to effectively employ existing resources (Obianefo et al., 2023). To determine the elasticity of production and return to scale, it is essential to evaluate how each input influences rice output. By enhancing how farmers manage their resources they achieve better yield levels and financial success (Izekor & Alufohai, 2014). The technical inefficiencies of rice production stem from numerous socio-economic factors including the education level, experience in farming, availability of credits, quality of extension services and market connections (Adejoh et al., 2018). High technical efficiency enables farmers to generate more production from their current input resources than farmers with lower efficiency levels. Few studies have investigated the relationship between socio-economic factors and technical inefficiency in Niger and Nassarawa States. It is essential to detect inefficiencies in rice farming along with their root causes in order to create specific intervention methods that will both enhance farmer output and boost the rice sector's productivity.

Rice farmers in Nigeria face numerous difficulties, which restrict their ability to maximize production. Nigerian rice producers face challenging circumstances marked by expensive operation costs along with minimal investment returns combined with unsatisfactory technical efficiency that restrains their output and financial returns (FAO, 2022). Research on rice output maximization in these specific states of Nigeria exists as a critical knowledge gap. The research has a crucial deficit due to the absence

of thorough assessment for key production input elasticity. Numerous research studies have studied individual input effects such as fertilizers and agrochemicals yet they fail to provide a complete analysis of farm size, labor, fertilizers, agrochemicals and seed interactions on rice output (Bello et al., 2021). Researchers have not established empirical evidence about how efficient rice farmers currently operate in Nigeria. Policymakers together with stakeholders face challenges when developing efficient rice production strategies because they lack full understanding of key influencing factors. These states lack comprehensive research which explores the relationship between socio-economic factors and technical inefficiency of their rice farming sector. Research on how socio-economic determinants including agricultural credit accessibility and agricultural education levels alongside extension service availability affect the resource efficiency of farmers needs further exploration despite other studies' lack of discussion on this subject (Ukwuaba et al., 2020). The improvement of knowledge about technical efficiency deficits enables better policy development which enhances productivity and livelihoods of rice farmers.

1.1 Research Questions

This research proffer answers to the under-listed research questions:

(i) What is the farm-specific and farmers' features of rice producers?
(ii) What are the optimum and determinant factors (farm size, labour, fertilizers, agrochemicals, seeds) affecting output of rice producers?
(iii) What are the socio-economic factors affecting the technical inefficiency of rice production?
(iv) What are the technical efficiency scores of rice producers?

1.2 Objectives of the Study

The main aim of the investigation focused on optimizing the output of rice farmers in Niger and Nasarawa States, Nigeria. The specific objectives were:

(i) describe the farm specific and socio-economic' features of rice producers,
(ii) optimize and determine the input factors (farm size, labour, fertilizers, agrochemicals, seeds) affecting output of rice producers,
(iii) evaluate the socio-economic factors affecting the technical inefficiency of rice producers,
(iv) determine the technical efficiency scores of rice producers.

1.3 Hypotheses of the Study

This study was guided by the following null-hypotheses:

(i) Rice production is not profitable
(ii) The coefficient of elasticity of production for each input is not greater than zero
(iii) The return to scale is not greater than zero.
(iv) There are no significant input factors (farm size, labour, fertilizers, agrochemicals, seeds)
affecting output of rice producers
(v) There are no significant socio-economic factors affecting technical inefficiency of rice production.

2. Materials and Methods

This study was carried out in Niger and Nasarawa States, Nigeria. The study selected the two states because they are predominantly known for rice farming in the Northern region, Nigeria. The two states were chosen due to their favorable climate for the crop and better irrigation systems to support all year farming. A multi-stage sampling approach was utilized. A multi-stage sampling approach was utilized because of a variety of reasons, such as time efficiency, cost reduction, flexibility, and increase reliability. In the first stage, two states were purposively selected being known predominantly for rice farming in the Northern region. In the second stage, three local government areas were randomly selected in each state. In the third stage, three villages for each local government area were randomly selected making a total of eighteen villages. In the fourth stage, a simple random sampling approach was used, approximately ten rice producers were selected from each village making a total of 180 rice producers. The sample frame of rice producers approximately 327 respondents. The total sample number consists of 90 rice producers selected each from the two states, respectively. Primary data of cross-sectional sources were used based on a well-planned questionnaire that was subjected to reliability and validity test. The questionnaire was validated by the team of professional experts and appropriate reliability test was carried out. The questionnaire was pre-tested on selected rice growers to evaluate the appropriateness of the design, clarity, and relevance of the questions. The appropriate corrections were made on the pre-tested questionnaire in order to capture the relevant information required to achieve the objectives of the study, questions that proved vague or ambiguous, attracted additional corrections on the questionnaire to ensure its appropriateness, and reliability. The result of the pre-test was collated and subjected to reliability test using Pearson product moment correlation analysis. The correlation coefficient of 0.91 (91%) shows that there was a strong degree of correlation between the variables tested. The Cronbach's alpha coefficient for the variables was 0.828 (82.8%), suggesting that the factors included in the research instrument had relatively high internal consistency and highly reliable for the analysis. This sample number was estimated based on the established formula of Yamane (1967) as follows:

