

Research Article

Costs and Return Analysis of Irrigated Rice Production Among Small Scale Farmers in Birnin Kebbi Local Government Area of Kebbi State

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Abstract

This study investigates the costs and returns of irrigated rice production among small-scale farmers in the Birnin Kebbi Local Government Area of Kebbi State, Nigeria. Data were collected using a structured questionnaire, and a purposive multi-stage sampling method was employed to select 120 respondents from four major rice-producing villages: Ambursa, Dukku, Gulumbe, and Zauro. Descriptive statistics, multiple regression analysis, and gross margin analysis were used to analyze the data. The findings on socio-economic characteristics revealed that the respondents had an average age of 40 years, with 90% having a household size of 11 members. Most farmers (60%) had some form of education and possessed an average of 25 years of farming experience. The average farm size was 1.18 hectares, and 76.7% of respondents inherited their land. Furthermore, 77.5% of respondents had no extension contact in the previous season, and most were not part of any cooperative. Multiple regression analysis showed that significant factors influencing rice output were age, farming experience, farm size, and credit access. The study found that the total cost of production was ₦148,844.70 per hectare, while the gross return was ₦391,017.30 per hectare, resulting in a gross margin of ₦248,172.30 per hectare. Major constraints included lack of government support (17.3%), high fuel costs (16.2%), and poor market structure (15.3%). The study recommends increased government intervention in the form of subsidized farm inputs, improved extension services, and market access to enhance farmers' productivity and profitability.

Keywords

Costs and Returns, Paddy Rice, Irrigation, Production

1. Introduction

1.1. Background to the Study

Rice has emerged as the most important staple food and the predominant cereal crop in Nigeria [1]; National Cereal Re-

search Institute [11]. Rice consumption in Nigeria has grown at an annual rate of 4.4%, making it the fastest-growing staple food [7]. Within the West African sub-region, Nigeria stands out as the largest rice producer [12]. Consumption patterns have shifted dramatically; while the intake of cereals like

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sorghum and millet has declined, rice consumption has due to changes in consumer preferences, urbanization, and population growth [2]. Demand for rice in Nigeria has increased at a rate surpassing that of other African nations the mid-1970s (Food and Agriculture Organization [4]. Currently, Nigeria accounts for 50% of the total 10 million tons of rice produced in Africa, with local production estimated at only 3 million metric tons [2].

Annually, approximately 5.4 million metric tons of rice is consumed in Nigeria; however, local production meets only 2.3 million metric tons, necessitating imports of around 3.1 million metric tons to satisfy demand [8]. This disparity highlights a significant challenge in achieving in rice production. Despite gradual increases in rice production, it has not been sufficient to meet the rising consumption demands in Nigeria. To address this demand-supply gap, the government has implemented various policies and programs over time. However, these policies have often been inconsistent [13]. The erratic nature of these policies reflects a dilemma: ensuring affordable rice for consumers while providing fair prices for producers.

Currently, Nigeria's rice processing capacity stands at 2.8 million tonnes of paddy annually [9]. As one of the world's largest rice importers, Nigeria ranked as the largest importer in 2011/2012, accounting for approximately 3.4 million metric tonnes of rice [15]. Consequently, the country has relied heavily on imports to bridge the supply-demand gap. Despite possessing vast agricultural land and a suitable ecological environment for rice farming, Nigeria has the potential to produce enough rice to satisfy domestic demand and even export to other countries [3]. However, domestic rice production has not sufficiently risen to meet the increasing demand, despite various policy measures aimed at enhancing production. According to [5], Nigeria's rice imports grew from 2,630 metric tonnes in 1970 to 1.876 million metric tonnes in 2014. The country is ecologically equipped to achieve self-sufficiency in paddy rice production, with potential land suitable for rice cultivation estimated between million and 4.9 million hectares [6].

1.2. Statement Problem

Rice is essential for food security across Africa, particularly in Nigeria. For decades, it has recorded the fastest-growing consumption rate among staple crops, primarily driven by significant demand growth in urban centers [12]. Consumers are increasingly shifting their preferences from traditional staples, such as cassava, maize, and yams, to rice [4, 1]. Currently, Nigeria has an annual demand of approximately 5 million metric tons (MT) of rice, yet local production totals only about 3.2 million MT, resulting in a demand gap of 1.8 million MT [11]. This shortfall forces Nigeria to rely heavily on rice imports, which costs the country around N356 billion annually for approximately 2 million MT of milled rice [8]. Dependence on expensive

imports not only drives domestic inflation but also adversely impacts Nigerian farmers, displacing local production and contributing to rising unemployment [3]. In 2016, the price of rice doubled compared to 2015, largely due to fluctuations in foreign exchange rates and government policies regarding rice importation. Despite the high prices, domestic demand for rice remains strong.

