Comparative Economic Analysis of Lowland and Upland Rice Production Systems in Benue State, Nigeria

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Abstract
This study compared the economics of lowland and upland rice farming systems in Benue State, Nigeria, with a focus on upland and lowland systems. The study aimed to identify existing production systems, analyze their profitability and the constraints to rice farming. Systematic sampling technique was used to select 180 respondents for the study. A well-structured questionnaire was used to obtain primary data. Data collected were analyzed using descriptive statistic, gross Margin and budgetary technique specifically Return on Investment (ROI). Findings revealed that Lowland rice production emerged as the most widely (71.7%) practiced and economically viable, yielding a significantly higher profit (₦1,014,047.54/ha) and return on investment (ROI) of 1.26 compared to upland systems (₦682,069.50/ha; ROI of 0.92). The results indicate that lowland rice production proved to be significantly more profitable than upland systems driven largely by higher yields and favourable returns, with the higher returns adequately compensating for the relatively higher production costs. The study recommended that agricultural security *networks be strengthened, access to credit should be expanded and input delivery systems be improved.*

Key Words*: Profitability; Lowland and Upland Production Systems*

Introduction

Rice production in Nigeria is carried out under different production systems that reflect the country's diverse agro-ecological conditions, water availability, and resource endowments. Longtau (2003) classified six rice-growing environments (RGEs) in Nigeria as; upland, hydromorphic, rain-fed lowland, irrigated lowland, deep inland water, and mangrove swamps. Each system varies in terms of production practices, environmental requirements, yield potential, and profitability, thereby influencing farmers' production decisions and overall rice output.

In Nigeria, rice production has attracted increasing government attention in recent years as part of policy efforts to achieve food self-sufficiency, reduce heavy reliance on imports, and minimize foreign exchange expenditure. This renewed focus has resulted in the implementation of several intervention programmes and projects including; National Rice Development Strategy II (NRDS II, 2020–2030) and Competitive Africa Rice Platform (CARP) aimed at boosting domestic rice production (Yusuf, 2022). However, the continued importation of rice raises concerns about the effectiveness of these policies and the extent to which the country has been able to harness its

production potential. According to Cadoni and Angelucci, (2013) majority of domestic rice production comes from resource-poor and weakly organized smallholders. These smallholders apply a low-input strategy to agriculture, with minimum input requirements and low output (International Fund for Agricultural Development [IFAD], 2009). The livelihood of these smallholder farmers have been constrained by a host of challenges: low productivity; paucity of opportunities for value addition; limited access to productive assets and inputs; inadequate support services (extension and research); inadequate market and rural infrastructure; post-harvest losses and a constrained enabling environment (IFAD, 2012). More so, a huge proportion of domestic rice in Nigeria is not tailored to meet market needs. This has also limited the market share of the domestic rice producers. Benue State is predominantly characterized by lowland ecology, lying within the lower River Benue trough at elevations of about 100–300 meters above sea level. The state experiences two major rice production seasons: the wet season (June–December) and the dry season (February–July). With annual rainfall exceeding 2,000 mm, wet-season rice production is more widespread, especially near river channels and streams that retain monsoon rainfall. During the dry season rice farming, irrigation practices are the basic mechanisms used to distribute water over the rice farms (Benue ACReSAL, 2023). These ecological conditions make lowland rice farming the most suitable and commonly practiced system in Benue State. Since 2019, the prices of rice have yet doubled again despite considerable improvements in local production indicating that a demand-supply gap still exists. Local rice is majorly produced by small-scale resource poor farmers that use traditional technology for their production activities. Despite the favorable ecological conditions in Nigeria, local rice producers are yet to explore this advantage for profitability purposes. Although, rice production is a profitable business, there is need to study the potential of the production systems under which rice farmers carry out their production activities. This study seeks to explore the different types of rice production systems as well analyze the profitability of various rice production systems in the State

Methodology

The Study Area

The study was carried out in Benue State, Nigeria. It is located in the North-Central geopolitical zone of the country with a population of 4,219,244 persons (NPC, 2006). Administratively, it has 23 Local Government Areas (L.G.A), 3 Senatorial zones and 3 Agricultural zones (Terver, 2013) with Makurdi as the State Capital. Major ethic groups in the state are Tiv, Idoma, Igede, Etulo, Abakpa and Jukun. Agriculture is the major occupation of the people and subsistent agriculture is prevalent and about 75 percent of the population engage in it. The presence of River Benue and Katsina- Ala which are the two major rivers in the state make irrigation farming worthwhile for the inhabitants**.** The State lies between latitudes 6^0 25′N and 8^0 8′N of the equator and longitudes 6^0 47′E and 16′E of the Greenwich meridian, at an elevation of 97 meters, above sea level in the Southern guinea savannah Agro-ecological zone.

