COMPARATIVE ECONOMIC ANALYSIS OF UPLAND AND LOWLAND RAINFED RICE PRODUCTION IN SELECTED LOCAL GOVERNMENT AREAS OF KADUNA STATE, NIGERIA

BY

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DECLARATION

I hereby declare that the work in this dissertation titled **"Comparative Economic Analysis of Upland and Lowland Rainfed Rice Production in Selected Local Government Areas of Kaduna Statie, Nigeria"** has been written by me and is a record of my research work. No part of this thesis has been presented in any previous application for another degree or diploma in this or any other institution. All consulted sources of information had been duly acknowledged in the text and a list of references provided.

_____ _____

Evans Ngaltungo YURKUSHI **Date**

CERTIFICATION

This thesis titled: "**Comparative Economic Analysis of Upland And Lowland Rainfed Rice Production in Selected Local Government Areas of Kaduna State, Nigeria"** by **Evans Ngaltungo YURKUSHI** meets the regulations governing the award of the degree of Doctor of Philosophy in Agricultural Economics of the Ahmadu Bello University and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to my late sister, Mrs Jummai Judith Iloba whose memory and words of wisdom will ever remain with me. Sister may your gentle soul rest in peace. Amen.

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ABSTRACT

This research carried out a comparative economic analysis of upland and lowland rainfed rice production in selected local government areas of Kaduna state, Nigeria. The study set out to compare the profitability and efficiency of resource use in upland and lowland rainfed rice production. A multistage sampling technique was used to select 75 upland and 150 lowland rice farmers . Primary data were collected using structured questionnaire. The data were analyzed using descriptive statistics, stochastic frontier production function, gross margin analysis, return on investment and student t test. The result showed that rice productions were more dominated by male farmers in the upland with 89% than the lowland with 75% .The upland rice farmers participated more than the lowland farmers in years of schooling with 78% and 17% schooling for more than 13 years respectively. The lowland farmers had more experienced in rice cultivation than upland farmers with about 5% and 3% cultivating the crop for more than 30 years respectively. The upland rice farmers had more farm size than lowland farmers with average of 1.47 hectares and 1.30 hectares respectively. The lowland rice farmers had more household size than upland farmers with average of 9 and 8 people respectively. The lowland rice farmers comprise of older people than the upland farmers with mean age 43.75 and 40.75 years respectively. The upland rice farmers accessed more credit than the lowland farmers with 47% and 37% accessibility respectively. The upland rice farmers showed higher allocative and economic mean efficiencies of 0.897 and 0.503 than lowland rice farmers with 0.648 and 0.453. The upland rice farmers were more profitable than the lowland rice farmers with gross margin of ₦97, 673.58 and ₦84, 278.01 per hectare of land, return on investment of 68K and 41K respectively. The thesis found out that both production systems showed no significant difference in their profitability level, The mean efficiencies of both systems were significant at p<05. Both production systems were operating in stage II of production cycle with return to scale of less than unity (0.84167 and 0. 95770) for upland and lowland rice respectively. Major constraints ranked by upland from the most important were insufficient finance, high cost of fertilizer, pest and diseases and high cost of labour among others while the lowland rice ranked inadequate finance, high cost of fertilizer, pest and diseases, inadequate seed and high cost of agrochemical among other constraints. It was recommended that the farmers should form group contribution locally known as *adashi* to raise credit for their production, the extension agent should train farmers on how to multiply seeds at their farm, that the farmers association can go into partnership with our national universities to supply labour- saving technologies to reduce production cost, that government agencies responsible for execution of the Growth Enhancement Scheme should identify and supply farmers with more need of fertilizers, and that the farmers' association activities should attract all tiers of government to provide rural areas with modern infrastructures.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Rice is a major commodity in world trade and a staple food for about 2.6 billion people in the world. The global output showed that the Asian continent accounted for about 92%, America and the Caribbean accounted for 5% and 3% for Africa (Spore, 2005). In sub-Saharan Africa, West Africa is the leading producer and consumer of rice with 63.4% and 69.1% of total rice production and consumption respectively (WARDA, 2007). Three African countries are among the twentieth world highest producer of rice. Nigeria is the nineteenth highest producer of rice in world surpassed only by Egypt and Madagascar in Africa. It has been reported that Nigeria, Egypt and Madagascar produced 3218760, 4329500 and 4737970 metric tonnes of rice respectively (FAO 2010). In the entire continent of Africa, it is reported that only Egypt and Madagascar have attained self sufficiency in local rice production, all other countries have rice demand exceeding local production (FAO, 2008).