Estimates by the United States Department of Agriculture (USDA) for the 2014/2015 period indicated that, of the 6.4 million MT domestic demand for milled rice, only 2.84 million MT were produced locally [15]. The rising prices of rice are expected to affect both domestic production and consumption patterns; however, consumer preference continues to favor imported rice. This preference is attributed to several factors, primarily the perceived quality of imported rice, which urban consumers favor for its long white grains, reduced preparation time, absence of stones, and lower fuel consumption during cooking [2].

This significant gap between production and consumption has prompted various governments to implement policies aimed at efficiently bridging this divide. However, the inconsistency of these policies has often hindered their effectiveness in achieving the intended goals of increasing rice production and promoting agricultural growth and equity. low levels of productivity in food grain production also inadequate technical, allocative, and economic efficiencies. Consequently, enhancing agricultural growth in Nigeria is crucial for improving farm profitability. As of 2016, rice demand in Nigeria was estimated at 19.2 million MT, while production only reached 4.5 million MT, resulting in a substantial demand-production gap of about 14.7 million MT [13].

This study seeks to provide answers to the following research questions:

- What are the socio-economic characteristics of rice producers?
- What are the factors that influence paddy rice production?
- Is rice production profitable?
- What are the constraints of rice production in the study area?

1.3. Objectives of the Study

The broad objective of the study is to evaluate the economics of rice production in Birnin Kebbi Local Government Area of Kebbi State.

The specific objectives are to:

- Describe the socio-economic characteristics of rice producers in the study area.
- Identify the socio-economic characteristics that influence output of irrigated rice.
- Determine costs and returns in rice production.
- Identify the constraints associated with rice production in the study area.

1.4. Hypothesis

The following is the hypothesis to be tested:

There is no significant relationship between farmers' socio-economic characteristics with their output in rice production in the study area.

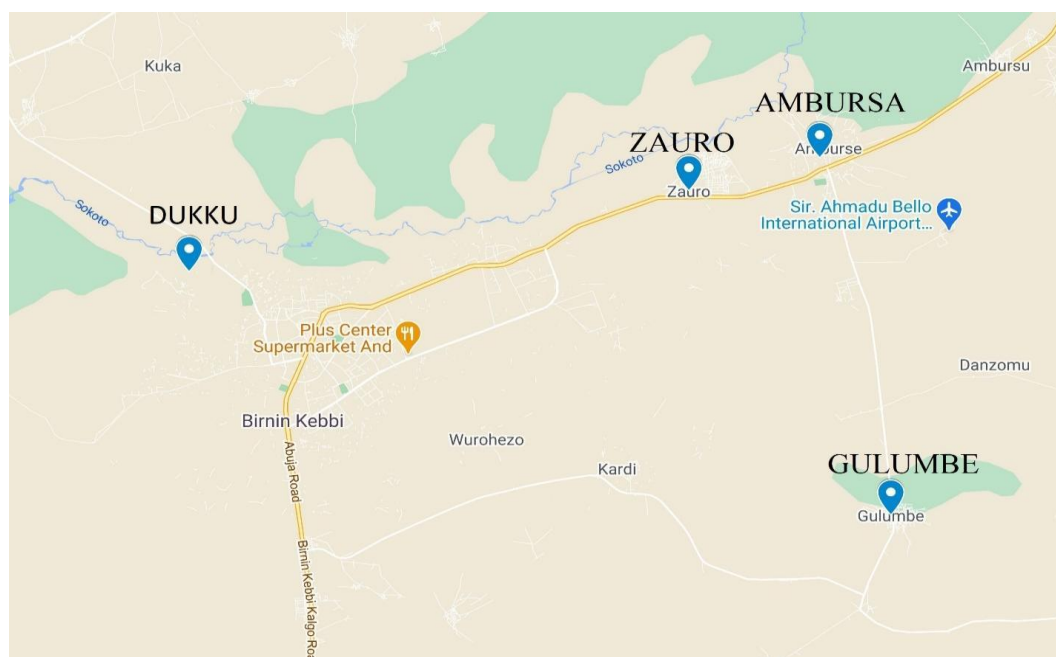
2. Methodology

2.1. Description of the Study Area

The study was carried out in Birnin Kebbi Local Government Area. It is the capital city of Kebbi State and headquarters of Gwandu Emirate, and located in northwestern region of Nigeria. As of 2007 the city had an estimated population of 125,594. Projecting the population to be 366,200 by 2020 [10]. Birnin Kebbi is located on the Sokoto River and is connected by road to Argungu (45 km northeast), Jega (35 km south-