The State has a tropical climate with two distinct seasons namely the raining season and Dry season. The rainy season lasts from April to October with annual rainfall in the range of 100-200mm. The dry season begins in November and ends in March. The minimum and maximum temperatures are 21°C and 37°C respectively. The vegetation in the study area is guinea savannah type, characterized by grasses with few scattered shrubs and trees (Benue State Agricultural and Rural Development Authority BNARDA, 2013). The State is endowed with both mineral and natural resources. Mineral resources include Limestone (found in Tse-kucha), Kaolinite (found in Otukpo), Baryte, Gypsum, Wolframite, Mineral Salts and Gemstone.

Population of the Study

The population of the study comprised all 6,860 registered rice farmers obtained from BNARDA, in 2023 in Benue State.

Sample Size and Sampling Techniques

sample size of 378 rice farmers determined using Taro Yamane's method was used for the study. Systematic Sampling technique was employed to select respondents for the study from the three (3) Agricultural zones (Zones A, B and C). Of the 378 questionnaires administered, only 180 were correctly filled. In other cases, the rice farmers were not accessible. The data for the study were collected using structured questionnaire.

Analytical Technique

The data collected were analyzed using descriptive statistics such as percentages and frequency distribution, Gross Margin and budgetary technique specifically the return on investment (ROI). The descriptive statistics were used to describe the type of rice production systems and constraints to rice farming while ROI and Gross Margin were used to determine the costs and returns of rice under the different production systems.

The ROI was specified as follows:

ROI = $\frac{TR - TVC}{TVC}$ …… (i)

ROI= return on investment (Naira)
TR= total revenue (Naira)
TVC= total variable cost (Naira)

The GM was specified as follows:

GM = TC -TVC …… (ii)

Results and Discussion

Types of Rice Production Systems

The analysis of rice production systems reveals that the upland rice production system was the most widely practiced among the respondents, accounting for 71.7% of the respondents. This suggests that a significant number of farmers operate in non-irrigated, rainfed areas often located on elevated terrains with well-drained soils. The dominance of upland systems is likely due to their lower establishment costs, minimal requirement for water infrastructure, and accessibility in rural areas. Similar findings were reported Oloyede *et al.,* (2021) who found out that majority (48.3%) of the rice farmers practiced the upland production system. Only 38.3% of the rice farmers practiced lowland rice production system. This could be attributed to the nature of production in lowland system since it is labour intensive and expensive. Only six farmers (3.3%) reported practicing irrigated rice farming, making it the least utilized production system in the study area. Irrigated rice systems offer the potential for year-round cultivation and significantly higher yields, but they require considerable investment in infrastructure such as canals, pumps, and water regulation facilities.