$$n = \frac{N}{1+N(e^2)} = \frac{327}{1+327(0.05)^2} = 180 \ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where,

n = The Sample Number

N = The Complete Number of Rice Growers

e = 5%

The data obtained were analyzed using descriptive statistics, and stochastic production frontier model.

2.1 The SPEFM (Stochastic Production Efficiency Frontier Model)

According to Alabi et al. (2022), the SPEFM is stated thus:

$$Y_i = f(X_i, \beta_i)e^{v_i - u_i} \quad (2)$$

$$Ln\ Y_i = Ln\ \beta_0 + \sum_{j=1}^{5} \beta_i\ LnX_i + (v_i - u_i) \quad (3)$$

$$TE_i = \frac{Y_i}{Y_i^*} \quad (4)$$

$$TE_{ij} = \frac{F(X_i,\beta)\exp(v_i - u_i)}{F(X_{i,}\beta)\exp(v_i)} \quad (5)$$

$$TE_{ij} = \exp(-u_{ij}) \quad (6)$$

where,

Y_i = Output of Rice (Kg)

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

X_i = Inputs

β_i = Vectors of Estimated Parameters

V_i = Random Errors

U_i= Error Term as a result of TIE (Technical Inefficiency)

X_1 = Farm Sizes (ha)

X_2 = Labour (Mandays)

X_3 = Fertilizers (Kg)

X_4 = Agrochemicals (Litre)

X_5 = Seeds (Kg)

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 \quad (7)$$

where,

Z_1 = Age (Years)

Z_2 = Experience (Years)

Z_3 = Education (Years)

Z_4 = Household Size (Number)

Z_5 = Cooperative Organization (Years)

α_0 = Constant Term

$\alpha_1 - \alpha_5$ = Estimated Parameters

U_i= Error Term due to TIE

2.2 Return to Scale (RTS) and Elasticity of Production (EP) Model

Elasticity of production (EP) is a measure of a farm success in yielding maximum output from a given set of factors. The (E_P) and (RTS) was estimated following the study of Alabi et al. (2022) as:-

$$E_{P_{x_i}} = \frac{\partial Y}{\partial X_i} \cdot \frac{\overline{X}}{\overline{Y}}, i = 1, 2 \ldots k \quad (8)$$

$$\sum_{i=1}^{K} E_{P_{x_i}} = RTS \quad (9)$$

Where;

$\overline{X}$ = Mean of Inputs (Units)

$\overline{Y}$ = Mean of Output (Units)

$E_{P_{x_i}}$ = Elasticity of Production of Input x_i

$\sum_{i=1}^{K} E_{P_{x_i}}$ = Return to Scale i.e Sum of Elasticity of Production