east), and Bunza (45 km southwest) and the city is dominated by the Fulani ethnic group. Average Temperature in Birnin Kebbi The hot season lasts 2.1 months, from May 11 to May 16, with a high temperature above 101 °F on average every day. The most sizzling month of the year in Birnin Kebbi is April, with an ordinary high of 104 °F and low of 81 °F. The cool season happens for 2.3 months, from July 7 to September 18, with a common everyday high temperature under 91 °F. The coldest month of the year in Birnin Kebbi is January, with an ordinary low of 66 °F and high of 90 °F [17].

It has many urban areas and villages including Birnin Kebbi, Marafa, Ambursa, Dangoladina, Gwadangaji, Gulumbe, Yamama, Kola, Tarasa, Laga, Makera, Nassarawa I & II, Zauru, Ujariyo, Gawasu, Kardi and Mijin Nana. Agriculture is the main occupation of the people in these areas, and the crops produced are mainly rice, millet, sorghum, cowpea, tomato, pepper, onion, potatoes, etc. Many of them are also involved in animal rearing and fishing.



Source; Googlemap, 2023.

Figure 1. Map of Study Area.

2.2. Sampling Design

A multi-stage sampling procedure was adopted in the selection of respondents, composed of paddy rice farmers. In the first stage, Birnin Kebbi LGA was divided into four areas namely; Ambursa, Dukku, Gulumbe and Zauru. Secondly, from each of the locations four villages were selected, and Thirty farmers each were randomly selected. Thus, a total of 120 respondents were used for the study as sample size based on the limitation of time and resources, as well as logistical

feasibility.

Table 1. Distribution of Respondents.

L.G.A	Selected Area	Selected Village	Sample size
B. Kebbi	Ambursa	Ambursa	30
	Birnin Kebbi	Dukku	30
	Gulumbe	Gulumbe	30

L.G.A	Selected Area	Selected Village	Sample size
	Zauro	Zauro	30
Total	4	4	120

2.3. Data Collection

Primary source data was used for the study. The interview method was used to collect data with the aid of structured questionnaire and with the help of trained enumerators that understands the local language. The structured questionnaires were pre-tested before they were administered to the sampled farmers for the study. Data collection centered on the following:

- Socio-economic characteristics of the respondents such as age, gender, household size, farming experience, educational level, farm size, mode of land acquisition, number of extension visits, amount of credit obtained and membership of farmers' cooperatives.
- Quantities of inputs used and their costs.
- Quantity of output and the value.
- Constraints associated with paddy rice production.

2.4. Analytical Technique

The analytical tools that were used to achieve the stated objectives of the study were descriptive statistics, gross margin analysis and multiple regression analysis.

2.4.1. Descriptive Statistics

Descriptive statistics such as means and percentages were used to achieve objectives (i) and (vi) of the study.

2.4.2. Gross Margin Model

Gross Margin analysis was carried out to determine the profitability of paddy rice production. The gross margin is estimated as the difference between total revenue and total variable cost in rice production. This was used to determine objective (iii).

$$GM = TR - TVC$$

Where:

GM = Gross Margin

TR = Total Revenue

TC= Total cost (Total variable cost (TVC) + Total fixed cost (TFC)

NFI =Net farm income (TR/TC)

2.4.3. Multiple Regression Analysis

This was used to achieve objective (ii) of the study. The selection of independent variables in a research study is a critical aspect of the research design, as these variables are

chosen based on their potential impact on the dependent variable (farm output or productivity). The choice of specific independent variables is typically grounded in existing literature, theoretical frameworks, and the unique context of the study.