Rice is primarily a cash crop in Nigeria that is produced mainly for market. Therefore in rice producing areas the enterprise provide employment for more than 80% of the inhabitants in various activities along the production/distribution chain from cultivation to consumption (Olorunfemi and Victor 2006). Some remarkable developments have also taken place in the Nigerian rice sector for more than ten years now. Both production and consumption have increased during the period, however the increase in production was not sufficient to match the consumption increase, with rice imports making up the short fall. Nigeria is reported to be the world's fifth largest importer of rice in 2010 spending about $800 million US dollars annually (FAO, 2010). Nigeria is

reported to have imported 1.7 million tonnes of rice in 2001, 1.5 million tonnes in 2002, 3.9 million tonnes in 2005 and 2 million tonnes in 2012 being the largest importer of rice in Africa (CBN, 2006, CBN, 2012). This means that such importation will create a negative implication on the foreign exchange earnings and of course hinder development of the rice sector. The World Bank projected that from 2010, the poorest income households in Nigeria may depend much on rice to obtain not less than 35% of their cereals based calories annually. This is due to changes or shift in consumption pattern from root and tuber crops in favour of rice. This could probably be the reason why rice that was once consumed at ceremonies, now consumed as a daily food intakes in most houses in Nigeria. If Nigeria is to be self-sufficient in rice production, productivity must increase. This implies that the resources allocated to rice production must be efficiently utilized.

Rice growing environment in Nigeria are usually classified into four rice ecosystems namely: Rain-fed upland, Rain-fed lowland, Irrigated lowland, and Mangrove swamp (ATA 2010). It further reported that the land area coverage of mangrove swamp ecology is the least important accounting for less than 1% of total rice area. Irrigated systems (including large-scale irrigation schemes and small-scale irrigation schemes) account for 16% of total rice area; rain-fed upland systems, 30% and rain-fed lowland systems, taking the remaining 53%. Hence the classification system in the above context is used to select the two rice growing environments of upland and lowland rainfed for the purpose of this study. The distinguishing feature of lowland rainfed from upland rainfed is that the farms has the soil covered completely by water at some stage in the growth cycle of the lowland while the upland is not flooded and are even cultivated on

hills. Rainfed lowland rice is the dominant system in flood plains of river Niger, Benue, Katsina, Kaduna and Yobe.

1.2 Problem Statement

Despite the increase of rice productions in Nigeria the gap between supply and demand continue to increase (Garba and Fushion, 2007). This is due to many problems facing the Nigerian agriculture in general and rice production in particular. Yield have been consistently low on farmers field in the face of ever increasing cost of inputs like fertilizer, tractorization, herbicides, manual labour and transportation of produce. Nigeria has a potential land area for rice production of between 4.6 and 4.9 million hectares among which only 1.7 million hectares of the land was cropped to rice (Moses and Adebayo, 2007). Rice is cultivated in virtually all the agro-ecological zones of Nigeria. Despite this, the area cultivated to rice still appears small. In 2013 out of about 17 million hectares of land cultivated to various cereal crops, only about 15% was cultivated to rice with a yield of 1.8 tonnes/hectare (FAO, 2013). The Nigerian demand for rice had been reported to be increasing at a much faster rate than in any other African counties since the mid 1970. Nigerian per capita consumption of paddy rice in 2009 was 31.30 kg/capita/year (FAO, 2009). In spite of this the production increase was not sufficient to match the consumption increase to address the demand supply gap. Government at various times has come up with different policies and programmes in an attempt to address this demand-supply gap. It is however observed that these policies have not been consistent to effectively address the problems (Ogundele and Okoruwa, 2004). The erratic policies reflected the dilemma of securing cheap rice for consumers and a fair price for the producers. Example of such inconsistent government policy was the banning of rice importation in 1985 to mid-1990s and in 1995 inputs of rice were