2.3 The t-Test of Difference Between Means

This is stated thus:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (10)$$

Where,

$\overline{X}_1$= Mean of Values in Group 1

$\overline{X}_2$= Mean of Values in Group 2

s_1^2, s_2^2 = Standard Deviation in Group 1 and Group 2

$n_1 n_2$= Number of Observation in Group 1 and Group 2

3.Results and Discussion

3.1 The Continuous Variables of Farm-Specific and Farmers Features of Rice Producers

Table 1 below shows the continuous variables farm-specific and socio-economic features of rice producers. The average age of the rice farmers approximately 46 years, having a standard deviation (SD) of 7.23. This suggested that most of the farmers were middle aged. The result is in consonance with the findings of Kadiri et al. (2014) who indicated that middle age farmers were the most prominent in rice farming in Nigeria as a result of their physical strength and experience. This is in line with studies of Oluleye et al. (2022) and Oluleye et al. (2024) who obtained an average age of 45 and 39 years among farmers in Nasarawa and Kaduna States, Nigeria, respectively. The average farming experience of the rice farming was 11 years, having a standard deviation (SD) of 4.98. This suggested that most farmers had some level of experience on rice production. This outcome is in consonance with the findings of Bala et al. (2020) who noted that farmers having longer experience are likely to adopt new farming techniques to improve and optimize production. The studies of Oluleye et al. (2022) and Oluleye et al. (2024) noted that the average farming experiences were 10 and 7 years among farmers in Nasarawa and Kaduna States, Nigeria, respectively. The average size of the farm was 1.27 hectares, with a standard deviation (SD) of 0.64. This implies that most of the rice farmers cultivated on a small-scale farm land. This finding is in the line with the results of FAO (2020) who reported that majority of Nigeria rice output is produced by small-scale farmers. Productivity of rice production is low because these small farms may limit economies of scale and mechanization. The average level of education of the rice farmers was 12 years, having a standard deviation (SD) of 2.97. The study indicated that the farmers have completed secondary school education. This study is in line with the findings of Esiobu (2020) who noted that the level of education attained by the farmer is sufficient for them to access and

interpret agricultural information and adopt new practices to optimize their production. The average household size of the farmers approximately 9 persons, having a standard deviation (SD) of 2.07. This suggest that a large household size and family labour will be grossly utilize as the means of labour to reduce cost but by implication, household consumption pressure will increase thereby affecting savings and reinvestment in farming (Edeoghon, 2017). The average rice yield was estimated at 2 tons per hectare, indicating that production may be below optimal. This could be as a result of some constraints such as limited access to input, climate change as stated in a similar study by Kamai et al. (2020).

Table 1. The Continuous Variables of Farm-Specific and Socio-Economic Features of Rice Producers

Variables	Unit of Measurement	$\bar{X}_i$	SD
Age	Years	46	7.23
Farming Experience	Years	11	4.98
Farm Size	Hectares	1.27	0.64
Education	Years	12	2.97
Household Size	Number	9	2.07
Output	Kilograms per Hectare	2	0.70

Source: Field Survey (2024)

3.2 The Descriptive Analysis of Categorical Variables of Farmers Characteristics among Rice Producers

Table 2 shows the categorical variables of rice farmers characteristics in Niger and Nasarawa States, Nigeria. The results demonstrate that male respondents represent the largest group accounting for 81.66% among all respondents, while the female participants constitute 18.34% of the total respondent. A previous study by Mwalyagile et al. (2024) validates how Nigerian rice farming shows male domination because men both own land and need to perform physically demanding work. Although women participate at lower rates, they are still crucial for processing after harvest and marketing activities.

Among the respondents, 88.33% are married individuals followed by 11.67% who are single. Married farmers gain additional labor support from their household members which enables them to carry out their ongoing farm work (Tijani et al., 2010). A large proportion of 70.56% within the sample population belongs to cooperatives but 29.44% of the respondents do not have cooperative membership. The rice farmers that actively belong cooperative societies benefit from it because it improves their ability to obtain financial support and vital agricultural materials in addition to operational support (Lin et al., 2022). The combined power of cooperative membership enables participants to gain better income and crop yields through group negotiation and exchange of agricultural information.

Table 2. The Categorical Variables of Rice Farmers Features

Farmers Characteristics	Frequency	Percentages
Sex		
(a) Male	147	81.66
(b) Female	33	18.34
Marital Status		
(a) Married	159	88.33
(b) Single	21	11.67
Members of Cooperatives		
(a) Yes	127	70.56
(b) No	53	29.44
Total	**180**	**100.00**

Source: Field Survey (2024).

3.3 The Factors Influencing the Output and Technical Inefficiency of Rice Producers

Table 3 below shows the maximum likelihood estimates using stochastic production frontier. The result shows a positive correlation between farm size and rice output since the coefficient value is 0.2460 and the statistical significance level reaches below 0.01. The results support previous findings which showed that expanding farm sizes leads to increased productivity through advantages of scale (Omotilewa et al., 2021). Labor input deficiencies do not drive changes in rice output levels because the labor variable (0.2309, $p>0.05$) has no statistically significant effect on rice production results. The findings suggested that there was a broad use of manual labor techniques because the output was low compared to mechanized techniques. The study also revealed that productivity will increase when farmers use more fertilizer according to statistical analysis with a value of 0.2035 at $p<0.05$. The study findings confirm previous research by Eze et al. (2020) that shows adequate fertilizer application as a key factor in promoting rice yield improvement. The lack of significance in agrochemical variables (0.1539, $p>0.05$) indicates these inputs do not substantially affect output since improper applications alongside resistance problems may be evident. The coefficient value of high-quality seeds was 0.1857 at $p<0.05$, suggested that it has a significant impact of rice output. In a report by FAO (2020), it was indicated that implementing better seed varieties leads to raised productivity within climate-smart agricultural systems which is supported by this study. The measured return to scale value of 1.020 revealed that rice farmers in the research location operate with increasing returns to scale thereby generating more than output expansion from proportionately raising all input resources. The socio-economic factors (experience and education) decrease technical inefficiency of rice production at 1% alpha level. The institutional factor (cooperative) decrease technical inefficiency of rice production at 1% alpha level. This implies that a one-unit increase in experience and education of rice farmers, while keeping all other predictors constant will give rise to 0.2207 and 0.2581 units increase in technical efficiency of rice producers. Similarly, a one-unit increase in cooperative membership, while keeping all other predictors fixed will give rise to 0.2751-unit decrease in technical inefficiency of rice production.

