Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

Master's Thesis

ECONOMIC ANALYSIS OF RICE PRODUCTION IN NORTH-CENTRAL NIGERIA: A CASE OF KOGI STATE

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Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

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Economics and Management

Thesis title

Economic Analysis of rice production in North-Central Nigeria – A case study of Kogi State

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Objectives of thesis

The objectives of the thesis are to:
(1) Quantify the cost of non-human related inputs (such as land acquisition, seeds and agrochemicals) and their implications on rice production in the study area.
(2) Determine the effects of the expenses on human labouron rice production.
(3) Assess the variations in rice production quantities among the rice farmers from the different rice fields and ecology in the study area.
(4) Examine the profit or loss from rice production among the farmers and proffer achievable recommendations to the stake-holders (farmers, businessmen and policy-makers) for sustainable production of rice.

Methodology

Data for this study will be collected using both primary and secondary sources. In the application of the primary source, the researcher will make use of field survey, questionnaires and interviews, which will be distributed randomly across farmers in the top eight rice producing local government areas (LGAs) in Kogi State, Nigeria.. Secondary sources to be used include materials from peer-reviewed journals, books, book chapters, NGOs and government established institutions and agencies such as Nigerian Bureau of Statistics, Ministry of Agriculture.

The proposed extent of the thesis

60 pages

Keywords

Rice cultivation, rice processing, soil tenacity

Recommended information sources

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Prague on 01. 04. 2023

Declaration

I declare that I have worked on my master's thesis titled "Economic Analysis of Rice Production in Nigeria, a case study of Kogi State, Nigeria" by myself under the supervision of Doc. Ing. Petr Procházka, Ph.D., MSc. I used only the sources and references mentioned at the end of my thesis.

In Prague on 1st April 2023 _____

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I am grateful to Jehovah God for good health, wisdom and Knowledge that were necessary to achieve this book. I wish to express my deeper thanks to Doc. Ing. Petr Procházka, Ph.D., MSc my supervisor for guiding me and providing me with all the helpful materials for the research. I am also grateful to my lecturers, in PEF faculty, I am sincerely thankful for them for sharing their knowledges, expertise and valuable encouragement and guidance extended to me. I place on record my sincere thank you to my family, especially my sister Feyisayo Mercy for her unceasing encouragement and support. I am also thankful to my special friends, Joel Bamidele, Bolu Ekunseitan , Funsho, Raphael who encouraged and supported me through this process. Thanks to all people near or far who contributed to complete this book, my classmates, my friends from Czech Republic, France, Belgium, Germany

Economic Analysis of Rice Production in North-Central Nigeria – A case study of Kogi State

Abstract

In Nigeria and other areas of the world, rice is one of the main basic foods that is eaten daily. Nigeria has been classified as both an importer and an exporter of rice grains in addition to being one of the world's major consumers of rice. Although the level of acceptance of locally produced rice has increased recently due to improvements in production methods, varieties, and government policies, economic factors have been cited as one of the main threats to the industry. This thesis examines the economics of rice production in Kogi State, one of the States with the highest records for rice production in central Nigeria, within this environment. Further, the study hypothesized that (1) Cost of acquiring non-human related inputs has no significant impacts on the production of rice. (2) The cost of human labour does not have a significant effect on the rice production. (3) Cost of processing, post-harvesting, marketing, and farmer's economic status have significant influence on rice production in Kogi State, Nigeria. Data were collected by interviewing 80 farmers randomly selected from eight local government areas (LGAs) which produces the highest quantity of rice in the State. The results were analyzed by adopting regression models, ordination of the associated variables and spatial distribution of the farm sites using SPSS, Canoco and ArcGIS which are statistical and geospatial software packages. The findings revealed that (a) Though variations existed between the farm age, size and productivity among the farmers, but neither the farm age nor the size of farms has substantial influence on the rice production. (b) All the farmers agreed that they make profit though some farmer's profit exceed those of their counterparts, but no farmer had a loss during the growing season(s). (c) the cost of acquiring land and agrochemicals such as pesticides and herbicides had significant impacts on the production of rice, while the second hypothesis, confirmed that the cost of human labour had a significant effect on the rice production the rice production. This study will support the government, NGOs and other stakeholders in rice production and food security in establishing policies to regulate rice production, market prices, and other economic factors as to enhance food production for the growing population in the State and country.

Keywords: Rice processing, cultivation, soil fertility

Ekonomická analýza produkce rýže v severo-Střední Nigérii-případová studie státu Kogi

Abstrakt

Rýže je jednou z hlavních základních potravin široce konzumovaných v Nigérii a dalších částech světa. Kromě toho, že patří mezi největší spotřebitele rýže na celém světě, Nigérie byla uvedena jako vývozce i dovozce rýžových zrn. Nedávné zlepšení výrobních procesů, odrůd a vládních politik však pomohlo zvýšit úroveň přijatelnosti místně produkované rýže, ale ekonomické faktory byly identifikovány jako jedna z hlavních výzev ohrožujících produkci rýže v zemi. V této souvislosti je tato práce zaměřena na analýzu ekonomiky produkce rýže ve státě Kogi, který je jedním ze států s vysokými záznamy o produkci rýže ve střední Nigérii. Studie dále předpokládala, že (1) Náklady na získání vstupů nesouvisejících s člověkem nemají významný dopad na produkci rýže. (2) náklady na lidskou práci nemají významný vliv na produkci rýže. (3) Náklady na zpracování, posklizeň, uvádění na trh a ekonomický status zemědělce mají významný vliv na produkci rýže ve státě Kogi v Nigérii. Data byla shromážděna dotazováním 80 farmářů náhodně vybraných z osmi oblastí místní správy (LGA), které produkují nejvyšší množství rýže ve státě. Výsledky byly analyzovány přijetím regresních modelů, uspořádáním přidružených proměnných a prostorovým rozložením farem pomocí SPSS, Canoco a ArcGIS, což jsou statistické a geoprostorové softwarové balíčky. Ze zjištění vyplynulo, že a) ačkoli existovaly rozdíly mezi věkem, velikostí a produktivitou zemědělských podniků mezi zemědělci, ale ani věk zemědělských podniků, ani velikost zemědělských podniků nemají podstatný vliv na produkci rýže. B) všichni zemědělci se shodli, že dosahují zisku, i když zisk některých zemědělců převyšuje zisk jejich protějšků, ale žádný zemědělec neměl během vegetačního období ztrátu. C) náklady na pořízení půdy a agrochemikálií, jako jsou pesticidy a herbicidy, měly významný dopad na produkci rýže, zatímco druhá hypotéza potvrdila, že náklady na lidskou práci měly významný vliv na produkci rýže produkce rýže. Tato studie podpoří vládu, nevládní organizace a další zúčastněné strany v produkci rýže a zajišťování potravin při vytváření politik pro regulaci produkce rýže, tržních cen a dalších ekonomických faktorů, aby se zvýšila produkce potravin pro rostoucí populaci ve státě a zemi.

Klíčová slova: zpracování rýže , pěstování , úrodnost půdy

Table of content

1 Introduction

Globally, Rice (oryza, family Gramineae) is one of the essential staple cereals consumed by over half of the world's population with Nigeria rated among the top in the list of the countries (Ayoade 2016). The sustainability and efficiency in rice or general agricultural production and distribution as an agricultural commodity is highly dependent on several factors. These factors include human population (such as increasing family sizes), farmers' age, education, and financial status (Abidin et al. 2022). Other factors are decline in farmland sizes, variability in climate, soil fertility and land elevation (Abidin et al. 2022; Nieves et al. 2017; Amiri et al. 2023; Milner and Boldsen 2023). These factors have to a large extent affected food security and safety including rice which is the most staple food commonly eaten by everyone especially in the developing tropical countries including Nigeria.

In respect to the environmental factors, the large number of climate change impacts on rice production occur due to variations in rainfall and temperature that might induce infertile soil, surface runoff, inadequate water, and promote pests and invasive species including weeds. It is also unique to know the important to know that the country depends heavily on agricultural activities with rice farming a one of the key products. Rice is cultivated for food, employment, commercial reasons, industrial purposes, and foreign income. The most outstanding implications of environmental factors are the impacts of climate change on smallholder farmers and their ability to successfully adapt. Small-scaled farmers are in most scenarios in dilemma because they are supplied with little or no knowledge, no financial or material support, and dearth of resources to sustainably cope. To worsen the situation is when considering the high number of rice growers who are involved in small-scale production in in the country, and Nigeria is in the first (1st) position for rice production in Africa (Graphure 1.1) followed by Egypt which made use of the River Nile basin. Globally, Nigeria is the 13th country in the production

of rice with a total production of 8,435,000 tons, and average yield of 1,597.10 kg per hectare.

2 Objectives and Methodology

2.1 Objectives

The objectives of the thesis are to:

(1) Quantify the cost of the non-human related inputs (such as land acquisition, seeds and agrochemicals) and their implications on rice production in the area of study

(2) Determine the effects of the expenses on human labour on rice production.

(3) Assess the variations in rice production quantities among the rice farmers from the different rice fields and ecology in the study area.

(4) Estimate the relationships between farmer's economic status and rice production.

(5) Examine the profit or loss from rice production among the farmers and proffer achievable recommendations to the stake-holders (farmers, businessmen and policy-makers) for sustainable production of rice.s

2.2 Methodology

Kogi State is one of the 36 States in Nigeria created in 27 August 1991 It is located in the North-Central geopolitical zone of Nigeria (Graphure 2.1). With 29,833 km2, Kogi State is one of the largest States in Nigeria in terms of landmass. There are 21 Local Government Areas (LGAs) in the region, including Adav, Bassa, Dekina, Ibaji, Idah, Igalamela-Odolu, Ijumu, Kabba/Bunu,, Karfe, Lokoja, Mopa-Muro, Ofu, Ogori/Magongo, Okehi, Okene, Koton Ankpa (NBS, 2022).

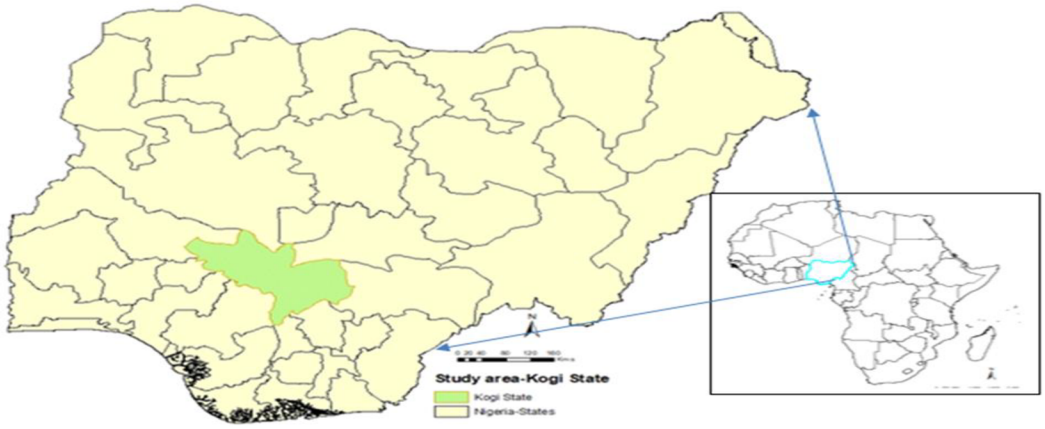


Figure 2.1. Study area showing location of Kogi State in Nigeria, and Nigeria in Africa (Source: Author's work)

Kogi State has an estimated population of about 4.5 million persons (NPC, 2016). Kogi State is surrounded by the states of Ekiti and Kwara to the west, the Federal Capital Territory to the north, Nasarawa to the northeast, Niger to the northwest, Edo and Ondo to the southwest, Anambra and Enugu to the southeast, and Benue to the east. It is the only state in Nigeria with ten additional states bordering it., and the only State in Nigeria that has LGAs covering people and indigenes of the three major tribes (Hausa, Igbo, and Yoruba).

Kogi State was selected for this study based on its significant contribution in food production especially rice. In terms of geographical and agroecological features, Kogi State lies within the savannah zones with mainly rainforest, Guinea savannah and mangrove forest vegetation. According to its topography, the State is surrounded by sedimentary rock from the upper Cretaceous period, which contains embedded shale, sand clays, and sandstone, as well as igneous and metamorphic rocks produced by the basement complex. In terms of weather, Kogi State typically experiences a tropical continental climate with wet and dry seasons. The average annual rainfall is between 1200 and 1500 mm, and temperatures are high virtually all year round with the exception of the harmattan period. Early November through early February is the harmattan period. More than 70% of the population relies on farming for a living, making it a significant socioeconomic activity. Besides rice, Kogi State also produces cassava, maize, yams, sugar cane, and vegetables (Emurotu and Onianwa 2017).

2.3 Research Methodology

In order to achieve this study's goal, considering the frame of the research problem and the research perspective, the study followed a mixed research design which includes qualitative and quantitative methods. The qualitative approach dealt with subjective assessment of opinion, attitude, behaviour, perception and observations of the farmers in the 8 selected farmlands (sites) from the State (Kogi State), Nigeria (**Graphure 2.2; Table 2.1**). The farmlands were being selected based on their age, land area and quantity of yearly production. Quantitative approach was used to analysis the data collected through field farm surveys, questionnaires, and authentically published documents from established institutions within and outside Nigeria.