The regression equation is expressed as follows:

$$Y_i = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + U$$

Where;

Y = Output of rice (kilogrammes)

X₁ =Age of the farmer (years)

X₂ = Household size (number of persons in the household)

X₃ = Farming experience (years)

X₄= Education (years of formal schooling)

X₅= Farm size (hectares)

X₆= Amount of credit received (Naira)

X₇ = Membership of cooperatives (years)

U = Error term

b₀ = Constant term

b₁ to b₇ = Coefficients of parameters estimated

3. Result and Discussion

3.1. Socio-economic Characteristic of Respondents in the Study Area

Table 2. Socio-Economic Characteristics of Respondents.

Age	Frequency	Percent
21-30	22	18.3
31-40	47	39.2
41-50	38	31.7
51-60	11	9.2
61-70	2	1.7
Total	120	100
Household Size	Frequency	Percent
1-5	28	23.3
6-10	54	45
11-15	26	21.7
16-20	4	3.3
Total	120	100
Educational qualification	Frequency	Percent
No formal education	48	40
Primary	18	15
Secondary	47	39.2

Age	Frequency	Percent
Tertiary	7	5.8
Total	120	100
Farming Experience	Frequency	Percent
1-10	76	63.4
11-20	27	23.5
21-30	17	13.1
Total	120	100
Farming Experience	Frequency	Percent
0.1-1.0	71	59.2
1.1-2.0	30	25
2.1-3.0	17	14.2
4.1-5.0	2	1.7
Total	120	100
Ownership	Frequency	Percent
Borrowed	11	9.2
Purchased	11	9.2
Gifted	4	3.3
Inherited	92	76.7
Total	120	100
No of Extension Contact	Frequency	Percent
No contact	93	77.5
Once	20	16.7
Twice	7	5.8
Total	120	100
Years of membership in cooperative	Frequency	Percent
1-3	7	3.5
4-6	26	13
7-9	19	9.5

Age	Frequency	Percent
10-12	3	1.5
Total	120	100

3.2. Socio-economic Characteristics of Irrigated Rice Producers That Influence Output of Irrigated Rice in Birnin Kebbi L. G. A

The results of the socio-economic characteristics of irrigated rice producers that influence output of irrigated rice in Birnin Kebbi L.G.A are shown in Table 3. The coefficient of multiple determination (R^2) was 0.81, indicating that 81% of the total variation in output of irrigated rice production was influenced by the socio-economic variables included in the regression model. The socio-economic variables of farmers that were significantly related with irrigated rice output were age, farming experience, farm size and amount of credit received. The coefficient obtained for age was positive (0.0185) and significant at 5% level of probability, implying that increases in age would lead to an increase in output of irrigated rice. Older farmers have more farm knowledge and may be well exposed to better farm practices than younger ones that could lead to increases in irrigated rice output. The estimated parameter for farming experience was positive (0.0175) and significant at 5% level of probability. This implies that increases in farming experience would lead to increases in output. More experienced farmers tend to possess greater ability to predict farm outcomes and identify farm problems and thus provide better solutions that result in higher rice output. The coefficient of farm size was positive (0.7179) and significant at 1% level of probability. This implies that increases in farm size would lead to increases in farm output. Farm land is a very important input in agriculture and therefore, its size matters a lot in production. Amount of credit received had a positive coefficient (0.0429) and was significant at 5 per cent level of probability. This implies that increases in the amount of credit received would lead to increases in output of irrigated rice.

Table 3. Socio-economic characteristics of irrigated rice producers that influence output of irrigated rice in Birnin Kebbi LGA.

Variable	Coefficients	Standard Error	t-value
Constant	8.0331	0.1899	42.30***
Age	0.0185	0.0064	2.89**
Farming experience	0.0175	0.0064	2.68**
Household size	0.0227	0.0141	1.62
Education	0.0081	0.0068	1.18
Farm size	0.7179	0.0318	22.55***

Variable	Coefficients	Standard Error	t-value
Credit	0.0429	0.0193	2.23**
Membership of cooperatives	0.0126	0.0089	1.42

$R^2 = 0.81$ F-value = 121.93***. Note: *** $P < 0.01$, ** $P < 0.05$ and * $P < 0.10$

3.3. Test of Hypothesis I

From the result in Table 3, the coefficient of multiple determination (R^2) was 0.81, indicating that 81% of the total variation in output of irrigated rice production was influenced by the socio-economic variables. Thus, the null hypothesis socio-economic characteristics are not significantly related with their output is rejected and the alternative accepted.