In the diagnostic statistics section, the coefficient of variance ratio(γ) also termed gamma was estimated at 0.8001, this connotes that 80.01% variations of rice output from frontier (potential) output was as a result of technical inefficiency, while the balance 19.99% of rice output deviation from the potential level was due to random noises such as frost, unexpected rainfall, and other natural disaster outside the control of rice growers. Therefore, reducing the extent of the effect of variance or gamma ratio will enhance the rice output and greatly improve the productivity of the producers. The coefficient of total variance (σ^2) also termed sigma square was evaluated at 3.3465, which is statistically different from zero at 1% alpha level. This hypothesized that perfect goodness of data conform with the Cobb-Douglas stochastic frontier model and the assumptions of the composite error term was correctly specified. The LLF (Log-Likelihood function) was estimated at -821.46. The finding is supported with

outcomes of Asfaw (2021) who reported the estimated Sigma-squared of 0.57, and gamma value of 0.89 among tomato producers in Ethiopia.

Table 3. Maximum Likelihood Estimates Using Stochastic Production Frontier

Variables	Coef	Std. Er.	*P*-value
Farm Size	0.2460***	0.0630	0.000
Labour	0.2309	0.2178	0.931
Fertilizer	0.2035**	0.0791	0.042
Agrochemicals	0.1539	0.1509	0.789
Seed	0.1857**	0.0709	0.047
Constant	2.5729***	0.6126	0.000
RTS	**1.020**		
Inefficiency Model			
Age	-0.2915	0.2674	0.945
Experience	-0.2207***	0.0515	0.000
Education	-0.2581***	0.0591	0.001
Household Size	-0.2072	0.1954	0.972
Cooperatives	-0.2751***	0.0562	0.000
Diagnostic Statistics			
δ^2	3.3465***		
Gamma	0.8001		
Log-Likelihood Function	-821.46		

Source: Field Survey (2024)

3.4 Technical Efficiency Scores of Rice Producers

The Table 4 below shows the technical efficiency (TE) scores evaluation of the rice farmers' efficiency levels. The calculated mean technical efficiency scores reveal farmers work with 71.67% efficient utilization of resources. Better resource utilization and management strategies would allow farmers to boost their rice production by 28.33%. This is similar to the findings of Linn & Meanhout (2019). The evaluation shows that almost half of the farmers (49%) maintain efficiency ratings above 0.81 which indicates high efficiency and another thirty-one percent (31%) demonstrates moderate efficiency from 0.61 to 0.80. The necessity for specialized interventions to enhance production efficiency exists since 5.56% of farmers perform under a 0.20 efficiency level. This results clearly indicates that government should implement policies, giving priority to three areas: quality input distribution and educational programs combined with farmer cooperatives to boost operational effectiveness. Farmer production processes receive additional support when agricultural extension services operate through investments.

Table 4. Technical Efficiency Scores of Rice Producers.

Technical Efficiency Scores	**Frequency**	**Percentage**
0.0 – 0.20	10	05.56
0.21 – 0.40	16	08.89
0.41 – 0.60	35	19.44
0.61 – 0.80	31	17.22
0.81 – 1.00	8	48.89
Minimum	0.0158	
Maximum	0.9810	
Mean TE	0.7167	

Source: Field Survey (2024)

3.5 The Return to Scale (RTS) and Elasticity of Production (EP) among Rice Producers

Table 5 below shows the Elasticity of Production (EP) of factor inputs and Return to Scale (RTS). Rice farmers in the study area show increasing returns to scale because their elasticities sum up to 1.020. Every proportional increase in all inputs results in more than proportional increase of output. Farm size had the highest elasticity value of

0.2460 at a significant level of 0.01, suggesting the most impact by any other input. This indicates that land expansion proves to be a significant factor that increases production levels. The finding of this study indicated that labor (0.2309, p>0.05) and fertilizer (0.2035, p<0.05) increase rice output yet proper staff management and precise fertilizer application remain crucial (Eze et al., 2020). The elasticity value for agrochemicals (0.1539, p>0.05) is low because improper application methods and below-optimal pesticide usage might restrict yield increase.