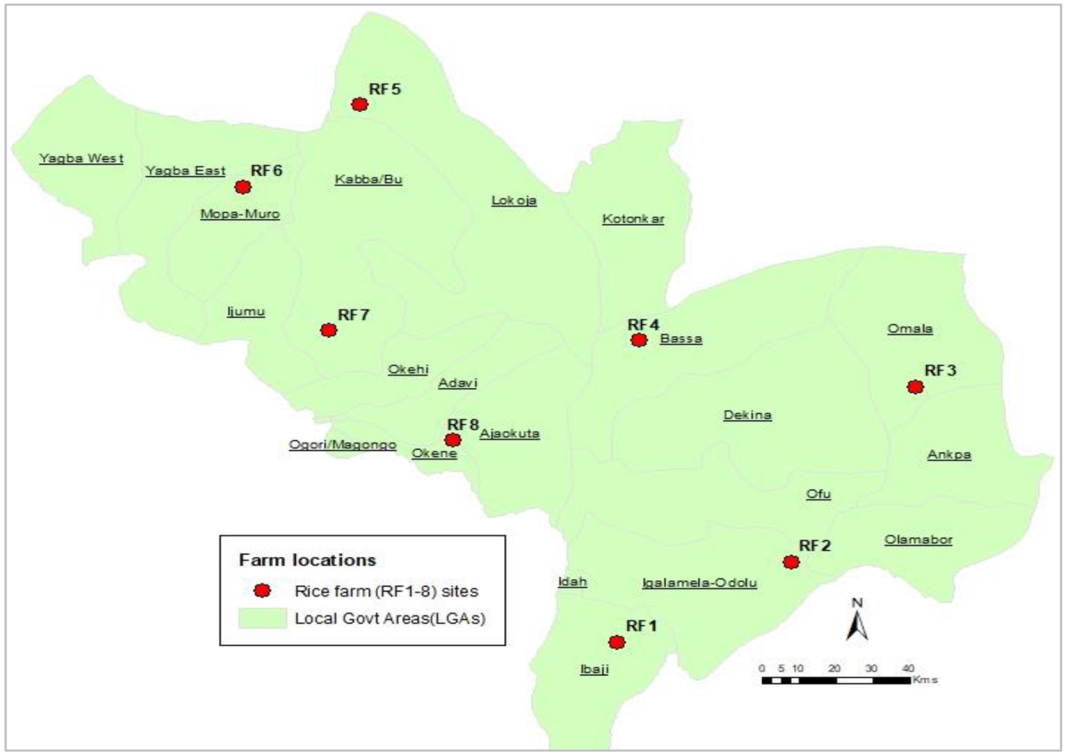


Figure 2.2. Study area showing the top 8 rice farm locations, communities and the LGAs where data and sampling will be conducted (Source: Author's preliminary field survey and work).

Table 2.1. To be sampled rice farm locations, communities and the LGAs in Kogi State Geographicalcoordinates

Farm sites	Community	Latitude (Y)	Longitude (X)	Local Govt Area
RF 1	Ejule	6.886522	6.822199	Ibaji
RF 2	Ebele	7.120078	7.244377	Igalamela-Odolu
RF 3	Oji-Aji	7.631421	7.548899	Omala
RF 4	Bassa	7.765163	6.97446	Bassa
RF 5	Aiyetoro-kiri	8.45376	6.195853	Lokoja
RF 6	Orokere	8.214084	5.908634	Mopa-Muro
RF 7	Out	7.796021	6.119723	Kabba/Bunu
RF 8	Onyukoko	7.47362	6.420784	Okene

2.4 Research Hypotheses:

The thesis postulated five hypotheses, and these are:

Hypothesis 1:

Null hypothesis: Cost of acquiring non-human related inputs has no significant impacts on the production of rice in Kogi State, Nigeria.

Alternative hypothesis: Cost of acquiring non-human related inputs has significant impacts on the production of rice in Kogi State, Nigeria

Hypothesis 2:

Null hypothesis: The cost of human labour has no significant effect on the rice production.

Alternative hypothesis: The cost of human labour has a significant effect on the rice production.

Hypothesis 3:

Null hypothesis: Cost of processing, post-harvesting and marketing has significant influence on rice production.

Alternative hypothesis: Cost of processing, post-harvesting and marketing has no significant influence on rice production.

Hypothesis 4:

Null hypothesis: Rice cultivation and profit maximization among the rice farmers. has no significant variations

Alternative hypothesis: There is significant variations in rice cultivation and profit maximization among the rice farmers.

Hypothesis 5:

Null hypothesis: Farmer's economic status have no significant influence on the rice production in in Kogi State, Nigeria.

Alternative hypothesis: Farmer's economic status have significant influence on the rice production in in Kogi State, Nigeria

2.5 Research Questions:

The aims of this research was achieved by addressing the following questions:

(i) To what extent has the acquisition of the non-human related inputs affected rice production in Kogi State, Nigeria?

(ii) Does the cost of human labour affect rice production?

(iii) Are there variability in rice production quantities among the rice farmers from the various rice fields and ecology in the study?

(iv) How does the economic status of the farmer's affect the rice production chain?

2.6 Relevance of the work/thesis:

The findings from this thesis helped to increase rice production and boost food security especially in a very high growing population like Nigeria by:

(a) Providing the farmers the accurate required information to enable them adapt and mitigate the related economic challenges, thus increase rice production;

(b) Supporting the policy-makers in enacting policies that will improve rice production;

(c) Enhancing the farmers and business people's profit (that is maximizing returns) in the rice production chain;

(d) Establish sustainability in rice production among the illiterate local farmers because they will be enlightened on the natty-gritty of rice cultivation and processing;

(e) Creating the database and guide for subsequent studies on how to promote rice production in Kogi State, Nigeria.

2.7 Scope and limitations of the study

This study was centred on the economic analysis of rice production in Nigeria in 2022. The study focused only on the economic factors, yet it does not mean that the other factors (social and environmental) are of less important..

The economic factors considered were cost of acquiring land, cost of labour for land preparation and cultivation of rice, cost of acquiring the rice seeds and seedlings, cost of fertilizer/manure, costs of controlling weeds, pests and diseases, and cost of harvesting and

processing of rice. The study is limited to the top one (1) out of the ten (10) major rice producing States in Nigeria which were identified and classified by IPAD-International Production Assessment Division in collaboration with USDA Foreign Agricultural Service, (2022) as shown in Figure 2.2. The 10 states are Kaduna, Niger, Benue, Kano, Kwara, Kogi, Taraba, Nassarawa, Plateau, Adamawa and Borno State. Since 2008 to date, theses ten States produce between 3 – 12% of the total rice produced in the country. However, the scope of this work will focus on only one of the States namely; Kogi State.

2.8 Gap in Knowledge

This study was motivated as to close the gap in knowledge because of its scope and coverage. Many people in the country do not know that Kogi State is among the States in Nigeria that produce rice at all the ecological bases (Rain-fed upland, rain-fed lowlands, irrigated upland and irrigated lowlands). This is due to the fact that Kogi State is one of Nigeria's larger States. In terms of land area, and it is Nigeria's sole State, that is joined by two major rivers (R. Niger and R. Benue) in Nigeria. The State also has many undulating landscape with highlands, lowlands, flood plains and valleys. Therefore, Kogi State has the potential to be cultivating rice in different ecologies than any other State in Nigeria.

2.9 Research design

The researcher used the "descriptive Survey method" and observation. According to Nwobodo (2008:36), a historical approach relies on the capacity to identify, assess, and explain significant past events with the sole aim of improving our understanding of the present and producing more accurate predictions for the future. A research design is a master plan that clearly documents the accurate procedures for collecting and analysing the necessary information from different sources including farmers, agricultural agencies and institutions. A research design offers a framework or game plan for the investigation. Therefore, this study falls within the descriptive, explanatory, and field research design categories. After the researcher has a clear understanding of the situation being examined and its explanatory scenarios, descriptive research can help to obtain a lot of information through description beneficial for identifying variables and hypothetical structures.

2.10 Sources of data

In order to gather the data for this study, primary and secondary sources were been used. In order to use the primary source, the researcher used a field survey, questionnaires, and interviews, which were carried out at random to farmers in the top eight local government areas (LGAs) in Kogi State, Nigeria, that produces the most rice. Secondary sources used included materials from peer-reviewed journals, books, book chapters, NGOs and government established institutions and agencies such as Nigerian Bureau of Statistics, Ministry of Agriculture, Commerce and industries, FAO, World Bank, and important international organizations. The importance of these sources cannot be overemphasized because this research has a theoretical and practical perspective

2.11 Reasons for adopting both sources

Secondary Sources

1. It provides data that was already out there and frequently subject to peer reviews, making it the finest on the subject of validity and dependability.
2. Because of the nature of the variables to be examined, secondary sources are crucial. In particular, if a study includes a substantial amount of empirical information, it becomes difficult to measure the study using a method like survey searcher only..
3. Strong levels of dependability on information released about the topics under study in secondary sources. There are always numerous sources available for confirming the content analysis and analysis of the already-existing data, even when conflicts regarding the empirical context may occur.

Primary Sources

1. Primary sources in data gathering process helps to gain a better understanding of the thinking of study groups like the farmers.
2. Primary data collection is expensive to adopt, because many visit were made to the various communities and States producing rice, but it is faster in gathering of reliable information/data.
3. The research topic is practical. Therefore, the use of primary sources was very necessary.

4. In respect to this study, the source data that was required to solve the hypothesis, question and objectives was obtained by means of primary and secondary source.

2.12 Population of the study

The sum of a research objective is the population. It is a count of all things or subjects that fit the description or have knowledge of the phenomenon under investigation. In this instance, the farmers and the state of their rice output. The registered rice farmers in Nigeria's Kogi State's top eight rice producing LGAs make up the study's population. The study focused on the top 8 major rice producers (with locations as shown in figure 2.1; Table 2.1) which were identified and classified by Kogi State Agricultural Development (KSAD), in conjunction with the guidelines from IPAD-International Production Assessment Division in collaboration with USDA Foreign Agricultural Service, (2022). The LGAs are Ibaji, Igalamela-Odolu, Omala, Bassa, Lokoja, Mopa-Muro, Kabba/Bunu, and Okene with the respective communities namely Ejule, Ebele, Oji-Aji, Bassa, Aiyetoro-kiri, Orokere, Out, and Onyukoko. Since 2-3 decades to date, theses these eight communities produced between 55 – 75% of the total rice produced in Kogi State.

2.13 Sampling design and sample size

The sample was chosen using a random sampling procedure. The sample covered 80 farmers which were randomly selected from the said population for this study. Every person in the population has as a chance or probability of being included in the sample procedure. The study is aimed at giving every employer and employee that has at least five years working experience in the targeted population an equal chance of being selected. Randomly, ten rice farmers each were chosen from the eight-rice producing LGAs of Kogi State in Nigeria that ranked highest in rice production from the State.

2.14 Research instrument

Survey method was adopted using questionnaire and personal interviews for the purpose of obtaining primary and secondary data. In addition, the farmlands were visited for further data collections (e.g. yields, farm size, and some environmental/biophysical variable data) and verifications of information released by the farmers gotten through the use of questionnaire (see Appendix Table 2) to the respondents in company of some native language speakers for

translation in cases where the farmer does not understand English Language. A systematic rating scale with numerous items was divided into parts corresponding to the biographical information of the subjects and the economics of rice cultivation. The 'section A' of the questionnaire was completed by the researcher, 'section B' centres on bio-data of the responding farmers which comprised of different items while 'sections C' focused on rice production variables such as cost of land acquisition, cost of labour, expenses incurred in sourcing for the non-human inputs (such as seeds, manure, agrochemicals, etc), and cost of harvesting and processing rice (See Appendix Table 2 on research questionnaires).

2.15 Measurement of variables

Economic variables

The data collected was analysed using regression model. The data was transformed where necessary and mean scores was used to analyse the data. The parametric statistical tests was also employed in finding answers to the earlier research questions. The scores for the items was solved using the following regression model formula:

$RP = B0 + B1 + B2 + B3 + B4 + B5 + U$

And,

$PL = B0 + B1 + B2 + B3 + B4 + B5 + U$

Where;

RP = Rice production (or yield)

PL = Profit and/or loss

B1 = Cost of land acquisition;

B2 = Cost of getting the seeds/seedlings;

B3 = Cost of acquiring the agrochemicals (herbicides, pesticides, manure)

B4 = Labour expenses (for cultivating, controlling weeds, pests and harvesting)

B5 = Cost of processing and marketing the rice products;

U = Error term.

Z0 = Intercept of the function,

B1 to B5 are the coefficients.

A regression model is applied to evaluate the inter-relationships between two or more parameters and determine one parameter based on the others. In regression analysis, variables or indicators may be independent, used as the predictor or causal input, and dependent, used

as the variables or indicators of the answer. In experimental research, independent parameter X is the variable that can be regulated whereas, parameter or variable Y is the variable/indicator that shows the transitions in the independent element/indicator X. The level of significance is 5% (0.05).

2.16 Method of data analysis

The data was obtained by administering the instrument on participants in the study through the visit. The researching student and her-helping team created good rapport and enabling ground for the rice farmers to see the need for the study, thus, promoting the motivation to complete and return all the copies of the responded questions. Identified mistakes and data gaps were also rectified as soon as possible. Once editing is done the data was analyzed qualitatively and quantitatively using IBM SPSS 29.0. Regression analysis, frequency distribution, and mean scores are some of the quantitative data analysis techniques that were used to test the hypotheses and figure out what percentage of respondents selected each type of response. This process was carried out for each group of objects connected to the research questions. Furthermore, geospatial analysis was also applied to map the locations for the sampling, and this was be done using ArcGIS 10.5. On the other hand, Canoco 5.0 software was used to show the information and support the analysis on the variability in rice production among the different sites investigated.