allowed at 100% tariff which was reduced in 1996 to 50% and was later increase to 85% in 2001, these somersaulting policies did not increase sufficiently the domestic rice production to meet the increasing demand (Ogheneruemu *et. al.*, 2012). What then are the reasons explaining why domestic rice production lag behind the demand for the commodity in Nigeria?

Central to answering the above question is the issue of efficiency of the rice farmers in the use of resources. An average yield of upland and lowland rainfed rice in Nigeria is 1.8 tonnes per/hectare, while that of irrigation system is 3.0 tonnes per/hectare. This is very low when compared with 3.0 tonnes per hectare for upland and lowland rice and 7.00 tonnes per hectare from irrigation system in places like Cote d'Voire and Senegal (Okoruwa *et al.,* 2009). Nigeria rice output decline was reported as traceable to inefficient use of farm resources, labour shortage and severe scarcity of resources, poor crop management practices and poor capital base (Umoh *et al.,* 2009). In addition inconsistent shifting between open and protectionist trade policy characterized rice policy in Nigeria do not help matters. Since whether open or protectionist policy which is aim to discourage the importation of rice as to encourage local rice production, the smuggling at the border poised a great problem. Potential rice farmers are therefore discouraged. As a result yield potential are not fully achieved on rice farms, although high yielding varieties and the associated technologies exists and are already being used by farmers.

The problem of rice production in Nigeria can also be described or studied on ecological production pattern, since rice can be produced in almost all the ecological zones of Nigeria. Since rice is mostly cultivated by the small scale farmers, the irrigation system

is not widely practiced due to the high cost of irrigation method. Rice farmers in the study areas are therefore faced with the problem of choice of system of production among the two major patterns. With production gearing towards business investment, the major factors that will guide the farmers' choice are efficiency and profitability, hence serving as the basis for choice of topic for study. The farmers are therefore left with the problem of drought when the period of rainfall is shortened which can lead to colossal loses. This has led to increase in demand-supply gap of Nigerian rice industry. The Federal Ministry of Agriculture attributed the lack of self-sufficiency in rice to low productivity, inefficiency in the use of resources, disincentive from macro-economic environment and production in the hand of small scale farmers who use traditional technologies. This study attempt to proffer answers to the following research questions:

i. What are the socio-economic characteristics of rice farmers under the upland and lowland rainfed rice production systems?
ii. What are the relationship between the inputs and output of the two production systems?
iii. Are the rice farmers in both production systems efficient in their resources use?
iv. How profitable are the upland and lowland rainfed rice production systems?
v. What are the production constraints faced by both groups of farmers?

1.3 Objectives of study

The broad objective of this study was to compare the profitability and efficiency of resource use in upland and lowland rainfed rice production in Kaduan State, Nigeria.

The specific objectives were to:

i. describe the socio-economic characteristics of rice farmers under the upland and lowland rainfed rice production systems,

ii. estimate and compare the technical relationship between the inputs and output of the two production systems,

iii. estimate and compare the technical, allocative and economic efficiencies of rice farmers in both production systems,

iv. determine and compare the profitability of rice production under the two production systems and

v. identify the production constraints faced by farmers under the two rice production systems.

1.4 Hypotheses

HO_1. There is no significant difference in the profitability of rice production among the two production systems.

HO_2. There is no significant difference in the mean efficiencies among the two production systems.