3.4. Costs and Returns of Irrigated Rice Production Birnin Kebbi Local Government Area of Kebbi State

The results in Table 4 show the costs and returns of irrigated rice production in the study area. The total cost of variable inputs (seed, labour, fertilizer and agro-chemicals) per hectare was estimated to be N142844.70. The cost of labour accounted for the largest percentage of the cost of production

(67.55%) while the cost of seed accounted for the least (3.82%).

The gross farm return was ₦ 391017 per hectare. The gross margin per hectare was, therefore, ₦248, 172.30. The average rate of return obtained was 2.74, implying that for every ₦1 invested, there was a return of 74 kobo. This implies that for every ₦1 invested in rice farming, the farmer gains an additional ₦0.74, making rice production a financially viable enterprise. This result shows that irrigated rice production is profitable in Birnin Kebbi LGA of Kebbi State. Thus, the null hypothesis that irrigated rice production is not profitable is rejected and the alternative accepted. This finding compares favourably to that of [14] who, in their work on economics of rice production in Bauchi State, found the average rate of return to be 77 kobo, and [18] in their study that examined the economics of rice production in Selected LGAs of Bauchi State, Nigeria.

Table 4. Costs and returns of irrigated rice production in Birnin Kebbi LGA of Kebbi State.

Cost and Return Items	Average quantity Kg/ha	Unit price (N)	Value (N)	Percentage (%)
(A) Variable Costs				
Seed (kg)	71.06	80	5684.8	3.82
Labour (man-day)	241.23	400	96492	64.87
Fertilizer (kg)	381.41	90	34326.9	23.07
Agro-chemical (litre)	7.46	850	6341	4.26
Total Variable Cost			142844.7	
(B) Output (Kg/ha)	6516.95	60	391017	
(C) Gross Margin / ha			248172.3	
(D) Average Rate of Return			1.73	

3.5. Constraints Associated with Irrigated Rice Production in Birnin Kebbi Local Government Area of Kebbi State

The results in Table 5 show the constraints associated with

irrigated rice production in the study area. The constraints identified by the respondents were ranked in order of severity. Lack of government intervention in form of access to credit and incentives was ranked as the first major constraint face by farmer (17.30%). High cost of petrol ranked second among the constraints faced by the farmers (16.20%). High cost of petrol used in pumping water to the farm due to

increase in price of petroleum. The third major constraint was poor government policy which hinders favourable market structure for the farmer to gain a reasonable share of profit in paddy rice production, also with an existing competition with foreign brands (15.30%). The fourth constraint identified by the respondents was high cost of pumping machine (13.50%). This reduces the chances of obtaining new pumping machine with more efficiency of fuel consumption reducing cost of buying petrol. High cost of livelihood was ranked fifth (12.30%) and High cost of fertilizer

Table 5. Constraints associated with irrigated rice production in Birnin Kebbi Local Government Area of Kebbi State.

Constraint	Frequency	Percent (%)	Rank
Lack of Government Intervention	96	17.30	1st
High cost of petrol	90	16.20	2nd
Poor Government policy	85	15.30	3rd
High cost of water pump	75	13.50	4th
High cost of livelihood	68	12.30	5th
High cost of fertilizer	63	11.40	6th
Lack of extension contact	51	9.20	7th
High cost of labour	26	4.70	8th
Total	554	100	

4. Summary, Conclusion and Recommendations

4.1. Summary

The study examined the economics of irrigated rice production in Birnin Kebbi Local Government Area of Kebbi State. The specific objectives were to determine the socio-economic characteristics of the farmers in the study area, identify the socio-economic characteristics of irrigated rice producers that influence output of irrigated rice, evaluate the costs and returns in irrigated rice production, and identify the constraints associated with irrigated rice production in the study area.

Primary data were used for this study and these data were collected with the aid of structured questionnaire. Multi-stage sampling procedure were used to randomly select 120 respondents from four major producing area in Birnin Kebbi LGA. These villages were Ambursa, Dukku, Gulumbe, and Zauro. Descriptive statistics, multiple regression analysis production function and gross margin analyses were employed to analyse the data.