3 Literature Review

3.1 Rice cultivation and production in Nigeria

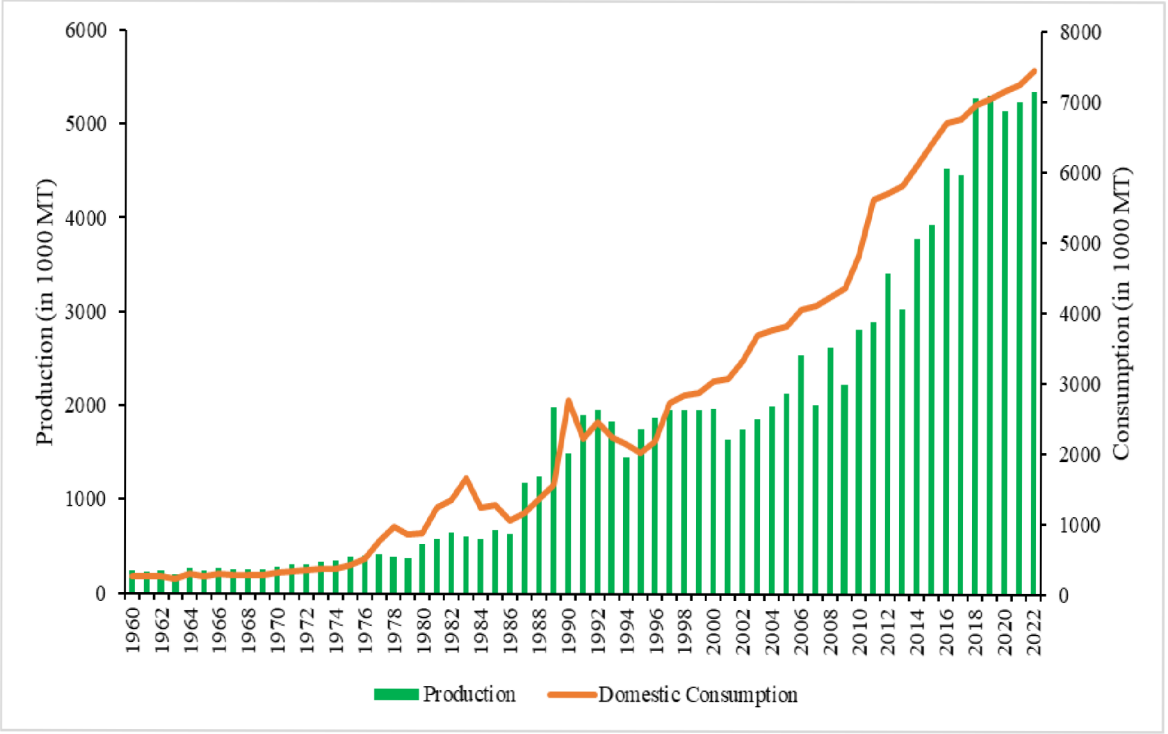
Rice is one of the key staple food crops that is consumed across all States and geopolitical zones of Nigeria. The need for rice in Nigeria has been increasing and the growing demand was partially due to change in population, shift in households' earning and financial status, increase in urban development, as well as the related changes in work status (Mohammed et al. 2023; Ekundayo 2023). Some authors have reported an high increase in the per capita annual rice consumption level in Nigeria in the recent years (Akano et al. 2023). In respect to the continuous increasing demand for rice throughout the country, the commodity has recently become a cash crop, particularly in regions where the crop is grown. The operations associated with food and rice productions contribute significantly to the creation of job opportunities and increase in economic development in the dominant areas in Nigeria (Ekundayo 2023). Nigeria has become one of the rice importing countries, and in 2012, the country imported at least 2.8 million metric tonnes of rice grains, a value which geometrically increased from the 2007 total imports of about 1.7 million metric tonnes (FAO, 2013). Rice production and the cultivated area in the country have increased rapidly since the past 5-6 decades (Graph3.1 and Graph 3.2).

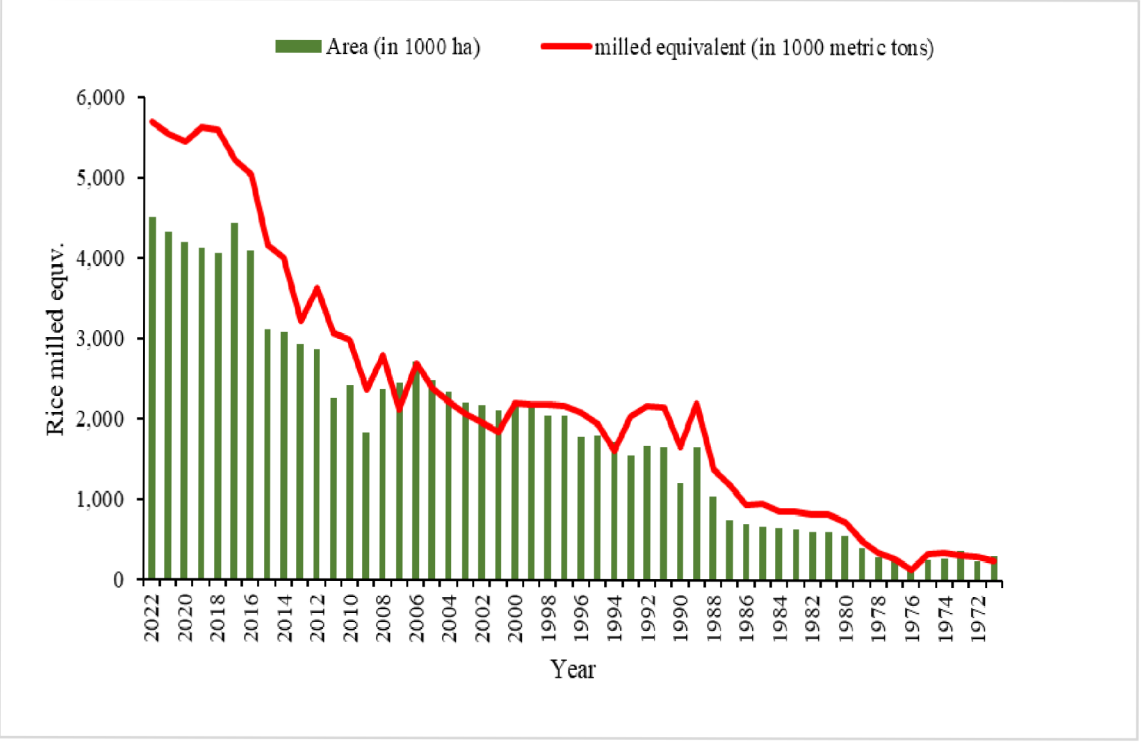
3.2 Consumption

A part from the growth in rice production which Nigeria has become popular for, the country is also famous as one of the top rice consumption country (Graph 3.1).

The country's consumption rate has increased from 240,000 MT in 1960 to 7540,000 MT in 2022. This has a lot to reveal about the rate of population growth in the country since the past 4-6 decades.

Graph 3.1. Trends of rice production (in metric tonnes) in Nigeria since independence year (1960) to 2022. [Source: Index Mundi, 2022]





Graph 3.2. Nigeria rice production showing cultivated area paddy milled rice equivalent from 1971-2022. (Source: FAOSTAT 2022).

In both the dry and wet seasons, Nigeria has good potential to produce rice. Though, these potential for rice production in the country have been largely truncated by various factors. Many authors including Ujoh et al (2019), Mahmood et al. (2012), Adamgbe and Ujoh (2013), Ujoh (2013) have reported that the decrease in crops production especially rice in Nigeria is explained by various factors namely, climate change and variability, over-exploitation of land resources caused by population growth and rapid decrease in farms, communal crises and farmers-herdsmen conflicts, and lack of manure. In Nigeria especially, Kogi States, rice production is commonly practiced by peasant farmers who grow rice in small land areas by applying the conventional techniques of cultivation; grain yields per hectare are very poor and leading to huge gap in demand and supply (Ohen and Ajah 2015; Bello et al. 2021). The importance of labour and its cost in rice production can never be overemphasized. For instance, Onubogu (2023) revealed that the growth of agricultural development in Nigeria is highly linked with availability of labour especially, male labour which tends to dominate and suppress that of the females. Resource use efficiency might be in form of technical, economic, or allocative. For example, the economic and allocative efficiency deal with a strong link between the input and output, while technical efficiency leans on the maximum potentials on the part of the management. Though many methods have been employed the assessment of the resource use efficiency yet, the most popular among them is the stochastic frontier production function (SFPF) which involves crop diversification (Celestina et al. 2023). Several studies have recently indicated that the FSPF method is universally accepted as a most effective system than the others (Pendharkar 2023; Al-gresey et al. 2023; Hou et al. 2023). Considering efficiency in production is a vital key, and it is defined by the farmer's potential and production output curve to stand on the frontier, whereas being below the frontier signifies technical inefficiency in production (Okoruwa, Ogundele, 2008). On the other hand, economic efficiency cannot be a stand-alone strategy; rather, it flourishes when both technological and allocative efficiencies are combined (Ogundari, Ojo, 2006; Kalirajan, Shand, 1999).

3.3 Research and developmental trends in rice production in Nigeria

3.3.1 Plant breeding

In the last 2-3 decades, the breeding of rice in Africa has seen huge transition with the goal of tackling two key challenges threatening rice and other cereal productions. Among the problems are environmental change and rice specific challenge such as choice of species, pests, diseases, and yield varieties (Iqbal, et al. 2023). History has it that the rice breeders have been working hard to improve Oryza sativa to ameliorate field production problems. Often, seed genes that ought to be applied in other species are being redirected to handle certain threats in prevailing in the O. sativa species. The new paradigm is on promoting, enhancing and improving the African rice species with Oryza glaberima and Oryza bithii in particular. Following the discovery of NERICAs which contains just about 13% rate of genes from O. glaberrima, the innovation has been to increase the gene status to more than 30% from the African rice species (Oryza glaberima and Oryza bithii). The hardworking breeders are addressing this by applying the crossing African rice species directly with interspecifics such as NERICAs. The researchers in Nigeria have also been employing the interspecifics, and have launched two O. glaberrima varieties (TOG 6542 and TOG 7442) through their efforts. At the moment, TOG 6542 and TOG 7442 varieties have been cultivated though they are confronted by some pitfalls and setback such as being too tall heights and with little grain yields (Demeke et al. 2023).

At the moment the initiation and motive are focused on employing essential and necessary materials to improve O. sativa elite lines. For instance, the FARO 52 and BC3F3 pedigree genes were crossed with the TOG 7442 variety, which was then tested and screened for declining primary production. In order to mitigate and adapt to climate change, much attempts are put in place towards breeding of varieties that are highly resilient to the recent environmental challenges including drought, flood and nutrient deficiencies (Amoo et al. 2022). The release of rice varieties that are more resilience to environmental changes such as climate change has been pioneered and sponsored by many institutes and organizations namely; Generation challenge Programme, Africa Agricultural Technology Foundation and others by the applications of Molecular biology and genetically modified crop systems.

3.3.2 Hybrid rice technology

Historically, Nigerian rice farmers and stakeholders have not been known for hybrid rice technology, but there has been recent developments in this direction. Currently, there are some research institutes and universities in Nigeria that a giving their attention to improving rice production through hybridization technologies. For instance the IITA in Ibadan, and National Cereals Research Institute (NCRI). The release of million dollars by the Bill Gate and Malinda Gate project under the Chinese Academy of Sciences theme called "Green Super Rice Project" is important for this development. The assistant, aid and funding through this project, IITA and NCRI has screened, examined and extracted about 95 Chinese hybrid rice varieties since the last 2 decades. This project has the vision of commercializing hybrid rice seed production, increasing rice production and marketing in Nigeria (Bello et al. 2021). In addition to the Green Super Rice Project, the joint efforts of the Nigerian researchers and West Africa Seed Alliance (WASA) has helped in the assessment and inculcation of India hybrid rice varieties in Nigeria. This has the objective which is in line with that of NCRI by evaluating 12 hybrid rice varieties since 2009. In 2006, WASA founded an Agricultural outfit in some States in Northern Nigeria with their name called 'West Africa Agricultural Company of Nigeria (WACON)'. Since the establishment WACON has acquired about 25600 ha of agricultural land across Nigeria and has cultivated about 400 to 500 ha of rice in the land with improved varieties. They have begun to test some hybrid rice varieties brought into Nigeria from some Asian countries such as Philippines. In addition, these funding research institutes in collaboration with Nigerian plant variety protection (PVP) Act have been working hard to improve rice production and secure the resources (Ngozi and Ikemefuna 2023).

3.4 Geographical settings and practices

Before now most Nigerian farmers have been used to cultivating the paddy under rain-fed systems, making it uncommon to see much of irrigated rice farmland, but the introduction of irrigation is gradually becoming adopted especially with the climate

change (Ugalahi et al. 2016; Opata et al. 2019). Nigeria is a large country in landmass and population, therefore there are large areas and opportunities to explore more landscapes to increase rice cultivation. For instance, the possibilities for intensification are found in the uplands, lowlands, deep waters, irrigatable fields, and mangrove ecosystems across Nigeria especially in the larger States such as Kogi, Niger, Cross-river, Kaduna and Adamawa (Table 3.1).

Table 3.1 Geography and ecological characteristics of rice cultivation in Nigeria

Production ecological system	**Major states covered**	**Estimated share of National rice area (%)**	**Average yield (Ton/ha)**	**Share of rice production (%)**
Rain-fed Lowland (Figure 1.3a)	Kogi, Adamawa, Ondo, Ebonyi, Ekiti, Delta, Edo, Rivers, Bayelsa, Cross River, Akwa Ibon, Lagos, all Major river valleys, e.g shallow swamps, of Niger basin, Kaduna basin, and inland of Abakaliki and Ogoja areas	45-50	2.2	43
Rain-fed Upland (Figure 1.3b)	Ogun, Ondo, Abia, Imo, Osun, Ekiti, Oyo, Edo, Delta, Niger, Kwara, Kogi, Sokoto, Kebbi, Kaduna, FCT and Benue States	30-35	1.9	28
Irrigated (Figure 1.3c)	Adamawa, Niger, Sokoto, Kebbi, Borno, Benue, Kogi, Adamawa, Enugu, Ebonyi and Cross River, Kano, Lagos, Kwara, Akwa Ibom, Ogun State	15-16	3.7	29
Shallow swamp/ Mangrove (Figure 1.3d)	Ondo, Delta, Edo, Rivers, Bayelsa, Cross River, Akwa Ibom, Lagos	< 1	2	1

Source: Adapted and modified from Maji et al. 2007; FMARD 2011; Onyeneke 2017

The potential areas for rice cultivation in the upland areas represents 30-35% of the paddy fields, rain-fed lowland (45-50%), irrigated rice field (15-16%), deep waters (8-10%), and the mangrove ecosystems of the south (0.3-1%) (Maji et al. 2007; FMARD 2011; Onyeneke 2017).

Figure 3.1 showing some ecological conditions of the rice farms (a) Rain-fed Lowland field, (b) Rain-fed Upland field, (c) Irrigated field (d) Shallow swamp field.

Though, the rapid change in climate variability caused by global warming has resulted to poor rice grain yields from the upland areas due to severe drought, hence, farmers give preference to the valleys in the East, West and Southern Nigeria. This trend has persisted for long thereby leading to low production since the upland areas of the northern Nigeria are minimally cultivated because of climate change. Great relief came to the farmers in the north

and in the upland areas with the discovery of the rapid-growing and early maturing varieties called FAROs 45 and FAROs 46 by the FAROs and IITA Research institute. The farmers in the northern and highland States such as Kebbi, Kano, Bauchi, Kaduna, Yobe, Zamfara and others are presently migrating rice cultivation to the upland areas. In the southern Nigeria especially in the States such as Rivers, Bayelsa, Akwa-Ibom, Lagos, and Delta States, the mangrove ecosystems remain highly underexploited with less than

1% of available mangrove area utilized for rice cultivation (Alagbo et al 2022). This could be attributed to the high rate of mineral exploration and exploitation activities in this southern region which have either diverted the peoples' attention from agriculture or have been negatively impacting the agricultural lands.