1.5 Justification of the Study

In Nigeria the demand for rice has been increasing at a much faster rate than in any other African countries (FAO, 2009) and as such the need to increase the production of rice cannot be overemphasized. Since rice can be grown in virtually every ecological zone of the country, the production of rice has tremendous potentials for increase. In Nigeria some great disparities are found among the States of the federation in rice production. In 2014 for example Kaduna State was the fourth largest producer of rice with a total of 329,400 metric tonnes surpassed by Benue, Kogi and Kwara States with values of 390,000, 539,800, and 548,700 metric tonnes respectively (NAERLS and FDAE, 2014). Series of researches are ongoing on the improvement in varieties and

germ plasm of rice. However little efforts are recorded in area of ecological comparison of rice to help farmers ascertain which one has high economic advantage. This study is an attempt to study the differentials in economic efficiency and the profitability of upland and lowland rainfed rice production in Kaduna State. This study will therefore help in providing information to the farmers concerning both upland and lowland rainfed rice productions which are the major types of rice production systems in Kaduna State (Optimum Agricultural Consultant, 2007). Rice is grown almost in all parts of Kaduna States and is mostly handled by small scale resource poor farmers that use traditional technology with resultant to low productivity.

From various studies of rice production, it has been observed that actual yield of rice differed significantly from potentials yields and this has been attributed to low resources productivity. This implies that there is a scope for additional increase in domestic output from existing hectares if efficiency of rice production is improved. This study become imperative as it will identify factors that influence technical efficiency among the rice farmers. The knowledge of these factors and how they affect the yield of rice is imperative for policy formulation. A situation of Nigerian economy where many negative indicators of unemployment are glaringly observed with scare resources, the efficiency study will show if the poor farmers can possibly raise their productivity without adjusting their resource base.

In a developing agricultural economy such as Nigeria, where resource increase and opportunities for developing and adopting better technologies are dwindling, efficiency measure is reported to be very important because it is faster for productivity growth (Moses and Adebayo 2007). Such studies will help the economy raise productivity by

improving the existing resources base and the available technology .It is believed that the productivity of farmers in general and rice farmers in particular could be enhanced through enhancing their technical and allocative efficiency in response to better information and education.

This study will provide information to the farmers on the better rice growing system that can achieve their basic household food security. The impact of the increase in rice yield as a result of making the right choice of production system on the livelihood of the farmers cannot be over emphasized. Generating information on the efficiency and profitability of the upland and lowland rainfed rice will definitely help to alleviate the problems encountered by the farmers to boost their productivity as well as guide farmers and attract investors to the producing areas. It is expected that the findings of this research will provide feedback to researchers such as National Cereal Research Institute on the rice production systems that is suitable in the study area. Policy makers will find this work useful in their effort to revamp the agricultural sector with specific emphasis on rice production in Nigeria. The result of this study will surely be of help to the present presidential initiative tax force on rice in Kaduna State.

CHAPTER TWO

LITERATURE REVIEW

2.1 History of Rice Production in Nigeria

Rice production started in Nigeria with the low yielding indigenous red grain species Oryza glaberrima that was widely grown in the Niger delta area .The higher yield white grain, Oryza sativa was introduce about 1890 and by 1960 accounted for more than 60% of rice grown in Nigeria (Optimum Agricultural Consultant, 2007).

Today rice is cultivated in almost all the agro-ecological zones of Nigeria but on a relatively small scale by the small scale farmers. The area of land devoted to production of rice in 2008 was 13% of the19 million hectares of land cultivated to various cereal crops (FAO, 2008). Presently rice is cultivated on 1.8 million hectares of land out of the estimated 4.6million hectares of land for rice production in Nigeria (FAO, 2013). The trend of production of rice shows that the first higher production was experienced in the early 70s when average output stood at 321,000 metric tonnes from average area of 234,000 hectares with average yield of 1.372 metric tonnes/hectare (Table 2.1). Another significant improvement in rice production in Nigeria took places between 1986 - 1990 with output of over 2 million metric tonnes from an average area of 1,060, 200 hectares and yield of 2.090 metric tonnes/hectares.