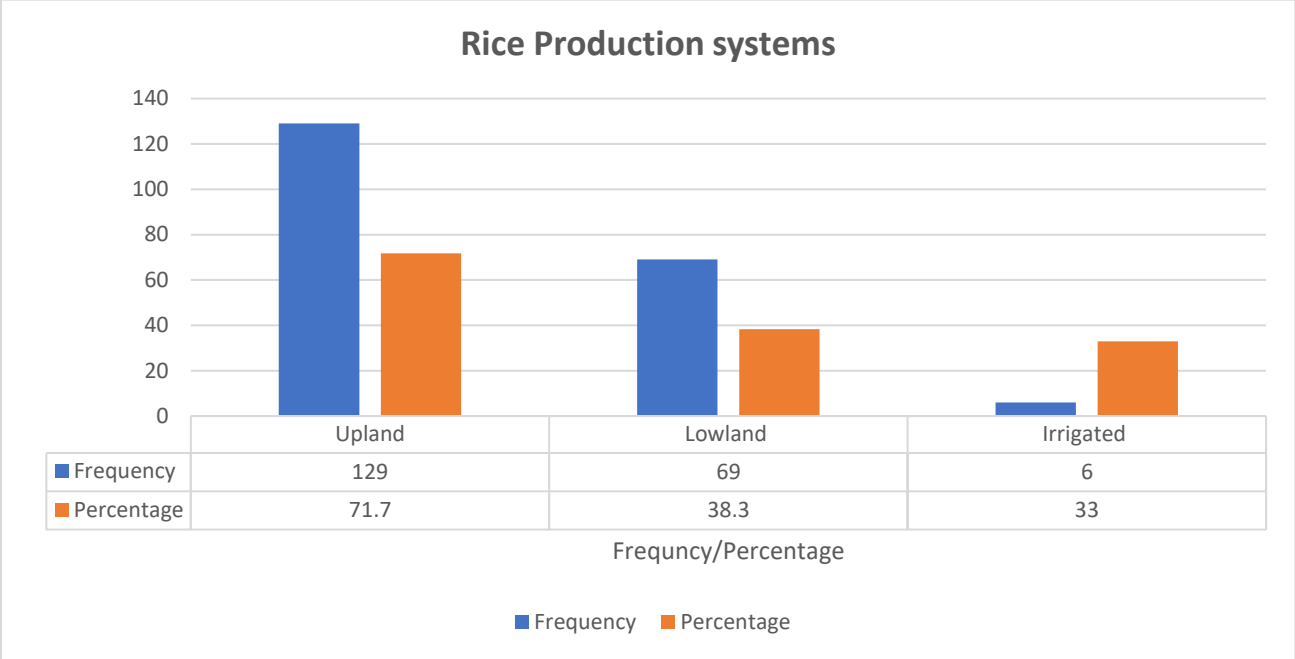

Figure 1: Types of rice productions systems practices in the study areas.

Costs and Returns on Upland Rice Production System

Table 1 shows the average costs and returns for Upland Rice Production System. The result revealed that the total revenue realized from upland production amounted to ₦1,425,532.05 per hectare. This high revenue figure reflects both favorable market prices and substantial yield output, calculated as 2,059.69 kg/ha and sold at ₦692.11 per kg. The gross margin was ₦682,069.50, indicating a highly profitable venture. This finding corroborates the work of Ayalew *et al*. (2019), who found that upland rice farming system generated in Fogera and Pawe realized substantial net returns. The analysis of cost components shows that the total variable cost incurred in upland production was ₦743,462.55 per hectare. The largest share of the cost was allocated to machinery rental (24.29%), followed by labour cost (22.30%), fertilizer (21.14%), seeds (8.16%), transportation (7.67%), and herbicides (4.45%), and pesticides accounted for 1.18%. This cost structure is consistent with the findings of Oloyede *et al*. (2021), who reported that machinery and fertilizer constituted the highest shares of production costs among upland rice farmers in Kwara State. The computed Return on Investment (ROI) was 0.92, suggesting that for every ₦1 invested in upland production, a return of ₦0.92 (ninety-two kobo) was realized. This is a strong indicator of profitability and economic viability.

Table 1: Average Costs and Returns per Hectare for Upland Rice Production System

Variables	Value (₦/ha)	Percentage
A. **Revenue**		
Quantity produced * Unit price = 2059.69 * ₦ 692.11	1,425,532.05	
B. Variable Cost		
Fertilizer cost	157,165.80	21.14
Herbicide cost	33,110.06	4.45
Pesticide cost	8,766.79	1.18
Labour cost	165,801.60	22.30
Seed cost	60,700.00	8.16
Transportation cost	56,994.79	7.67
Cost of renting Machinery (Land preparation)	180,590.18	24.29
Others cost (transportation)	80,333.33	10.81
C. Total Variable Cost	743,462.55	
Gross Margin: A – C	682,069.50	
Return on Investment: $\frac{A-C}{C}$	0.92	

Source: Field survey data, 2024

Costs and Returns of Lowland Production System

Table 2 shows the average costs and returns for Lowland Rice Production System. The study revealed that the total revenue from lowland rice production was ₦1,820,966.19 per hectare, derived from a quantity of 2,645.10 kg per hectare sold at a price of ₦688.43 per kg. The gross margin, calculated as the difference between revenue and total variable cost, was ₦1,014,047.54 per hectare. This revenue figure is higher than that of upland rice production and suggests a favorable level of profitability. This conforms to the findings of Fakayode (2009), Oloyede *et al*. (2021), Akanbi (2024), and Nwakpu (2024) who reported that Lowland rice production systems were more profitable than Upland rice production systems. This served a s a compensable for its capital- and labor-intensive nature. The analysis of cost components shows that the total variable cost incurred in lowland production was ₦806,448.34 per hectare. The largest share of the cost was allocated to Machinery Cost (23.89%) followed by Labour cost (21.62%), Fertilizer cost (20.69%), Seed cost (8.18%), Herbicides cost (4.01%), Pesticides cost (1.54%). The machinery cost, at 23.89%, is also notable, reflecting the capital-intensive nature of lowland rice farming.

The Return on Investment (ROI) for lowland rice production was calculated at 1.26. This implies that for every ₦1 invested in lowland rice farming, a return of ₦1.26 is realized. This ROI is higher than the ROI observed in upland production (0.92) and it suggests a profitable enterprise.