3.5 Socio-economics

In addition to biophysical and anthropogenic resource constraints, rice production in Nigeria and other African countries is grossly affected by socioeconomic and policy constraints. These include the unfavourable input and output marketing policies common at the national level. This to a large extent affect the poor farmers since low production prices coupled with increasing input costs significantly pose threat to profit maximization. Moreso, intensive act and system of competitiveness among the peasant rural farmers who has small-scaled rice fields in local, state, and international markets is a severe challenge to rice production in the region. In terms of credit facilities and financial grants, the local farmers suffer massively because the resources are either not available or difficult to be accessed. The rate of infrastructural development in the region is devastating as there are no feeder roads nor communication networks to exchange information and products between the farmers and the traders or consumers. Thus, the middlemen who manage to reach the farmers often devalue the prices of rice grains to their advantages. They tend to fix their prices as they wish without considering if the farmers make any gains or not. This unsatisfactory price rate portrays the inefficient marketing systems in developing countries including Nigeria. The establishment of efficient trading systems calls for genuine and reliably sincere trust among the producing rural farmers, the local traders and the urban merchants. This is because undesirable attitudes, such as swindling on product quality, late and inadequate delivery, might possibly arise in any business transactions. To ameliorate such unfavourable and questionable scenario, true trust needs to be built over time following regular business transactions. There are certain requirements necessary for full actualization of such fertile and friendly business environment. These are (i) the ability to enhance rural infrastructure including the communication and transportation network systems and, (ii)

the provision of fertilizer-responsive-improved varieties and efficient technologies that promote the benefits of long periods of transactions between producers, traders and final consumers. Though the possibility of such development occurring in SSA or if such development will be threatened by some challenges in the region are yet unknown. Therefore, collaborative research between social scientists and researchers engaged in the development of new rice technologies is highly required.

3.6 Impacts of anthropogenic resource and implications on rice production

Anthropogenic resource has been known as one of the factors impacting rice production in most developing countries including Nigeria. Agricultural Extension Services have been identified as vital in ameliorating the shortages and poor resource-use management in most developing countries, where smallholder farmers are highly deprivileged and extensively prone to technical inefficiencies in crop production (Djuraeva et al. 2023; Sachs and McArthur, 2005). It is also important to state that among the countries of the world, the countries in sub-Saharan Africa seem to be most affected by poor human-enriched knowledge and innovation in agriculture. Indeed, this is a critical challenge because African countries especially Nigeria needs strong information from research and development to increase production by overcoming the risks associated with sustainable agriculture by applying the newest technologies. The development of new profitable technologies will usher in the call for professionals in the field of extension services whose services will be in high need. Before then, there would be a capacity development trainings for the existing or interested extension workers as this will equip them with the accurate information and knowledge to be disseminated to the local farmers. It is also of paramount o mention here that high illiteracy rate among the rural farmers is worrisome. This is challenging because the more enlightened the farmers, the more interested they are to embrace new technologies. However, over the time, there might not be any need for the education, but at the initial stage of development, such skills are necessary to familiarize individuals with the latest agricultural innovation and technologies. In Nigeria, where there has been a great gap between farmers' and extension services due to illiteracy, Education is of utmost important to reach efficiency in rice production especially with the rapidly growing population and changing climate. Besides, the

farmers and the agricultural extension workers, with time the new technologies will improve and increase the stakeholders' awareness in more remote scientific discoveries that will be incorporated into the educational curriculum of the basic educational systems. With this, the new technologies will become part and parcel of the nation's living. Further, there are many other human resource-related limitations such as: flexible or non-existent research-extension-farmer linkage, poor or zero farmers' organizational bodies, and dearth of public–private partnership programs. Others are; decrease in the availability of manpower because of imbalanced diet and/or serious life-threatening ailments and diseases such as COVID-19, HIV/AIDS, cholera, tuberculosis, malaria, hepatises, bilharzia, and others.

3.7 Land and labour

The advent of the modern agriculture has extended the components of production to include land, labour, capital, and technology and information. These factors are indispensable in any production sector especially agriculture. Land is however known as the free gift of nature, yet it is a resource that is fixed in economic terms. The rapid increase in the human population especially Nigeria has led to over utilization of land for settlements, infrastructural developments and agriculture. The availability of land continues to decline daily in Nigeria. Rice farming cannot strive except if there are enough land for the cultivation of the paddy. There has been exacerbating pressure on earth's carrying capacity and land degradation including inadequacy and soil infertility are becoming worrisome (Akerele 2015; Ranganathan et al. 2022; Ray and Bhattacharyya 2016; Zhen and Du 2017; Ecker 2018; Yin et al. 2020). Shortage of land for agricultural activities due to population growth, climate change, and developmental infrastructures have led to increasing cases of land tenure system in in Nigeria especially in Kogi State. Land tenure system is a multi-complex social-cultural institution which guides the inter and intra-relationships among humans in terms of assets to land and its resources including water bodies and forests (Ashley 2016). Land tenure is a system that is characterised with either legal or customary backgrounds and dictates, or both. Ownership and/or access to land for the rural people in Nigeria including Kogi State is mostly dependent on tradition than title deed. The land tenure system governs the use of land, regulates the land control and transfer rights. It clearly defines the right owner of a

land whether a family, community, individual, or government. It also instructs with well documented information on whether that parcel of land can be shifted through inheritance to future generations including children or spouses of those who currently use it. Land tenure system further expatiates the rights of individuals or families to generate money from the land through agricultural purposes, constructing on it, leasing or selling it to second or third persons. It also clarifies who has the legal obligation to instruct that someone or groups do not possess the rights to utilize a given parcel of land. Kogi State and many other States in Nigeria have been recording many cases of tribal and family crises because of ownership of land disputes (Lewis 2023).

In addition, given that land is currently in short supply, the amount of land needed to produce food depends on the type of food to be grown, the amount to be consumed, the size of the population that will consume it, and the yield per hectare. (Gerbens-Leenes and Nonhebel 2005; Alexander et al. 2016; Gerbens-Leenes et al. 2002). This is because some food or cash crops require more land areas than the others. Land requirements for agricultural productions have been investigated using models and experiments at global, regional, national and local scales (Wirsenius et all. 2010; Kastner et all. 2012; Zhen et al. 2010; Das and Nonhebel 2019; Kastner and Nonhebel 2010; Hoff and De Boer 2020). These authors strongly affirmed that our food preferences to a large extent influence the size of land utilized for agriculture.

Labour is another essential factor of agriculture as a production system. Many authors have affirmed the potential of labour in agriculture and other production systems (Gao et al. 2020; Khamis et al. 2021; Vasyl'yeva and Karpenko 2021). To effectively execute any agricultural activities, human or animal labour or both are required. Labour is needed to clear the field before cultivation, level the land and plough or till the soil, sow the seeds, control weeds and pests, irrigate, harvest and perform the post-harvest operations. In fact, there is no phase or stage of the agricultural systems that labour is not essential. However, the advent of agricultural technologies has substantially reduced the need for human and animal labour forces, yet the modern technological devices are driven by people. It is also crucial to remember that developing nations like Nigeria, where the majority of farmers are impoverished and unable to buy modern agricultural methods, nevertheless have a significant demand for both human and animal labour. Labour has recently become a challenge for the rice farmers in Nigerian States including Kogi State.

This is because most of the youths who made up the working population prefer white-collar jobs or internet businesses to working in the rice fields. Thus, there have been rise in rural-urban drift in the country leading to decline in the available human force to work in the agricultural sectors located in the rural areas. Recently the rural rice farmers are complaining bitterly about the exorbitant rate they now paid to hire workers in the rice farms due to shortage of the labour forces. The roles of labor and its cost in rice production can never be under-estimated.

3.8 Seeds and seedlings

Seeds and seedlings are indispensable in rice production as well as in any other agricultural productions. The success of any farm production to a large extent depends on the quantity and quality of seeds input (Sharma et al. 2015). Healthy and high yielding varieties of seeds will probably produce healthy and substantial quantity grains while poor and low yielding varieties will also bring forth their kinds, all other factors being equal. For instance, rice production in Nigeria between 1960s and 1970s were pretty low because of the quality of seedlings sown. The recent discoveries in improved paddy varieties through cross-breeding, hybridization, and genetically modifications of genes, rice species and varieties with high yielding have been released. These have definitely enhanced food security in the country and globally. The kinds of seeds and seedlings applied in the farm also have potential to develop resilience and resistance to either environmental changes and pests and diseases. In Nigeria for instance, the release of the FARO 52- FARO 55 of WARDA has contributed immensely in the production of higher rice grains when compared with the FARO-1 and FARO-2 of NERICA-1. Besides applying healthy and high yielding seeds and seedlings, treatments of seeds are also important commitment to ensuring that the seeds are fit to be cultivated. Seeds and seedlings treatments could be defined as the application of particular physical, chemical or biological substances to the seed before sowing as to ameliorate, control or repel pests, fungi, pathogens, insects and diseases attacks on the seeds, seedlings or growing plants (Sharma et al. 2015). Seeds and seedlings treatments ranged from a basic dressing to coating and pelleting, and has been proved to be very helpful in agricultural productions.

3.9 Agrochemicals: manure/fertilizers, weeds and pests management

Agrochemicals (also known as agricultural chemicals and/or agrichemicals) could be described as the different chemical products that are applied in agriculture and food production systems. In most scenarios, the concept agrochemical points to a wide list of pesticide chemicals, such as insecticide chemicals, herbicide chemicals, fungicide chemicals, nematicides chemicals, synthetic fertilizers, hormones chemicals, with other chemical growth promoters, in addition to concentrated stocks of uncooked animal dung (Speight et al. 2017). Studies have revealed the importance of these agrochemicals in controlling and managing the enemies of the farmers as well as increasing food productions including rice grains (Singh et al. 2020; Mishra et al. 2020; Singh et al. 2021; Onyeneke 2017; Bhandari 2014). In Nepal for example, different agrochemicals including fungicide products were examined as foliar sprays for the suppression. Most of the applied agrochemicals substantially reduced the diseases and increased the grain yield (Bhandari 2014).

Though, agrochemicals have been reported to have good potential in improving rice yield by controlling the enemies and pests of the crop, but the adverse effects of the agrochemicals in the farms must not be ignored. Many studies in Nigeria and outside have demonstrated the negative impacts of some agrochemicals on the crops, soil and on humans and animals that consume products for such fields (Meena et al. 2020; Mandal et al. 2020; Kosemani and Bamgboye 2020; Oseghale et al. 2019). The agrochemicals including pesticides were adopted in agriculture for various aims such as increasing the crops yield and quality. But, their usage when applied without regulations poses toxicological and ecotoxicological threats. Thus a careful and moderation use have been encouraged to be established between the merits of using agrochemicals and their presence in food products and the environment (Devi et al. 2022).

The most hazardous chemicals are gradually being replaced by the recent development of natural-based agrochemicals. (Singh et al. 2020). Though these natural-product based agrochemicals are of more benefit than the inorganic ones, yet they are not available to the peasant and poor farmers in most developing countries including Nigeria.

3.10 Modern systems of rice production

3.10.1 Cultivation phase

Recently many practices have been adopted in rice cultivation including direct sowing of rice, alternate wetting and drying, regular irrigation yet the production was low, though not discouraging. The most significant obstacles to future rice production, however, include the land tenure system, a lack of labor, particularly in rural areas where rice is grown, diminishing land, and decreasing water supplies, as well as the cost of inputs for most rural farmers. In contrast to the development of a comprehensive package that may turn rice production into a very successful industry, especially in tropical poor nations like Nigeria, research and development operations in rice have frequently concentrated on new varietal improvement. Although high-yielding cultivars and new crop management techniques have helped to enhance overall rice grain production, there is still a significant disparity between farmers' potential yields and actual yields and between their maximum profit margins and returns. As a result, improving rice yield continues to be a major problem for governments and scholars in all countries that grow rice, notably in Nigeria, Africa, and other developing nations. It is imperative to embrace some contemporary production techniques if Nigeria and the majority of African nations are to increase their rice productivity. One highly profitable approach that has increased rice production in most nations is the approach of Rice Intensification (SRI). (Devi and Ponnarasi 2009). It is a unique method of cultivating rice using a whole package of sustainable practices that uses less seed, water, chemical fertilizers, and pesticides to increase rice yield. The SRI system of rice intensification was first used in Madagascar in 1999, and it has since spread quickly to many other nations with impressive results. This approach has the ability to enhance rice yields quickly without requiring additional seeds, chemical fertilizers, or other outside inputs, which is the main driver of its rapid growth. Poor farmers can affordably access the SRI, which sustainably uses limited resources including land, labor, capital, and water while protecting the soil and groundwater from chemical toxicity. It is quickly growing because it is adaptable and can more than triple farmers' net revenue. The SRI has been used in the Indian state of Tamil Nadu because it is particularly adapted to the regional circumstances in the Cauvery delta. It is impossible to compare the incredible performance of these

developing technologies and their prospective advantages over the technologies and systems now in use for the production of rice. For instance, researchers found that SRI had greater net returns (330.32 US dollars) when compared to the conventional systems in the Tamil Nadu region of India. (550.23 US Dollar) (Devi and Ponnarasi 2009). The authors also demonstrated that in addition to the net returns, the gross returns in SRI (595.17 US dollars) were also higher than in the conventional system. (494.25 US Dollar). In terms of the production cost, the SRI recorded lower than the traditional systems per tonne (48.15 US Dollar) relative to the conventional practice (90.54 US Dollar) of rice production. It might be thought that the production cost was twice its known rate in the conventional method of paddy cultivation, because the produced grains of rice were relatively less in this method. The researchers further demonstrated that the benefit-cost ratio recorded was at edge in SRI (2.25) when compared with the conventional system (1.56).

3.10.2 Harvesting and post-harvesting phase

At this phase rice production activities became more intensive in special skills requirements. The use of modern technologies in harvesting and processing such as de-stoning, parboiling, milling, winnowing, destining, bagging and marketing is very beneficial. For example, there are many de-stoning machines used by many rice farmers in Kogi State and in Nigeria at large. Several traders and investigators have designed and constructed mechanical devices to hasten the elimination of stones, pebbles and other impurities from processed rice to meet consumers' demand for a clean and quality product (Adetola and Akindahunsi 2020; Adejuyigbe and Bolaji 2005; Simonyan et al. 2010; Adegun et al. 2012; Okunola et al. 2015). Rice de-stoning devices have been known as some of the modern technological development in rice production because they have saved lots of human time, energy, and improved rice quality. In addition to these advantages, the operation or use of these mechanical devices are also associated with some disadvantages as reported by some studies (Table 3.2). Rice production in Kogi state is dominated by the rural people of which not all the farmers can afford to buy or maintain most modern rice processing technologies such as the de-stoners. Not only in Kogi State, Nigeria but globally, especially in the developing countries, there have been loss of rice products due to lack of these harvesting and post-harvesting devices.