Rice output and yield continue to increase until 1991-1995 when it output increased with a decline in yield; this means that the increase in outputs is due to extensive increase in area being cultivated. This trend continues up to 2010 which can be seen in Table 2.1.

Table 2.1: Trends of rice production in Nigeria (1961-2014)

Period	Average area cultivated/ha	Average output tonnes/ha	Average yield tonnes/ha
1961-1965	179,200	207,200	1.176
1966-1970	234,000	321,000	1.372
1971-1975	288,800	470,200	1.628
1976-1980	332,000	596,200	1.710
1981-1985	630,000	1,300,200	2.064
1986-1990	1060,200	2,216,064	2.090
1991-1995	1,678,000	2,979,600	1.776
1996-2000	1,742,582	3,011,028	1.728
2001-2005	1,869,172	3,158,900	1.690
2006-2010	1,871,344	3,201,870	1.711
*2011-2014	2,685,313	4,782,457	1.709

Source: PCU (2003), FMARD (2003), FAO (2010), FAO (2013), NAERLS and FDAE (2014) * =Average for four years

The story of rice production in West Africa as a whole have become more interesting in view of the technological breakthrough in the development of hybrid rice by West African Rice Development Association (WARDA) and other partners . The rice inter specific hybridization project has produced New Rice for Africa (NERICA). NERICA is literary at the verge of rice revolution as WARDA's participation in selections and community seeds production programmes become full-blown. NERICA is a progeny which exhibits a hybrid feature with advantages of both Oryza glaberrima and Oryza sativa surpassing both in many regards. Nigeria in particular has been participating so much in the spread of NERICA. These improve technology need to be delivered to farmers in a package that will address both the uncertain climatic conditions and the limited inputs. This study focuses on comparing the two major rice production ecologies and how efficient the limited inputs are incorporated. The increase in the average yield

of rice between 2006 and 2013 could probably due to the spread of NERICA cultivation in Nigeria as seen in Table 2.1.

2.2 Rice Agro-Ecological Zones in Nigeria

Rice which is ranked sixth in term of production in relation to crops like sorghum, millet, cowpea, cassava and yam is grown in all the agro-ecological zones of Nigeria. Due to long time interference by human beings on the agroecological zones of the Sahel in Borno state down to the coastal swamps of the south-west and south-south, most of the vegetation has been altered and hence classification of rice production based on these zones are unrealistic. In this study the classification according to Agricultural Transformation Agenda (ATA) in 2010 was adopted. The characteristics of these classifications are as follows:

Table 2.2: Major features of Nigerian rice production systems.

Production Ecology	**Estimated Share of National Rice Farm area**	**Share of total Domestic rice Production**	**Average yield Tonnes/ ha.**	**Potential yield (2013) Tonnes/ha.**
Rainfed upland	30%	28%	1.9	3.0
Mangrove Swamp	1%	1%	2.2	N.A
Rainfed Lowland	53%	42%	2.2	4.5
Irrigation	16%	29%	3.7	5.0

Source; ATA (2010) N.A: not available

For the purpose of this study the rain-fed upland and lowland rice production is compared. It will therefore be of importance to emphasize the description of the two types of rice environment.

2.2.1. Rainfed upland rice

This is the second most important rice system grown in Nigeria. The crop depends entirely on rainfall. The sudden cessation of rainfall can have a serious negative effect on this production system, like poor grain filling likewise heavy rainfall can lead to leaching of plant nutrients, soil erosion and possible flooding. The rainfed upland rice production is increasingly expanding probably due to the promising NERICA varieties now widely distributed; also it can easily substitute most of the arable crops for land since it does not need special amount of water. Hilly cultivation of rainfed upland rice is becoming increasingly important in some part of Nigeria. The rainfed rice can easily be intercropped with cocoyam, yam and not maize because of the unfounded beliefs that the pollen grains of the tassel are harmful to the rice crop. As can be seen in the table above the upland rainfed rice covers 30% of the national rice farm areas (ATA, 2010).