The results of the socio-economic characteristics of the

ranked sixth (11.40%). High cost of fertilizer may be due to inefficient fertilizer distribution systems and the artificial hoarding of fertilizer by middlemen. Lack of extension contact was ranked seventh (9.20%). Which means that the farmers had reduced access to information on modern agricultural technologies. High cost of labour was ranked eight (4.70%). This may be attributed to the fact that food production in the study area is labour-intensive and shortage of labour in relation to the demand as a result of competition for available labour raises the cost of labour.

farmers revealed that for age distribution, 39.2% of the farmers were within 31-40 years of age, 31.7% were between 41-50 years, 18.3% between 51-60 years, 9.2% between 21-30 years and 1.7% were between 61-70 years of age. For farming experience, about 34% had between 11-20 years of farming experience, about 36.7% had between 1-5 years of farming experience, 26.7% had 21-30 years of farming experience, and 11% had 1-10 years of farming experience. For household size, 45% had 6-10 members, 23.3% had 1-5 members, 21.7% had 11-15 members and 3.3% had 16-20 members.

For formal education, 40% had no formal education, 39.2% had primary education, 15% had secondary education and 5.8% had tertiary education. For farm size, 64% had farm size of between 0.1-1.0 hectares, 25.5% had between 1.1 and 2.0 hectares and 9.5% had between 2.1-5.0 hectares. For method of land acquisition, about 76.7% of the respondents in the study area obtained their farmlands through inheritance, 9.2% obtained their land through purchase, 9.2% borrowed their farm land and 3.3% were gifted. For extension contact, about 77.5% of the farmers in the study area had no contact with extension agents, 16.7% had one contact, and 5.8% had two contacts in a year. For membership of cooperatives, about 72.5% did not belong to any cooperatives, 3.5% had between 1-3 years of cooperative membership, about 13% had between 4-6 years of cooperative membership, 9.5% between 7-9 years of membership and 1.5% between 10-12 years of membership.

The results of the multiple regression analysis showed that the socio-economic variables that significantly influenced the output of irrigated rice are where age, farming experience, farm size and amount of credit received.

The cost and returns showed that the total cost of production was ₦148,844.70 per hectare and the gross returns was ₦391,017.30 per hectare. The gross margin was, therefore, ₦248,172.30 per hectare.

The constraints to irrigated rice production identified by the respondents, in order of their severity were Lack of Government Intervention (17.30%), High cost of petrol (16.20%), Poor Government policy (15.30%), High cost of water pump (13.50%), High cost of livelihood (12.30%), High cost of fertilizer (11.40%), Lack of extension contact (9.20%) and High cost of labour (4.70%).

4.2. Conclusion

Rice is one of the most important cereal foods in the world and the staple food of millions of people. The production of irrigated rice in the study area was found to be profitable and this has the potential of contributing to improved livelihoods of the farmers. Farmers' socio-economic characteristics were found to significantly influence their output, hence change agents in the study area should be trained to understand the factors influencing the underutilization of most of the inputs meant that farmers' lacked knowledge on the optimal rates of use of these inputs. The constraints associated with irrigated rice production in the study area must be addressed if the existing low-yielding rice production systems are to be transformed into higher yielding and sustainable production systems.

4.3. Recommendation

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

- Farm inputs such as farm size, seed, fertilizer and agro-chemicals positively and significantly influenced the production of irrigated rice in the study area. It was therefore, recommended that timely and adequate supply of inputs be made available to farmers at affordable price in order to enhance the production of this crop by the Government and non-Government organizations.
- Government should increase the number of extension agents in Kebbi State from the current 1 agent per 500 farmers to at least 1 per 200 farmers.
- Since extension contact was significantly determinant of technical efficiency, irrigated rice farmers should through their cooperative societies make arrangements for an extension agent to be visiting at least twice a month, so as to be able to benefit from the farm advisory services that would increase output.
- The study revealed that for every naira spent in irrigated rice production, a gain of 73 kobo was made; it is therefore recommended that farmers should be encouraged to go into irrigated rice production in the study area in order to generate more income. This can be done by direct intervention through empowerment programmes and training by government agencies and donor organizations that will stimulate and sustain farmer's interest in small-scale irrigated rice production in the study area.
- Future research should analyze the impact of climate variability on irrigated rice production in Nigeria, considering water shortages and changing rainfall patterns.

Abbreviations

USDA	United States Department of Agriculture
IFDC	International Fertilizer Development Center
JICA	Japan International Cooperation Agency

NCRI National Cereals Research Institute

Author Contributions

Illo Abdullahi Ibrahim: Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing – review & editing

Fingillah Ahmed Suleiman: Data curation, Resources, Software, Supervision, Visualization

Hassan Ajao Tijani: Data curation, Formal Analysis, Investigation, Methodology, Resources, Validation

Conflicts of Interest

The authors declare no conflicts of interest.

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