Table 3.2 Advantages and disadvantages of some rice processing devices such as rice de-stoning mechanical device

Machine type	Advantages	Disadvantages	References	
Rice de-stoner	Has reciprocating and vibrating sieves which are both involved in the de-stoning process.	It does not have speed adjustment mechanism and de-stoned rice is not properly clean.	Simonyan et al. 2010	
Rice de-stoner	Ease of operation and convenient to be used.	It cannot separate stones with relatively the size of rice. Only the large stones could easily be removed.	Ismail et al. 2013	
Rice de-stoner machine	Required less power to operate.	Complex working mechanism. Requires some training before use.	Olugboji and Jiya 2014	
Rice de-stoner	It has a good and efficient operating system.	De-stoning efficiency is low and takes longer time.	Gbabo et al. 2015	
Smooth Rice de-stoner machine	Excellent function in operation.	Required technical know-how and complex mechanism.	Usman et al. 2018	
Motorized Rice de-stoner machine	Effective and reliable in operation.	Calls for high operating speed by the operator to meet up.	Ojediran et al. 2019	

Source: Adapted and modified from Adetola and Akindahunsi 2020.

For example, a study in India on the post-harvest loss of rice affirmed that inadequate harvesting modern technologies let to prolonged harvesting and exacerbated rice loss by 10.3% (Kannan et al. 2015). In China, a study revealed that the loss of weight from rice caused by over-drying using traditional method was more than 2% of the total weight with an economic loss worth more than 5% (Liu et al. 2017).(Alavi et al. 2011). A study covering some African countries revealed that at least losses worth 6.4 billion USD are forfeited annually through losses from harvesting and post-harvesting of rice across the

region (Olorunfemi and Kayode 2021). In a recent study on cereal losses in developing countries, Gill and Sharma (2021) reported an estimated loss of rice in Nigeria during harvesting and post-harvesting to about 1.23 billion USD, and about 11.4% loss in Bangladesh.

In Kogi State, for example, Saliu et al. (2016) evaluated the socioeconomic controls of the adoption of improved rice technologies among the rural farmers by applying multistage random sampling method to choose a total of 120 registered local-rice producers with the Kogi State Agricultural Development Project (KSADP). The authors established that all the farmers adopted the agrochemicals though some applied them more than others. According to the study, the discrepancies in the adoption of the agrochemical technologies could be attributed to differences in income, field size, literacy rate, and awareness, and contact with the agricultural extension agents. It was further concluded that the adoption of the agrochemicals by the small-scaled farmers contributed to the increase of rice production by about 25% (Saliu et al. 2016).

3.10.3 The policy and political economy of rice production, consumption and distribution in Nigeria

There has been many agencies and policies developed by the Federal Government of Nigeria to regulate and manage the rice production, distribution and consumption sector. These policies are briefly summarized in Table 3.2 below:

Table 3.2: Government established initiatives, agencies, policies and mandates for the rice production system in Nigeria

2012	PropCom is a market-based intervention strategy. They aid initiatives aimed at generating enough high-quality local rice. It is meant to aid the poor stakeholders and compete with imported rice.
2015	The Multinational New Rice for Africa (NERICA) Rice Dissemination Project (MNRDP) was created to promote project coordination, capacity building, and knowledge transfer.
2017	In Akwa-Ibom State, the Ibom Rice Project was established to improve the practical education of local farmers in contem porary farming practices and the procedures involved in the rice production system.
2018	Embargo on the unlawful importing of rice. This enables agents who assert to be authorized by customs and government organizations to act as the only importers of rice. Although this strategy caused the price of foreign rice to be highly expensive, it was good for Nigeria's agricultural sector since it encouraged local farmers to grow rice on Nigerian soil.
2021	Some financial incentives to rice producers in the six geo-political zones of Nigeria.

Sources: Updated and modified by the researching student in 2023, after adapted from Emodi and Madukwe (2008) and Okonkwo et al. (2021).

Most of these moves by the government and the agricultural partners tend to overlook agricultural incentives to the farmers and ban on foreign rice importations. Thus, since the inception of the Nigeria as a sovereign country, rice production has always been negatively affected by the two most factors: incentives and importation of rice. It was a good development by the present administration in Nigeria to adopt policies that have helped to improve rice production in the country especially the 2018 policy. Though there are still many loopholes in the policy and these have not allowed the full actualization of the goal. More is needed to comb the activities of the cabals and profit maximization individuals you are still involved in rice importation and crippling the efforts of the government in promoting local productions.

4 Practical Part

4.1 Interviewed rice farmers number, percentages, and characteristics/description.

A total of eighty (80) rice farmers who have varied in educational qualifications, age, gender, and economic status were interviewed during the field sampling in Kogi State, Nigeria (Table 4.1).

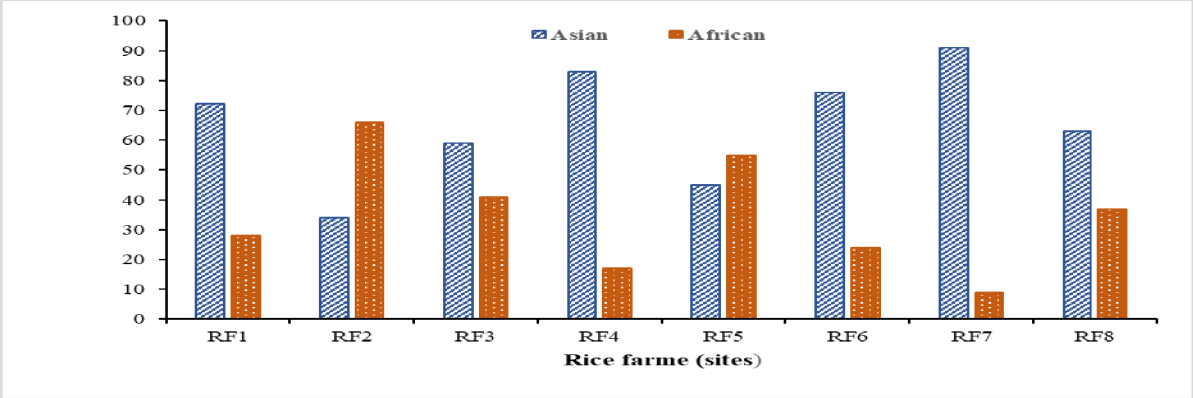
Table 4.1. Summary of the interviewed farmers characteristics

Gender	Number of respondents	%
Male	48	60
female	32	40
Total	80	100
Educational		
no formal education	4	5
primary	38	47.5
secondary	32	40
tertiary education	6	7.5
Total	80	100
Marital status		
Married	8	10
single	42	52.5
Divorced/divorcees	24	30
widow/widower	6	7.5
Total	80	100
Family position		
Head	52	65
Member/labourer	28	35
Total	80	100
Farm ownership		
Yes	60	75
No	20	25
Total	80	100
Age		
31 to 50	50	62.5
51 to 80	20	25
18 to 30	10	12.5
Total	80	100

The interview involved 48 male farmers which was 60% of the total sampled farmers, and 32 female (40%). Most of the farmers were between 31 to 50 years old (62.5%), followed by those whose ages ranged from 51-80 who accounted for 25% of the total respondents. Only 12.5% of the youths (18-30 years) were observed among the farmers interviewed. In terms of the educational qualifications, farmers who have primary education 38 (47.5%) and secondary education 32 (40%) accounted for the highest number of the interviewed rice farmers in the study area. Only 4 (5%) and 6 (7.5%) of the farmers have no formal schooling and tertiary education respectively. The marital status of the farmers also varied, and married farmers 42 (52.5%) recorded the highest number of farmers. There are 24 (30%) divorced farmers, single farmers 8 (10%), and widows/widowers 6 (7.5%). It was further found that higher number/percentage of interviewed farmers were family heads (65%) while 28 (35%) were either family members or laborers. Furthermore, 60 farmers (75%) were identified as the owners of the rice farms whereas, 20 (25%) were not the owners.

4.2 Specific variations in rice farm sites

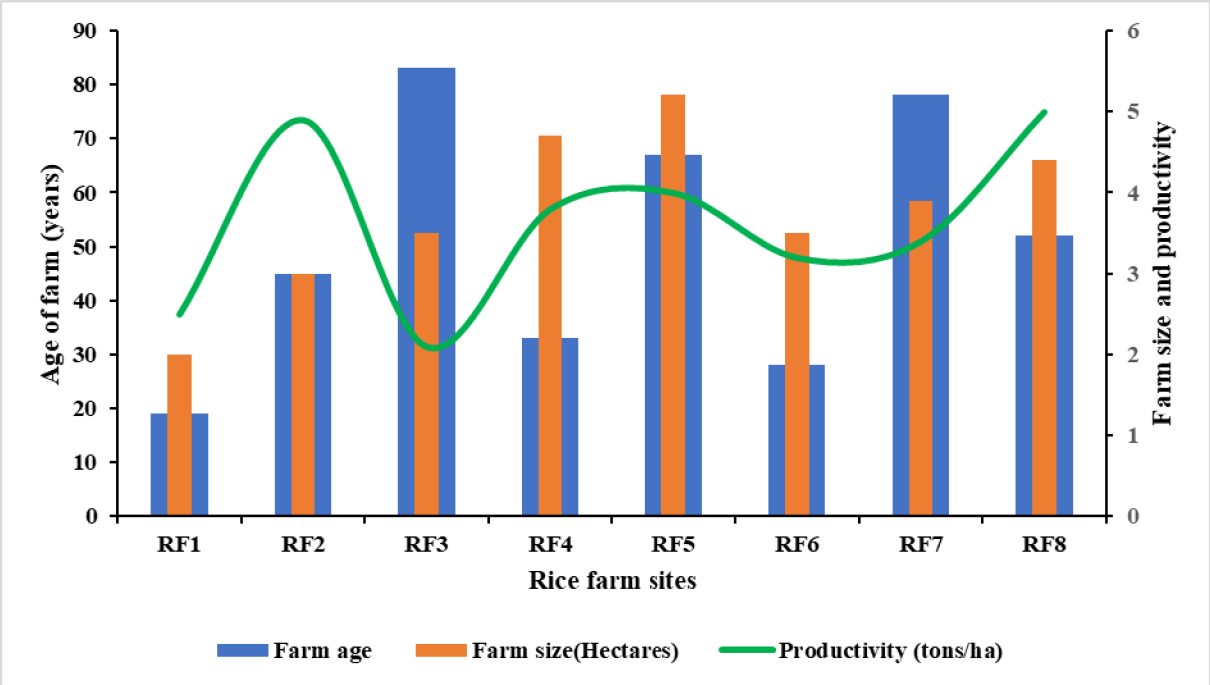
The rice farm sites differ in their adoption or cultivation of the two major rice species (Graph. 4.1). For example, RF7 recorded 91% area coverage for Asian species and only 9% area for the African species, while RF4 had 83% for Asian and 17% for African species. Others are RF1 (72% and 28%), RF2 (34% and 66%), RF3 (59% and 41%), RF5 (45% and 55%), RF6 (76% and 24%), and RF8 (63% and 37%) for the Asian and African species respectively. Only at two of the sites was the African species coverage higher than that of Asian. In general, Asian rice species had the highest coverage in the investigated farmlands.



Graph 4.1. Estimated percentage of common (major) rice species coverage based on site observations.

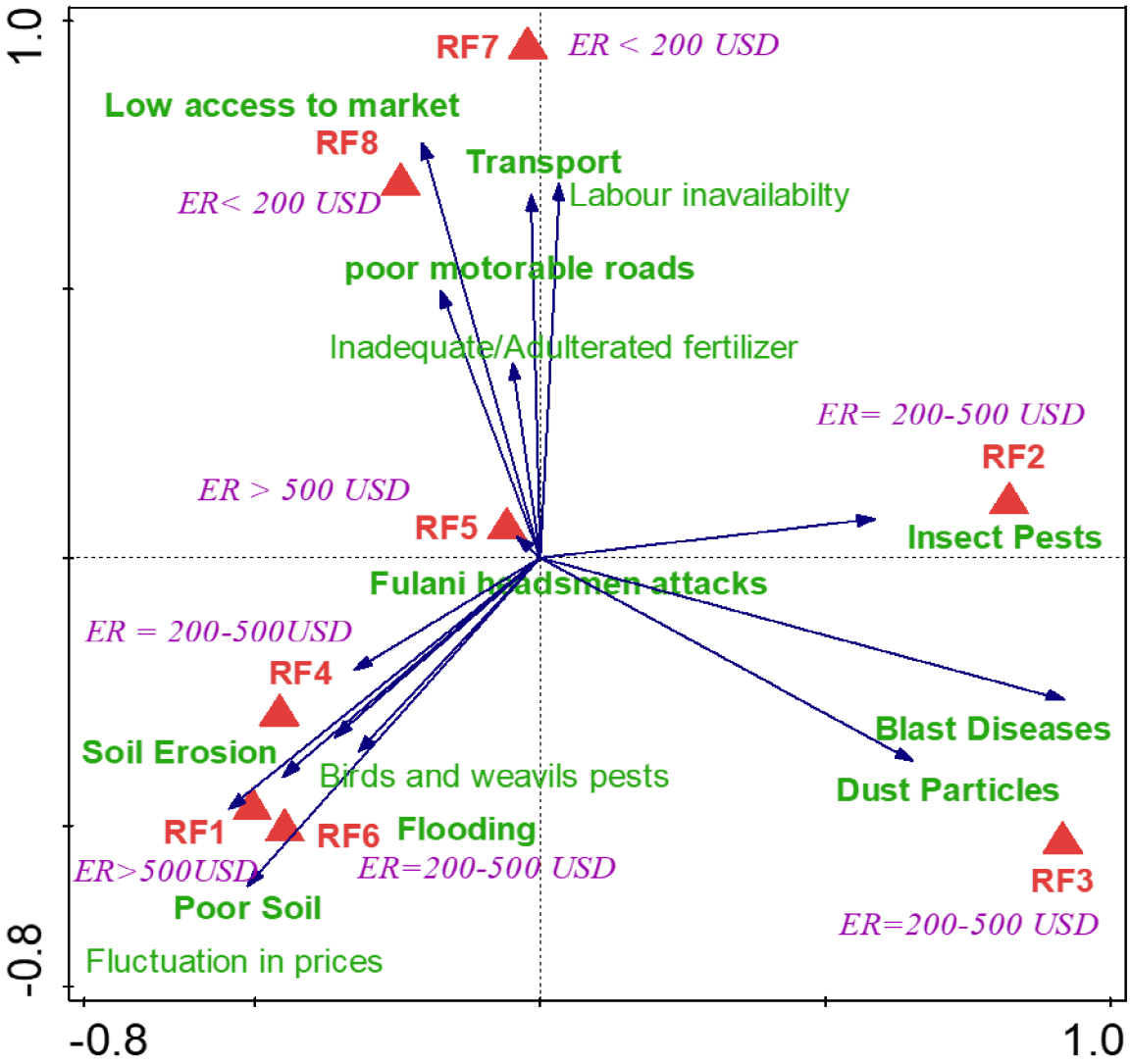
The result further highlighted the differences in the farm age, size and productivity (Graph. 4.2). RF3 was revealed as the oldest farm (83 years old) followed by RF7 (78 years), RF5 (67 years) while, RF1 was the youngest farm at 19 years old. In terms of the farm sizes, RF5 accounted for the highest hectares (5.2 ha). Others are RF4 (4.7 ha), RF8 (4.4 ha), RF7 (3.9 ha), RF6 (3.6 ha), RF3 (3.3 ha), RF2 (3.0 ha) and RF1 (2.0 ha). Productivity in the most recent growing season was established in RF8 which had 5.0 tons/ha. Others in ascending order were RF2 (4.9 tons/ha), RF4 (3.8 tons/ha), RF7 (3.4 tons/ha), RF6 (3.2 tons/ha) and the least was RF1 (2.1 tons/ha). It is crucial to state that there was no relationships between the farm size or age and the productivity rate.