2.2.2 Rainfed lowland rice

This is the most prominent rice ecological system in Nigeria. It is reported that 53% of Nigerian rice area is under rainfed lowland rice cultivation which contributes close to half of the national rice production (ATA, 2010). There are two subtypes which are shallow fadama and deep fadama. The distinguishing feature of this system is that the soil must be covered completely by water at some stage in the growth cycle. This is the dominant system in the flood plains of the river Niger, Benue, Katsina Ala, Kaduna, Yobe. Jigawa States has one of the highest networks of fadama lands for rice cultivation

but now have been substituted for sugar cane plantation due to policy thrust of the state government.

2.3. Importance of Rice Production in Nigeria

Rice production that was once neglected in Nigeria, has for some decades received the attention of the government because of it important contribution to the economy. Rice production the world over has gained prominence that is now the second largest produced cereal surpassed only by wheat. The Nigerian rice sector is special in West Africa. Rice is now primarily produce as cash crop. Rice production can now boast of providing 80% employment to the inhabitants of rice producing areas (Norman and Kebe, 2004). Since rice has become a structural component of the Nigerian diet and rice imports make an important share of the Nigerian agricultural imports, there is considerable political interest in increasing the consumption of locally produce rice. Rice has contributed much as a major staple food in the farmers household, provided food security, help in alleviating poverty in Nigeria.

2.3.1. Rice as a staple food

Rice is rich in carbohydrates and proteins more than maize, cassava, sorghum and millet, hence providing more calories than many cereal crops. Rice form the basis of diet of millions of people in Africa. Despite the growing influence of western food which offers fast food mostly of flour materials, majority of Nigerian homes are now living mainly on rice meals. Where one is a humble farmer, a civil servant, student, professionals or members of the political elite rice meal has now become an important dish on their table. Nowadays in Nigeria rice is usually the main ingredient in festive dishes prepared in diverse forms such as steam, fried coked in coconut or white with

stews. There are other food qualities of rice that serve as medicinal. Rice is proven to be cholesterol free and low in sodium salt, hence is a good food for those with high blood pressure. Rice is rich in vitamins and minerals like niacin, thiamine and vitamin D, calcium and iron. It is also known to prevent dysentery and chronic constipation. No wonder it is called the delight of the children.

2.3.2 Rice for food security

Food security has been defined as "access by all people at all times to enough food for an active healthy life". Food security at household level is also important for ensuring a good livelihood and freedom from hunger. In countries where rice is the staple food it plays a very important part in food security and socio-economic development. As a food crop, rice has some inherent characteristics which make it attractive, in particular for small-scale farmers as well as for the urban poor and rich:

i. It is rich in carbohydrates that provide energy.
ii. It is available all year round because of its long shelf life making it preferable to other crops for food security.

Rice consumption is becoming increasingly popular in many countries of Africa, where rice is not traditionally a major food crop, for example, Benin, Burkina Faso, Cape Verde, Ghana, Guinea, Mali, Niger and Togo (Tshibaka and Klevor, 2002) .While cereals contribute 61% of the energy supply to the rural population, rice provides 54% of their energy needs. Rice forms the basis of the diet and is grown by more than 95% of rural families (Norman and Otoo, 2003). A combination of factors influences the increase in rice consumption. Urbanization is one of the major factors causing the shift in consumer preference towards rice. Rice dishes are comparatively easy to prepare

compared to other traditional cereals, such as sorghum, maize and millet, thereby reducing the work involved in food preparation. Rice, therefore, fits easily into urban lifestyles, which tend to be crowded with a multitude of time-consuming activities. The theme "Rice is for life" was adopted to implement the international year of rice (IYR) in 2004 which was declared by the United Nation General Assembly during it's 57th session. One major objective of the IYR was to focus attention on the role that rice could play in providing the population with food security and addressing poverty alleviation. Other issues include sustainable development, preservation of cultural heritage and biodiversity, scientific cooperation and economic policy.