Table 5. Elasticity of Production (EP) of Factor Inputs and RTS (Return to Scale)

Elasticity(ε_p)	Farm Size	Labour	Fertilizer	Agrochemicals	Seed	RTS= ($\sum\varepsilon_p$)
Estimates	0.2460	0.2309	0.2035	0.1539	0.1857	1.020

Source: Field Survey (2024)

3.6 The t-Test of Differences between Cost and Returns

Table 6 below shows the outcome of t-test difference between costs and returns. The results indicate that: the average cost per farmer equals ₦692,780.93. The research also shows farmers earn an average of ₦1,417,954.41 in revenue (returns) per person. The standard deviation of cost equals ₦313,992.66. The standard deviation of returns equals ₦899,787.75. The t-test statistics computed a t-value of 16.60 which exceeds the critical 1.96 value from the t-table at a 5% significance level thus proving the two variables differ significantly. Evidence from the study indicates that rice farmers achieve profitable earnings because their revenue exceeds their production costs by a substantial margin. Nwahia (2020) reached identical findings to the study which reveals rice farming profits when farmers use their resources wisely. The profitability data urges governments to implement policies which improve both input access and cost reduction efficiency and effective financial management measures to maximize profits in rice farming operations.

Table 6. t-Test of Difference Between Costs and Returns

Variable	Estimates (Number)
Costs (Naira)	692,780.93
Returns (Naira)	1,417,954.41
Standard Deviation Cost	313,992.66
Standard Deviation Returns	899,787.75
t-Calculated	16.60
t-Table	1.96

Source: Field Survey (2024)

4. Conclusion

This investigation focused on optimizing the output of rice farmers in Niger and Nasarawa States, Nigeria. A multi-stage sampling approach was utilized to select 200 rice growers. The following conclusions were made based on study hypotheses:

Rice production is not profitable

The hypothesis that rice production is not profitable is rejected. The findings from t-test analysis established a statistically important distinction between expenses and income of rice cultivation. The values from rice farming revenue exceed all production expenses effectively demonstrating economic feasibility in the study area.

The coefficient of elasticity of production for each input is not greater than zero

The hypothesis that the coefficient of elasticity of production for each input is not greater than zero is rejected. The result revealed that all production variables including farm size and the use of labor and fertilizers and agrochemicals and seeds produce positive effects on rice farming yield.

The return to scale is not greater than zero.

The hypothesis that the return of scale is not greater than zero is rejected. The calculated return to scale of 1.020 indicates farmers in the rice cultivation zone function beneath increase returns to scale because they achieve more than output growth from equal input proportion increases.

There are no significant input factors (farm size, labour, fertilizers, agrochemicals, seeds) affecting output of rice producers

The hypothesis that there are no significant input factors (farm size, labour, fertilizers, agrochemicals, seeds) affecting output of rice producers is rejected. The study analysis found that farm size and labor and fertilizers and seeds function as fundamental factors in shaping rice output production where farm size demonstrates maximum elasticity rate. Increased land distribution together with ample input resources have the power to greatly improve rice yield levels.

There are no significant socio-economic factors affecting technical inefficiency of rice production.

The hypothesis that there are no significant socio-economic factors affecting technical inefficiency of production is rejected. The results give concrete evidence that factors including education level and farming experience as well as cooperative associations strongly affect rice farmer.

Author Contribution

Design of the Article-AOO,EFA, KHK, SGF, EAO, OAO, APA, OOD, YCA, Administration of Questionnaire- AOO,EFA, KHK, SGF, EAO, OAO, APA, OOD, YCA, Coding and Analysis-AOO,EFA, KHK, SGF, EAO, OAO, APA, OOD, YCA, Report Writting and Corrections-AOO,EFA, KHK, SGF, EAO, OAO, APA, OOD, YCA, Final Report- AOO,EFA, KHK, SGF, EAO, OAO, APA, OOD, YCA

Conflict of Interest Declaration Information

There is no conflict of interest.

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