Graph 4.2. Rice farm sites, age, size and productivity as at when the survey was conducted.



To display other important attributes associated with the rice farm sites, the multivariate Canoco software was used. It was found that the fields tend to fall into five different groups based on the measured parameters such as financial returns, and factors affecting rice production (Graph. 4.3). Farm sites RF7 and RF8 were more related while, RF1,

RF4 and RF6 have more attributes in common. The result revealed that RF7 and RF8 had the lowest economic returns (< 200 USD/ha) while, RF1 and RF5 had the highest economic returns which were above 500 USD per ha. Low market accessibility, poor motorable roads, and transport had more impacts in for the RF7 and RF8 fields, whereas RF1, RF4 and RF6 suffered more from flooding, soil erosion, and poor soil status. On the other hands, pest and diseases were more predominant at the RF2 and RF3. The impacts of Fulani headsmen attacks tend to affect all the fields.



Graph 4.3. Multivariate ordination plot showing the relationship among various variables across the farm sites. Description of abbreviations: ER = Economic returns per hectare;

USD = UAS dollars. Words in green colour showed the major factors affecting rice production at each of the fields.

4.3 Overview of the farmers' responses

The responded items were categorized into three different parts (rice cultivation, rice production and profit or loss) (Table 4.2).

Table. 4.2. Ordinal regression analysis for rice production and cultivation

Question items	Total	strongly agreed(%)	agreed (%)	undecided (%)	disagreed (%)	strongly disagreed (%)	Total
Rice cultivation (RC)							
My rice field/farm is at least 10 years old (Farm age, A1)	80	50%	42%	8%	0%	0%	100%
The size in hectare is at least 3 hectares (Farm size, A2)	80	51%	34%	8%	5%	2%	100%
Cost of presowing and precultivation such as land surveying was above 25 USD (above 11,250 Naira)/ hectare. (A3).	80	0%	0%	14%	48%	38%	100%
Cost of acquiring farmland is/was between 200 – 400 USD (90,000-180,000 Naira)/ hectare (A4).	80	33%	48%	13%	3%	5%	100%
Cost of clearing and preparing land for cultivation is/was between 30-50USD (13,000 – 22,000 Naira)/ hectare (A5).	80	30%	35%	15%	15%	5%	100%
Cost of getting seedlings and seeds is/was between 75-100 USD (33,750-45,000 Naira) / hectare (A6).	80	40%	35%	15%	5%	5%	100%
Cost of preparing and preserving seeds for sowing is/was between 15-25 USD (6,750-11,250 Naira)/ hectare (A7).	80	45%	35%	10%	10%	0%	100%

Cost of weed control is/was between 15-25 USD (6,750-11,250 Naira)/ hectare (A8).	80	55%	35%	10%	0%	0%	100%
Cost of labour for sowing is/was above 25 USD (above 11,250 Naira)/ hectare (A9).	80	0%	0%	85%	5%	10%	100%
Cost of applying pestcides and herbicides is/was above 25 USD (above 11,250 Naira)/ hectare (A10).	80	65%	35%	0%	0%	0%	100%
Cost of labour (cultivating and harvesting) is/was above 100 USD (above 45000 Naira/ hectare (A11).	80	50%	45%	5%	0%	0%	100%
Cost of post-harvesting, processing and marketing is/was above 25 USD (above 11,250 Naira) per ton (A12).	80	45%	45%	10%	0%	0%	100%

Rice production						
Grain yields are estimated at 8-10 tons/hectare (RP1)	80	0%	15%	20%	30%	35%
Straw yields are estimated at 8-10 tons/hectare (RP2)	80	0%	5%	10%	40%	45%
Husk yields are estimated at 8-10 tons/hectare (RP3)	80	0%	5%	10%	55%	30%
Sales of rice residues for livestock and manure are estimated to range from 300 – 500 USD (135,000 -225,000 Naira)/ton (RP4)	80	30%	55%	10%	5%	0%
Cost/price for selling rice grain is between 900-1100 USD (RP5)	80	15%	10%	20%	30%	25%

Cost/price for selling rice grain is between 100-200 USD (RP6)	80	0%	10%	20%	40%	30%	100%
Cost/price for selling rice grain is between 100-200 USD (RP7)	80	0%	5%	30%	40%	25%	100%
Profit or loss							
Make profit of less than 200 USD per growing season	80	5%	15%	10%	30%	40%	100%
Make profit of 200 - 500 USD per growing season	80	35%	35%	5%	15%	10%	100%
Make profit of more than 500 USD per growing season	80	10%	38%	10%	30%	13%	100%

Ninety-two percent of the farmers agreed that their farms are more than ten years old while only 8% have no idea if their farms are at least 10 years old. Most of the farmers (85%) affirmed that their farms are at least 3 hectares in size, while only 7% of the farmers have farms less than 3 hectares large. Exactly 86% of the farmers disagreed that the cost of pre-sowing and pre-cultivation such as land surveying is/was above 25 USD (above 11,250 Naira) per hectare. Eighty percent (80%) of the farmers acknowledged that the cost of acquiring the farmland is/was between 200 – 400 USD (90,000-180,000 Naira)/ hectare, while only 7% disagreed. In respect to the cost of clearing and preparing the land for cultivation, more than 65% of the farmers agreed that they spend between 30-50 USD (13,000 – 22,000 Naira)/ hectare to clear and prepare the land for sowing, whereas 20% of the farmers had contrary opinions (Table 4.2). Seeds/seedlings are important for the rice production, and 75% of the farmers concurred that the cost of getting seeds/seedlings is/was between 75-100 USD (33,750-45,000 Naira) / hectare, whereas only 10% disagreed. Ninety percent (90%) of the farmers acknowledged that they spend between 15-25 USD (6,750-11,250 Naira)/ hectare on weed control, but 10% of the farmers have zero information, and no farmer disagreed with this fact. Larger number (85%) of the farmers tend to provide vivid information about cost of labour for sowing when 15% disagreed. All the farmers agreed that the cost of applying pesticides and herbicides per hectare is above 25 USD (above 11,250 Naira)/ hectare, and that the cost of labour for cultivating and harvesting is above 100 USD (above 45000 Naira)/ hectare. One of the most important criteria for rice production has been highlighted as

post-harvest, processing, and marketing, and 90% of the farmers confirmed that they spend more than 25 USD (above 11,250 Naira) per ton to accomplish them at any growing season.

In the case of production, at least 65% of the farmers disagreed that their yields for grain, straw and husk were 8-10 tons/hectare but 2-5 tons. On the other hand, majority (85%) of the farmers agreed that the sales of rice residues for livestock and manure are estimated to ranging from 300 – 500 USD (135,000 -225,000 Naira)/ton. In respect to the prices for selling the rice products, the opinions of the farmers differ. For example, 25% of the farmers agreed that price for selling rice grain is between 900 - 1,100 USD (400,000 - 500,000 Naira)/ton, while 55% disagreed, and 20% gave no decision.

The responded farmers were also diverse in their view about the rates of profit or loss they make (Table 4.2). For instance, 20% of the farmers agreed that they make profit of less than 200 USD per growing season whereas 70% disagreed. On the other hand, more than 65% of the respondents agreed that they make a profit of 200 – 500 USD per growing season, while about half in the number of the farmers endorsed that they make a profit of more than 500 USD per growing season. In sum, all the farmers revealed that they make profit in the rice production as no farmer disagreed.

4.4 Hypotheses

The study used both parametric and non-parametric statistical methods in analysing and testing the hypotheses. Linear regression as a parametric method was adopted when the data set met the assumptions of the normal distribution, while ordinal regression (which is a non-parametric method) was used when the data did not pass the test of normality.

Hypothesis 1:

Null hypothesis: Cost of acquiring non-human related inputs has no significant impacts on the production of rice in Kogi State, Nigeria.

Alternative hypothesis: Cost of acquiring non-human related inputs has significant impacts on the production of rice in Kogi State, Nigeria

The analysis gotten from the data revealed that the cost of acquiring agrochemicals such as pesticides and herbicides has significant impacts ($p = 0.002$) with the production of rice in the study area (Table 4.3). Therefore, the alternative hypothesis was accepted at

0.05 confidence level, while the null hypothesis was rejected. Still under the cost of acquiring non-human related inputs, other variables were incorporated and analyzed in the test using collected data. For example, the cost of acquiring seeds/seedlings showed a non-significant (p = 0.082) impact on rice production at 0.05 level of confidence. On the other hand, the cost of land acquisition indicated a significant influence on the rice production in the study area by denoting that p = 0.005 at 0.05 significant level.

Therefore, it could be concluded that two of the acquisition (agrochemicals and land acquisition) out of the three non-human related inputs had significant effects on rice production. The cost of acquiring seeds/seedlings revealed no significant impacts. The analysis also revealed that rice production significantly varied among the farmers across the rice farm sites in the local government areas.

Table 4.3. Ordinal regression analysis for rice production and cultivation

							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Rice production	[Rice Prod = 1.71]	-15.336	3.804	16.257	1	<.001	-22.791	-7.881
	[Rice Prod = 1.86]	-14.565	3.780	14.844	1	<.001	-21.974	-7.156
	[Rice Prod = 2.00]	-13.353	3.746	12.702	1	<.001	-20.696	-6.010
	[Rice Prod = 2.14]	-12.768	3.727	11.733	1	<.001	-20.073	-5.462
	[Rice Prod = 2.29]	-12.084	3.702	10.655	1	.001	-19.340	-4.828
	[Rice Prod = 2.43]	-11.875	3.694	10.333	1	.001	-19.116	-4.635
	[Rice Prod = 2.57]	-11.397	3.676	9.611	1	.002	-18.602	-4.192
	[Rice Prod = 2.71]	-10.484	3.645	8.272	1	.004	-17.628	-3.339
Rice cultivation *	RiceCult1	-.309	.348	.788	1	.005	-.992	.373
	RiceCult2	-.506	.291	3.031	1	.082	-1.076	.064
	RiceCult3	-1.817	.578	9.872	1	.002	-2.950	-.683
	RiceCult4	.094	.434	.047	1	.029	-.757	.944
	RiceCult5	-.288	.593	.237	1	.627	-1.450	.874

Link function: Logit.

*RiceCult1= cost of land acquisition; RiceCult2 = cost of acquiring the seeds/seedlings; RiceCult3 = cost of acquiring the agrochemicals; RiceCult4 = cost of labour; RiceCult5 = cost involved in postharvest, processing and marketing.

Hypothesis 2:

Null hypothesis: The cost of human labour has a significant effect on the rice production.

Alternative hypothesis: The cost of human labour does not have a significant effect on the rice production.

The findings from the analysis ascertained that the cost of human labour had a significant effect on the rice production with $p = 0.029$ at 0.05 confidence level (Table 4.3). Therefore, the null hypothesis is rejected while the alternative hypotheses was accepted that cost of labour indicated a significant effect on rice production.

Hypothesis 3:

Null hypothesis: Cost of processing, post-harvesting and marketing has significant influence on rice production.

Alternative hypothesis: Cost of processing, post-harvesting and marketing has no significant influence on rice production.

The findings from the analysis demonstrated that the cost of processing, post-harvesting and marketing had no significant effect on the rice production with $p = 0.627$ at 0.05 confidence level (Table 4.3). Therefore, the alternative hypothesis was accepted instead of the null hypothesis.

Table 4.4. Ordinal regression model on Rice cultivation and profit maximization

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Profit	[Profit = 2.00]	10.940	3.541	9.543	1	.002	3.999	17.881
	[Profit = 2.25]	11.748	3.550	10.952	1	<.001	4.790	18.705
	[Profit = 2.50]	12.722	3.582	12.611	1	<.001	5.700	19.743
	[Profit = 2.75]	13.676	3.622	14.254	1	<.001	6.576	20.775
	[Profit = 3.00]	13.804	3.628	14.481	1	<.001	6.694	20.914
	[Profit = 3.25]	14.272	3.647	15.310	1	<.001	7.123	21.421
	[Profit = 3.50]	14.863	3.672	16.380	1	<.001	7.665	22.061
	[Prpfit = 3.75]	16.587	3.741	19.656	1	<.001	9.254	23.920
	RiceCult1	.388	.338	1.318	1	<.001	-.274	1.050
	RiceCult2	.409	.288	2.018	1	.015	-.155	.972
	RiceCult3	1.341	.562	5.703	1	.017	.240	2.442
	RiceCult4	1.441	.457	9.932	1	.002	.545	2.336
	RiceCult5	-.035	.575	.004	1	.951	-1.163	1.092

Link function: Logit.