2.3.3 Rice for poverty reduction

Rice production is a major source of employment, income generation and nutrition in many poor food-insecure families in Nigeria (Norman and Kebe, 2004). The numerous activities provide employment to millions of people who work either directly in rice production or in related support services. After harvesting rice, farm activities shift to post-production operations, namely harvesting, threshing, drying, milling, storage and trade. The preparation of milled rice for consumption, the transformation of milled rice to other products, and the utilization of broken rice, rice bran, rice hulls and husks, and rice straw provide additional employment opportunities for a large number of people. In Nigeria, for example, rice is usually parboiled before hulling. These operations are typically done using small scale equipment; generating substantial post-harvest activity in rural and secondary urban areas (Misari, 2002).The income generated from rice cultivation and postharvest activities provides cash to cover the expenses of clothing, housing, education and other social activities of the majority of people in rural areas. In countries, such as the Gambia, Guinea and Madagascar, sustainable rice production is

the key to the improvement of rural livelihoods, not only of small rice farmers but also of poor families in urban centres.

2.4 Production and Economic Importance of Rice in Kaduna State.

Rice is one of the prominent crops cultivated in Kaduna State. Rice is reported to be produced in all the twenty-three Local Government Area but only ten of them are the major producers (KADP 2011).The main types of rice ecologies cultivated in Kaduna State are the lowland about 82% and upland accounting for 18% (Optimum Agricultural Consultant, 2007). Due to many tributaries of rivers flowing within Kaduna State, there exist wide ranges of fadama land areas which are either devoted to rice or sugar cane. Most of these river tributries are seasonal giving the rice farmers with no other choice than to cultivate rainfed rice. It is reported by the Optimum Agricultural Consultant (2007) that about 40% of rice farmers are educated to tertiary education and about 40% are able body men between the ages of 36 - 45.This is indicating a great potential of rice industry in Kaduna State. The objective of producing rice in Kaduna state is mainly for profit and means of livelihood (Kudi *et al.*, 2010). Kudi further reported a profitable rice production in Kaduna State with a return to investment of ₦2.01k on NERICA rice and 80k on local rice variety, while they also reported a gross margin of ₦234641.90k and ₦71699.00k respectively. Paddy rice serves as liquid cash to the rural farmers, who often take some part of it and sell to get cash anytime the need arises.

The production of rice has given rise to many economic activities in Kaduna state. It has become one of the major sources of income to the rural farmers and to the state in general. With such profit coming from rice production, many youths are getting easy employment through their participation in many areas of the production chain. In the

rice industry there are labourers, traders and inputs sellers of rice gainfully employed. Private parboiling of rice is becoming an important business which is always closer to the rice millers. Most important is the use of rice as the fundamental source of food security in the households where it supply calories to human more than many cereal and root crops. The residues from the farm and the millers serve as feeds for animals.

2.5 The Concept and Measurement of Efficiency in Agriculture.

2.5.1 The stochastic production frontier function.

The level of technical efficiency of a particular farmer is characterized by the relationship between observed production and some ideal potential production. The measurement of a firm specific technical efficiency is based upon deviations of observed output from the best production frontier. If a farmer's actual production lies on the frontier, it is said to be perfectly efficient if it lies below the frontier, then it is technically inefficient where the ratio of the actual to the potentials production defines the level of efficiency of the individual farmer.

The estimation of production frontier has proceeded along two general paths, full frontier which focuses all observations to be on or below the frontier and hence where all deviation from the frontier is attributed to inefficiency and also the stochastic frontier where deviation from the components reflecting measurement error and statistical noise and a component reflecting inefficiency. The disadvantage of these methods is that they are extremely sensitive to outliers. Hence if the outliers reflect measurement errors they will heavily distort the estimated frontier and the efficiency measures derived from it. However, the stochastic frontier approach appears superior, because it incorporates the traditional random error of regression. In this case the random error, besides capturing

the effect of unimportant left out variables and errors of measurements in the dependent variables, could also capture the effect of random breakdown on input supply channels not corrected with the error of the regression as reported by Jondrow *et al.*, (1982). Farrell, (1957) started the measurement of efficiency by proposing a division of technical efficiency which represent the farmer's ability to produce a maximum level of output from a given level of inputs and allocated efficiency which is the ability of the farmer to use inputs in optimal proportions given their respective prices and available technology. The combination of these two measures yields the level of economic efficiency.