Table 2: Average Costs and Returns per Hectare for Lowland Rice Production System

Variables	Value (₦/ha)	Percentage
A. **Revenue**:		
Quantity produced * Unit price = 2,645.10 * ₦ 688.43	1,820,966.19	
B. Variable Cost		
Fertilizer cost	166,988.66	20.69
Herbicide cost	32,364.04	4.01
Pesticide cost	12,419.75	1.54
Labour cost	174,435.87	21.62
Seed cost	66,021.70	8.18
Transportation cost	75,608.28	9.37
Machinery cost (Land preparation)	192,830.35	23.89
Others cost (transportation)	86,250.00	10.69
C. Total Variable Cost	806,918.65	
Gross Margin: A – C	1,014,047.54	
Return on Investment: $\frac{A-C}{C}$	1.26	

Source: Field Survey Data, 2024

Comparison of the Profitability of the Lowland and Upland Production Systems

Table 3 shows the comparison of the profitability of the lowland and upland production systems. The analysis of profitability across rice production systems reveals a statistically significant difference in returns per hectare between upland and lowland rice farming. The mean profit derived from upland rice cultivation stands at ₦682,069.50 per hectare, while the corresponding mean for lowland rice is ₦1,014,047.54 per hectare. This yields a mean difference of ₦331,978.04, which is statistically significant at the 5% level (t = 2.376; p = 0.019). The implication of this result is that, under current production conditions, lowland rice farming is significantly more profitable than upland rice farming in the study area (Table 3).

Table 3: Comparison of Significance difference of the Profitability of the different Production Systems

Variable	Mean Value	Mean Difference	T	p-value
Profit from upland rice (₦/ha)	682,069.50	331,978.04	2.376	0.019**
Profit from lowland rice (₦/ha)	1,014,047.54			

Source: Field survey data, 2024 ** Significant @ 5%

Constraints to Rice Production

The results in Table 3 show various constraints associated with lowland and upland production systems in the study area. All the rice farmers (100%) identified insecurity a major challenge in

the rice production. This emphasis the overwhelming impact of land conflict and instability particularly due to herder-farmer clashes and community disputes. Insecure farming environments restrict access to productive land, deter investments, and limit labor mobility. Low productivity was reported by 79.4% of farmers. This suggests persistent inefficiencies in rice cultivation which is likely due to poor soil fertility management, lack of access to improved varieties, limited extension support, and outdated farming techniques. Climate change and competition from imported rice brands were each reported by 66.7% of farmers. The influence of climate change through irregular rainfall, flooding, prolonged dry spells, and increased flooding has disrupted traditional farming calendars and reduced yield stability. Similarly, the influx of cheaper, better-packaged imported rice continues to erode the market share and profitability of locally produced rice. About 66% of the respondents considered poor access to credit as a problem that militates against their ability to achieve their desired production level. Limited access to affordable credit reduces farmers' ability to invest in essential inputs like fertilizers, herbicides, machinery, and labor. This constraint is consistent with Usman *et al.,* (2024) who reported that poor access to credit facilities militated against rice production and commercialization among the farmers in the Nasarawa State, Nigeria. Lack of favourable government policies, reported by 62.2% of farmers, points to institutional failures in supporting rice value chain development. When policy environments are not farmer-centric, adoption of improved practices and long-term investments are discouraged.

Production-level constraints such as lack of timely access to improved rice seeds and inputs (54.4%) and pests and diseases (53.9%) directly affect crop quality and yield as reported by the farmers. Poor and untimely access to quality seeds and fertilizers delays planting and lowers output, while pests and diseases remain uncontrolled due to limited extension support or unaffordable agrochemicals. Lack of fertilizers at the peak time of plantation as severe most problem in the area as it limits the total production capability of soil and plant can't yield to their maximum potential thereby giving low yield due to lack of essential nutrient for growth, development, grain formation and grain filling (Acharya *et al.,* 2020).

Table 3: Constraints to Rice Production (n=180)

Constraints	Frequency	Percentage
Insecurity	180	100.0
Low productivity	143	79.4
Competition from imported brands	120	66.7
Climate change	120	66.7
Poor access to credit	118	65.6
Lack of favourable government policies	112	62.2
Lack of timely access to improved rice seeds and other inputs	98	54.4
Pest and diseases	97	53.9
Variability in price of rice	89	49.4
Poor market information	88	48.9
Unavailability of irrigation facilities	85	47.2

Source: Field survey data, 2024

Conclusion and Policy Implications

Rice production under Lowland proved to be significantly more profitable than upland systems, driven largely by higher yields and favorable returns, with the higher returns adequately

compensating for the relatively higher production costs. However, challenges like insecurity, poor access to inputs, climate variability, and policy inadequacies continue to undermine the sector's full potential. These findings underscore the urgent need for targeted interventions to improve access, reduce risks, and increase productivity in rice farming**.**

Based on the findings of the study, the following recommendations were made:

i. Government should intensify efforts to restore peace and security in farming communities to allow displaced farmers to return and cultivate their land.

ii. Financial institutions and government agencies should collaborate to provide affordable and accessible credit options tailored to the needs of rice farmers. This can enable them to invest in inputs and technologies that improve yield and profitability.

iii. Government should ensure and prioritize timely provision of quality seeds, fertilizers, and agrochemicals through its trusted agencies.

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