*RiceCult1= cost of land acquisition; RiceCult2 = cost of acquiring the seeds/seedlings; RiceCult3 = cost of acquiring the agrochemicals; RiceCult4 = cost of labour; RiceCult5 = cost involved in postharvest, processing and marketing.

Hypothesis 4:

Null hypothesis: There is no significant variations in rice cultivation and profit maximization among the rice farmers.

Alternative hypothesis: There is significant variations in rice cultivation and profit maximization among the rice farmers.

The study went further to test if there is no significant difference in rice cultivation and profit maximization among the rice farmers. The data did not conform to the assumption of normal distribution for this specific test., so, ordinal regression model was used. The overview of the results disclosed that all the variables under the rice cultivation supported profit maximization by showing significant variations except processing, post-harvesting and marketing which revealed the p-value of 0.951 at 0.05 confidence level (Table 4.4).

Hypothesis 5:

Null hypothesis: Farmers' economic status have no significant influence on the rice production in in Kogi State, Nigeria.

Alternative hypothesis: Farmers' economic status have significant influence on the rice production in in Kogi State, Nigeria

The linear regression model was employed when discovered that the data passed a normality distribution test when tested whether farmer's economic status have no significant influence on the rice production. The result proved that at the confidence level of 0.05, a p-value of 0.030 was significant (Table 4.5). This revealed that farmer's economic status had significant influence on the rice production. Based on the result of the test, the null hypothesis is rejected at 0.05 level of confidence, whereas the alternative hypothesis is accepted.

Table 4.5. Linear regression model on the relationships between farmers income and rice production

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	2.199	.117		18.819	<.001
	Ave monthly income	.106	.060	.197	1.771	0.030

Residuals Statistics[b]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.3050	2.5180	2.3929	.07144	80
Residual	-.59072	.55214	.00000	.35624	80
Std. Predicted Value	-1.230	1.752	.000	1.000	80
Std. Residual	-1.648	1.540	.000	.994	80

a. Dependent Variable: Rice Prod; b. Dependent Variable: Rice Prod

5 RESULT EVALUATION

5.1 Description of farmers number, percentages and characterization

In line with some past studies in the region by Nwele (2016), Babajide et al (2020) structured questionnaires were used to interviewed farmers and collect vital data in this research which involved 80 participants in the eight rice fields. The socioeconomic details of the rice farmers, such as their gender, age, level of education, marital status, family situation, income, and number of years of rice farming experience, were gathered from them. These variables were deemed important because they have direct or indirect influence in rice production (Kolawole and Michael 2021). For instance, one of the most important aspects to increase rice yield is the number of years of experience in rice farming. (Huong et al. 2018; Bello and Manan 2015). This study observed that there are 20% more male farmers than females which aligned with some other findings (Onyeneke et al. 2023; Ochieng et al. 2016; Huong et al. 2018). Many authors have affirmed that the more experienced farmers could have higher practices and skills in crops cultivation as to address the effects of some externalities such as climate change (Onyeneke et al. 2023). Gender difference has also been reported as essential in agricultural production including rice (Ochieng et al. 2016; Huong et al. 2018). Reports have revealed that the female folks tend to have lesser impacts on agricultural production systems because of many reasons including land accessibility, constraining financial services, cultural limitations, lower education and lack of strength in market competitions (FAO 2011). The study revealed that more than 90% of the farmers have at least a primary education while just 5% have no formal education. Formal educational attainment has been considered as a strong driver in crop production because it determines the farmers' intellectual ability to adopt novel technologies and innovations for increase in production (Nyuor et al. 2016). According to some other studies in the developing countries, farmers who have higher levels of schooling or who spent more years in acquiring formal educational trainings are anticipated to achieve higher outputs under changing environmental and socio-economic situations (Egbeadumah et al. 2023; Nyuor et al. 2016; Ochieng et al. 2016; Huong et al. 2018). It is also an advantage of the rice production in the study area to discover that 75% of

the farmers are owners and not just hired labourers. In most production sectors or systems, the involvement of the owners tends to yield higher results than when the owners are out of site. Beside swift remediation of any imminent challenges that might arise, the presence of the owners could motivate other workers to give in their best (Mahdu 2019).

5.2 Farmers responses and specific variations in rice farm sites

The study observed that out of the eight fields investigated, only two of the farms have higher area coverage for the African rice species (O. glaberrima) while six of the fields had large coverages for the Asian rice species (O. sativa). This could be explained by the fact that, when compared to African variety, Asian species have higher stand growth potentials, higher grain quality and yield per hectare, and non-shattering kinds. (Mohammed et al. 2019). The Asian species has undergone several genetic modifications and improvement that have enhanced the traits relative to the African species (Sikirou et all. 2015). It is also significant to highlight that the African variety possesses essential distinctive qualities that have also kept it popular among some farmers, particularly those in less favorable settings. According to Mohammed et al (2019), the unique genetically inherent traits of the African rice species such as its potential to adapt favourably to the different ecological settings of Africa is still making it a valuable crop in the region. Though it yields might be lower, yet the advantage of surviving where the Asian species might not is a great asset for the African species.
In this study, farms (RF3 and RF7) were the oldest farms but were not the farms with the highest productivity. On the other hand, RF5 and RF4 were the largest farms yet they were not the farms that produced the highest production per hectare. This might be a revelation and an affirmation that neither the age nor the size of farms has substantial roles in yields. However, the implications of farm sizes and farm age on crop production have been studied my many researchers, but there has not been a consensus agreement on whether large farms or older farms are better than smaller or new farms in terms of productivity (Wood and Mendelsohn 2014; Huong et al. 2018; Nyuor et al. 2016). Some authors are of the opinion that the larger size farms have positive impacts on the production (Huong et al. 2018; Nyuor et al. 2016), in contrast, other scholars are of the view that large farms showed negative effects on net economic returns (Sarker 2012; Closset et al. 2015).

The study further found out that the cost of acquiring farmlands is as high as 400 USD. This could be possible nowadays because of recent growth in human population which is making land a scarce commodity Nigeria and other emerging nations throughout the globe. The land is a fixed asset, cannot expand while the human needs to use it continues to increase daily, especially in rapidly population growing countries such as Nigeria (Oluwatayo et al. 2019; Ahmed and Fasilat 2020).

The cost of labour, seeds and seedlings were generally agreed by the farmers to be relatively high per hactares. The high cost of labour has become a norm in Nigeria in the recent decades because most of the youths nowadays prefer white-colar jobs and internet gambling popularly called “yahoo-yahoo boys” in Nigeria where they assume to be making higher amount of money than going to work in the farms. In addition, some authors have reported that lack of incentives and mechanization of agriculture contributed to low morale of youths in Nigeria farming systems (Adekenle et al. 2009). This has resulted in significant decline in labour force as only few youths are available to be hired by the farmers. The availability of seeds/seedlings are becoming scarce because the impacts of climate change has been devastating on the seed banks. It takes presently higher management and financial inputs to maintain a seed whether in the seed bank or in the nursery farm level. Furthermore, the cost of harvesting, postharvesting, processing and marketing of the rice products has been on a high rate of increase (Adetola and Akindahunsi 2020; Zhang et al. 2021). This is because it has been discovered that a large quantity of grains is lost during the harvesting and postharvest processes in Nigeria (Ogundele 2022), thus, serious attempts are on-going to ensure that advanced technologies are embraced to enhance food security.

Regarding profit maximization, almost all the farmers affirmed that they had profit though some higher while some low, but no farmer had a loss. This could be attributed to the fact that Nigeria is a large and growing population that needs more food to the masses. Hence, there is very high demand for staple foods such as rice because it is consumed by everyone in the State and country. Moreso, rice can be cultivated and produced with moderate energy and resources input when compared with some other crops that require more resources.

In respect to economic returns, RF7 and RF8 had lower values (ER < 200 USD), and this could be attributed to the reason that the farms are located farther from the State capital city which makes it difficult and cost-intensive to transport the products to the city where there are larger population and higher bidders. Another reason could be explained by the closeness

of the farms (RF7 and RF8) to a State called Benue which is known as Nigeria's "Food Basket". Much grain foods are produced in Benue State than any other parts of Nigeria. Therefore, any State or rice farms closer to Benue State could be suffering low competitions in prices of their produce. The RF5 and RF1 had high economic returns or more than 500 USD. This might be due to their locations which are very close to Lokoja (the Capital of the State) and Abuja (the capital of Nigeria). Thus, the rice products are sold at higher rates when compared to the other farm sites.

Though, Fulani headsmen attacks on farmers is predominant in all the fields but the other factors affecting rice production varied across the fields based on the information from the farmers (Demelu et al. 2016). Fields RF7 and RF8 suffer more of transportation and poor motorable roads because they are more located at farther areas from the city. Farmers in most rural areas in Nigeria have high challenges in the aspects of transportation (Olorunfemi 2020). Poor soil induced by soil erosion and flooding were the major factors affecting rice production in RF6, RF4 and RF1. Many authors in the region have reported the impacts of poor soils on socioeconomic activities including agricultural production (Badamosi et al. 2023). Areas prone to soil erosion and flooding suffer soil degradation as they lose their essential nutrients due to the surface washes. Other factors threatening rice production in the study area were insect pest (common in RF2), as well as the blast diseases and dust particles which are at RF3. The RF3 field have a challenge of dust particles because it is located close to untarred and dusty-motorways.

5.3 Overview of the hypotheses

The study's first hypothesis showed that the price of buying land and the cost of agrochemicals like pesticides and herbicides had a big impact on how much rice was produced in the study area. However, the price of purchasing seeds or seedlings did not reveal any effects on rice output.. This might be attributed to the high cost of lands and agrochemicals due to rapid population growth and high rate of inflation in the country. Studies by Osotimehim et al (2012) investigated many factors that are causing hike in the prices of land in Nigeria. The high cost of agrochemicals could be understood by the facts that Nigeria does not produce any agrochemical. The country depends solely of importations

from other countries in America, Europe, Oceania, and Asia. Therefore, any rise in foreign currency exchange automatically leads to inflation rates which in turn increases the prices of importing the agrochemicals (Olukunle 2013). Thus, these rises in the prices of the agrochemicals affects agricultural productions including rice.

In the second hypothesis, the findings from the analysis ascertained that the cost of human labour had a significant effect on the rice production. As earlier discussed in the initial section of this work, most of the States in Nigeria including Kogi State are facing the problems of shortage of human labour due to rural-urban migration of youths in search of higher paying jobs (Adekenle et al. 2009).

In addition, based on the third hypothesis, the findings from the analysis revealed that the cost of processing, post-harvesting and marketing had no significant effect on the rice production. Though, the result from this hypothesis was contrary to the researcher's expectations. However, one of the best reasons in support of this could be because most farmers depend on using cost effective technologies in processing and post-harvesting activities. For instance, the use of the energy from the sun in drying the rice grains instead of the sophisticated and highly expensive tools. The fourth hypothesis confirmed that there were variations in rice cultivation and profit maximization among the rice farmers. This is expected because of the locations of the different farmlands: some closer to the cities with high population and high demand for rice, while other in very remote areas where demand in relatively low.

The fifth and last hypothesis revealed that farmers' economic status had significant influence on the rice production. Many other studies have reports that are consistent with these findings that the economic status of farmers to a large extent influence their productivity rate (Bolarinwa and Fakoya 2011; Croppenstedt and Muller 2000). According to the study in Ogun State by Bolarinwa and Fakoya (2011), dwindling farmers productivity was recorded by many farmers due to lack of capital to increase their farm inputs. Farmer's economic status could also have direct or indirect impacts of the productivity because when a farmer is not rich enough to feed well or take good medical treatments, these could affect his health and limit his/her activities in the farm (Croppenstedt and Muller 2000).

CONCLUSION AND RECOMMENDATIONS

5.4 CONCLUSION

Most of the farmers are married men of ages 31-50 who formal primary and secondary educations. Though the rice farm sites differ in their adoption or cultivation of the two major rice species yet, the Asian rice species had the highest coverage in the investigated farmlands. Only two of the farms have higher area coverage for the African rice species (O. glaberrima) while six of the fields had large coverages for the Asian rice species (O. sativa) because the Asian species have potentials for high stand growth, high grain quality and production per hectare, and non-shattering varieties when compared with the African varieties. However, the study established that variation was found between the farm age, size and productivity among the farmers, but neither the farm age nor the size of farms has substantial influence on the rice production. The is high cost of acquiring farm lands, agrochemicals and labor when compared to other farm inputs such as drying/processing inputs. All the farmers agreed that they make profit though some farmers' profit exceed those of their counterparts, but no farmer had a loss during the growing season(s). Farmlands that are closer to the capital cities have higher profit maximization when compared with those in the remote areas because of market accessibility and demand. All the farmers have the challenges of Fulani headsmen attacks which is affecting the total time they spend in the farms vis-a-vis their production.

The first hypothesis of the study affirmed that the cost of acquiring land and agrochemicals such as pesticides and herbicides had significant impacts on the production of rice, while the second hypothesis, confirmed that the cost of human labour had a significant effect on the rice production. On the other hand, the third hypothesis revealed that the cost of processing, post-harvesting and marketing had no significant effect on the rice production. The fourth hypothesis established that there were variations in rice cultivation and profit maximization among the rice farmers whilst, the last hypothesis revealed that farmers' economic status had significant influence on the rice production during the growing seasons.

5.5 RECOMMENDATIONS

The government, NGOs and stakeholders in rice and production and food security should establish policies to regulate rice markets and price support. This will help to curb market prices that fluctuates and differ substantially among the farmers. There should be a widespread and continuous enlightenment on the need to fully embrace and accept the locally produced rice brands by giving preference to it than the foreign rice. Also inflation in the cost of production needs to be addressed by the government by ensuring that not all the agrochemicals are imported but some should be produced locally and distributed to the farmers at cheaper rates.

Furthermore, access to agro-financial aids helps farmers to acquire improved quality inputs such as seeds, fertilizer, and pesticides which will support them to increase their production. These financial funds, soft loans, and/or credit facilities could be paid or refunded in installments by the farmers in a long-term duration.

Lastly, the government should fund and train the crop research institutions and researchers to breed and develop improved varieties for the Africa species of rice that could be competing with the Asian varieties in terms of growth and yields. Agricultural activities should be made to be more profitable by introducing more mechanizations instead of manual. This will motivate and encourage the youths to get fully involved.

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8 List of tables, figures, graphs, and abbreviations

8.1 List of tables

8.2 List of Figures

8.3 List of Graphs

8.4 List of Abbreviations

ADP stands for Agricultural Development Project
IITA represents International Institute of Tropical Agriculture
NCRI represents for National Cereals Research Institute
IAR&T indicates Institute of Agricultural Research and Training
WARDA denotes West Africa Rice Development Association
FUNAAB signifies Federal University of Agriculture, Abeokuta
FRRS means Federal Rice Research Station
NAFPP stands National Accelerated Food Production Program
OFN is an acronym for Operation Feed the Nation
NACB represents Nigerian Agricultural and Cooperative Bank
INGER stands for International Network for the Genetic Evaluation of Rice
NERICA represents New Rice for Africa
Adaptation and mitigation: These are processes that enable people to minimize the adverse effects of climate variability and change on their health and well-being. They also refer to the capacity of people or societies to take advantage of the changes that the climate might provide.
Farmers' awareness and perception is the characteristics of farm households and agricultural property, as well as property protection policies closely linked to the opinions of farmers with respect to land protection.
Production is a method of combining various material inputs and intangible inputs (plans, know-how) to generate something for consumption (output).
SSA: sub-Saharan Africa including Nigeria and other African countries.
Agrochemicals are chemicals used in agriculture, such as plant growth hormones, insecticides, and fertilizers, to protect plants?

Appendix

Appendix Table 1. World rice production records by countries as at 2022
Appendix Table 2: Questionnaire for data sampling on rice production in Kogi State, Nigeria

World rice production records by countries as at 2022

Country	Production (Tons)	Production per Person (Kg)	Acreage (Hectare)	Yield (Kg / Hectare)
China	211,405,211	151.669	29,960,066	7,056.20
India	177,645,000	132.92	43,780,000	4,057.70
Indonesia	54,604,033	206.041	10,677,887	5,113.70
Bangladesh	54,586,344	330.574	11,516,553	4,739.80
Vietnam	43,448,504	458.995	7,469,890	5,816.50
Thailand	28,356,869	409.881	9,715,358	2,918.80
Myanmar	26,269,814	487.718	6,920,875	3,795.70
Philippines	18,814,827	176.816	4,651,490	4,044.90
Pakistan	11,115,428	55.062	3,033,965	3,663.70
Cambodia	10,886,000	677.415	3,001,313	3,627.10
Japan	10,527,000	83.224	1,542,000	6,826.80
Brazil	10,368,611	49.484	1,710,049	6,063.30
Nigeria	8,435,000	42.731	5,281,286	1,597.10
USA	8,376,720	25.557	1,000,390	8,373.50
Egypt	6,690,000	68.618	799,032	8,372.60
Nepal	5,610,011	192	1,491,744	3,760.70
South Korea	5,016,083	97.145	729,814	6,873.10
Sri Lanka	4,592,056	214.142	957,596	4,795.40
Madagascar	4,231,145	161.108	815,693	5,187.20
Tanzania	3,474,766	64.111	1,052,547	3,301.30
Laos	3,438,000	493.88	783,766	4,386.50
Mali	3,196,336	167.28	924,644	3,456.80
Peru	3,188,306	102.067	414,509	7,691.80
Colombia	3,012,311	60.332	531,158	5,671.20
Malaysia	2,912,203	89.179	684,416	4,255
North Korea	2,803,713	109.474	465,839	6,018.60
Guinea	2,599,164	218.72	1,924,161	1,350.80
Iran	1,993,000	24.377	437,231	4,558.20
Côte d'Ivoire	1,884,000	75.645	697,886	2,699.60
Taiwan	1,791,211	75.974	270,066	6,632.50
Italy	1,492,620	24.697	220,030	6,783.70

Congo-Kinshasa	1,378,846	16.952	1,813,464	760.3
Uruguay	1,200,000	342.272	145,000	8,275.90
Argentina	1,189,866	26.742	183,285	6,491.90
Senegal	1,155,730	73.491	345,596	3,344.20
Ecuador	1,099,686	64.435	257,273	4,274.40
Russian Federation	1,098,660	7.48	190,691	5,761.50
Dominican Republic	1,081,000	105.298	195,507	5,529.20
Paraguay	1,069,200	151.595	162,000	6,600
Guyana	1,050,000	1,342.33	206,428	5,086.50
Turkey	1,000,000	12.375	126,419	7,910.20
Sierra Leone	947,464	122.733	601,748	1,574.50
Ghana	925,000	31.235	321,215	2,879.70
Spain	778,780	16.691	103,370	7,533.90
Venezuela	764,631	24.024	179,041	4,270.70
Bolivia	600,044	53.067	187,281	3,204
Iraq	574,705	14.609	127,673	4,501.40
Kazakhstan	560,668	30.684	101,970	5,498.40
Nicaragua	468,115	74.484	73,890	6,335.30
Benin	406,000	35.732	113,719	3,570.20
Mauritania	383,000	96.129	72,964	5,249.20
Afghanistan	382,500	12.114	127,530	2,999.30
Cuba	377,700	33.66	108,402	3,484.30
Burkina Faso	376,527	18.599	177,256	2,124.20
Mozambique	341,000	11.815	724,801	470.5
Uzbekistan	314,659	9.636	64,923	4,846.60
Cameroon	313,084	13.158	268,408	1,166.40
Panama	305,000	73.339	89,559	3,405.60
Chad	290,563	18.925	192,327	1,510.80
Suriname	274,266	482.607	60,185	4,557
Mexico	245,217	1.966	38,518	6,366.30
Greece	220,930	20.517	29,860	7,398.90
Uganda	220,000	5.667	77,398	2,842.50
Guinea-Bissau	187,000	117.999	120,000	1,558.30
Haiti	177,000	15.927	65,007	2,722.80
Chile	174,897	9.952	26,242	6,664.80
Ethiopia	170,630	1.587	57,576	2,963.60
Liberia	170,000	38.792	240,000	708.3
Kenya	160,584	3.152	23,490	6,836.30
Costa Rica	153,805	30.74	31,657	4,858.50
Portugal	152,750	14.843	28,500	5,359.60
Togo	147,053	20.002	89,678	1,639.80
Malawi	133,000	7.417	74,862	1,776.60

Rwanda	131,577	10.964	32,896	3,999.80
Turkmenistan	130,000	22.217	171,180	759.4
Niger	121,760	5.672	26,739	4,553.60
Tajikistan	106,442	11.918	12,394	8,588.20
Burundi	88,510	8.287	58,997	1,500.20
France	82,570	1.227	15,100	5,468.20
East Timor	80,000	63.421	24,978	3,202.80
Bulgaria	70,920	10.06	11,820	6,000
Australia	66,835	2.668	7,620	8,771
Morocco	64,598	1.858	7,973	8,102.10

QUESTIONNAIRE FOR DATA SAMPLING ON RICE PRODUCTION IN KOGI STSTE, NIGERIA.

Dear respected respondents/farmers, my name is **OLAMIDE OWOEYE.** I am a Master's degree researching student studying in Czech University of Life Sciences Prague, Czech Republic. My MSc research thesis is on "***Economic analysis of rice production in Kogi State, Nigeria***". Kindly provide to me the following questions to help in my study and to contribute to the development of rice production in your area. Complete the questions as they apply to you by filling the gap or ticking the box. Your answers are only for the research purpose and will be treated confidentially.

SECTION A: **Farms/Fields Geographical Related Information** (*To be completed by the researcher*)

Farm/field community name: …….. Date of sampling: ……..

Farm/Field site identification number/code: ……... Geocoordinate point(s): ……

Local Government Area (LGA): …… Region of the State: ……

SECTION B: **Farmers' Bio/Personal Data** (*To be completed by the farmers/respondents*)

1.How old are you? …… 2.What is your gender? Male ☐ Female ☐

3.What is your highest educational qualification?

No basic/formal education ☐

Primary education (FSLC) ☐

Secondary education (WASC/WAEC/NECO/TTC) ☐

Tertiary education: NABTEC/NCE ☐ OND ☐ HND/Bachelor's degree ☐ MSc ☐ PhD ☐

4. Marital status: Single ☐ Married ☐ Divorce/separated ☐ Widow/widower ☐

5. What is your position in your family? Head ☐ Member ☐

6. What is your status/profile in the rice farm community? Indigene ☐ Non-indigene ☐

7. How long have you lived in this rice farm community? ……

8. How long have you spent in the rice farm and production business? ……

9. Are you the owner of the rice farm? Yes ☐ No ☐

10. Are you a labourer in the rice farm? Yes ☐ No ☐

11.What is your average monthly income from all your business activities including the rice production?

(a) < 100 USD ☐ (b) 100 – 200 USD ☐ (c) > 200 USD ☐

12. What are the major factors affecting rice production in your farm (Kindly state the challenge(s) below:

_____

SECTION C: **Data about the rice farm and production** (*To be completed by the farmers/respondents*)

1. How old is the rice farm? ……
2. What are the common rice species? Asian species ☐ African species ☐ Both ☐ species
3. What are the main rice varieties/brand? List at least one: ……., ……., ……
4. Why did you choose this/these rice varieties? (*Tick as many that are applicable to you*).
   (a) High yields ☐ (b) pests and diseases resistant ☐ (c) Climate adaptation ☐
(d) Other environmental factors resilience ☐ (e) People's preference ☐
5. What is/are the size(s) of your rice field(s) in hectares? ……

6. What is/are the ecology(ies) of your rice cultivation? (a) Rain-fed upland ☐ (b) Rain-fed lowland ☐ (c) Irrigated upland ☐ Irrigated lowland ☐

7. Who owns the rice farmland? Family ☐ Rented ☐

8. (a) If it belongs to your family (as in above), do you pay certain amount to your family?

If yes, how much (amount per year) ……..

   (b) If rented, what is the cost of the rent per year? ……

9. What are the costs of acquiring input resources/materials that would cover a hectare in the farm?
   (a) Cost of seeds/seedlings ……
   (b) Cost of agrochemicals such as ferilizers/manures, pesticides, herbicides (if applicable) …..
   (c) Cost of water for irrigation (if applicable) ……..
   (d) Cost of manual weeding (if applicable) ……

10. What are the costs of labour? (*respond to the one applicable to you*)
    (a) Cost of land clearance per hectare ……
    (b) Cost of sowing per hectare……..
    (c) Cost of irrigation per hectare……
    (d) Cost of weed control per hectare ……
    (e) Cost of applying pesticides and herbicides per hectare …….
    (f) Cost of harvesting per hectare ……
    (g) Cost of postharvest and processing (per ton) ……

11. What are the yields/production estimates (in tons/heactare)?
    (a) Total grain yields ……
    (b) Total straw yields ……
    (c) Total husk yields ……..

12. What is the cost of transportation from farm to processing locations and to the buyers/consumers?

13. What is/are your purpose of rice production? (*tick where it is applicable to you*).
    (a) Subsistence/family consumption ☐
    (b) Commercial only ☐
    (c) Both Subsistence and commercial purposes ☐

The Economic returns:

14. What are the cost derived from selling the proceeds from the rice farm production (in USD/tons)?

(*respond appropriately where it is applicable to you*)
    (a) Cost/price for selling rice grain ……..
    (b) Price/cost of selling rice straw ……
    (c) Price/cost of selling rice husk ……

15. What are the net profit and/or loss from the rice production and sales (in tons)? (*tick where it is applicable to you)[Note: the official exchange rate is 455 NGN = 1 USD]*
    (a) Grain profit ☐ or grain loss ☐ < 20 USD ☐ 20 – 50 USD ☐ > 50 USD ☐

    (b) Straw profit ☐ or grain loss ☐ < 20 USD ☐ 20 – 50 USD ☐ > 50 USD ☐

    (c) Husk profit ☐ or grain loss ☐ < 20 USD ☐ 20 – 50 USD ☐ > 50 USD ☐

SECTION D: LIKERT SCALE QUESTIONAIRE for further clarifications on the questions in section B and C.

Variables		Items	Agreement Scale				
	Code		Strongly Disagreed	Disagreed	Undecided	Agreed	Strongly Agreed
			1	2	3	4	5
Rice Cultivation	1	My rice field/farm is at least 10 years old.					
	2	The size in hectare is at least 3 hectares.					
	3	Cost of presowing and precultivation such as land surveying is/was above 25 USD (above 11,250 Naira)/ hectare.					
	4	The cost of acquiring the farmland is/was between 200 – 400 USD (90,000-180,000 Naira)/ hectare.					
	5	The cost of acquiring clearing and preparing the land for cultivation is/was between 30-50USD (13,000 – 22,000 Naira)/ hectare.					
	6	Cost of getting seeds/seedlings is/was between 75-100 USD (33,750-45,000 Naira) / hectare.					
	7	The cost of sowing the seeds is/was between 15-25 USD (6,750-11,250 Naira)/ hectare.					
	8	Cost of weed control per hectare is/was between 15-25 USD (6,750-11,250 Naira)/ hectare.					
	9	Cost of labour for sowing per hectare (if applicable) is/was above 25 USD (above 11,250 Naira)/ hectare.					
	10	Cost of applying pesticides and herbicides per hectare is/was above 25 USD (above 11,250 Naira)/ hectare.					
	11	Cost of labour (cultivating and harvesting) per hectare is/was above 100 USD (above 45000 Naira/ hectare.					
	12	Cost of postharvest, processing and marketing (per ton) is/was above 25 USD (above 11,250 Naira)/ hectare.					
Rice yields/ production	1	Grain yields are estimated at 8-10 tons/hectare.					
	2	Straw yields are estimated at 8-10 tons/hectare.					
	3	Husk yields are estimated at 8-10 tons/hectare.					
	4	Sales of rice residues for livestock and manure are estimated to ranging from 300 – 500 USD (135,000 - 225,000 Naira)/ton.					
	5	Cost/price for selling rice grain is between 900 - 1,100 USD (400,000 -500,000 Naira)/ton.					
	6	Price/cost of selling rice straw is between 100 - 200 USD (45,000 – 90,000 Naira)/tons.					
	7	Price/cost of selling rice straw is between 100 - 200 USD (45,000 – 90,000 Naira)/tons.					
Profit	1	Make profit of less than 200 USD per growing season					
	2	Make profit of 200 – 500 USD per growing season					
	3	Make profit of more than 500 USD per growing season					
	4	Make loss in some growing seasons					

[Note a ton is about 1000kg which is equivalent to 20 bags of 50kg rice].