There are several approaches to analyzed the determinants of technical efficiency from stochastic production frontier functions. One set of authors followed a two-step procedure in which the frontier production function is first estimated to determine the technical efficiency indicators while the indictors obtained are regressed against a set of socio-economic explanatory variables that are usually farm specific characteristics (Ogundele, 2003, Ben-Belhassen 2000, Parikh *et al*., 1995). However this method violated the assumption of error terms of stochastic frontier model which is assumed to be identically independently distributed (Jondrow *et al.,* 1982). This lead to the development of a more consistent approach that modeled inefficiency effects as an explicit function of certain factors specific to the farm and all parameters are estimated in one step using maximum likelihood procedure (Ajibefun and Daramola, 2003, Obwona, 2000, Battese and Sarfaz, 1998). The maximum likelihood estimates of the production function are estimated using the computer program called FRONTIER version 4.1 Coelli and Battese (1996). This approach was adopted in this study. The two steps described above can be explained using mathematical notations. The econometric

model is classified as either deterministic frontier model or stochastic frontier model based on the assumption about the classified noise and the way the inefficiency is defined.

The first approach called the deterministic frontier model assumed that the producer is producing single output. It is also assumed that the amount of inputs used to produce the single output is available for each number of producers. The production frontier model is stated as

$Yj=f(X_{ij}\beta)$. TEij…… (1)

Where Y_j=output of producer j=1……..N

X_i= vector of inputs use by producer j

$f(X_{ij}\beta)$= production frontier

β=parameter to be estimated

TE_{ij}=output oriented technical efficiency of producer j

From (1)

$TE_{ij}=\frac{Y_i}{f(X_{ij}\beta)}$…… (2)

Equation (2) defines the technical efficiency on the ratio of observed output to maximum output feasible given the prevailing technology. Y_i achieved its maximum value of $f(X_{ij}\beta)$ only if $TE_i=1$. The amount by which an observation lies below the frontier is called inefficiency when $TE_i<1$.

It can be seen from equation (1) that $f(X_{ij}\beta)$ is deterministic while in equation (2), the entire shortfall of observed output $f(X_{ij}\beta)$ is attributed to technical inefficiency. This expressed the shortfall of this method since facilities outside the control of farmers like bad weather, bad market, and error in model specification can translates into increasing

the inefficiency measures. With the introduction of random variable to the stochastic production frontier equation in (1)

$Y_i=f(X_{ij}\beta)$, exp [vi]). TE_{ij}…….. (3)

Where [$f(X_{ij}\beta)$, exp[Vi]]=stochastic production frontier.

Hence $TE_{ij}=\frac{Y_i}{(f(Xij\beta),\exp[vi])}$…… (4)

Defining technical efficiency as the ratio of observed output to maximum feasible output with effect of environment by exp{Vi}.

From the above equations the two disturbance term of production frontier is lacking, neither of them can give correct view of technical efficiency.

The second approach is called the stochastic production frontier model. The main feature of this method is that the disturbance term is composed of two parts. The first disturbance term is the symmetric component Vi which capture the random of error outside the control of farmers while the non-negative one sided component Ui capture the random of human error, which is under the control of the farmer. The random terms are independently and identically distributed (Meeusen and Vanden Broeck, 1977).

The appropriate equation for stochastic frontier model in term of general production function is as follows:

$Y_i=f(X_{ij}\beta) + V_i-U_i$----------(5)

Where

Y_i, X_{ij}, β are as explained above

V_i= is the stochastic error which is assumed to be identically, independently and normally distributed with zero mean and a constant variance (σv^2)

U_i= is a one-sided error term which is independent of vi and is normally distributed with zero mean and a constant variance (σu^2).

In the stochastic production frontier, the technical efficiency of the farm is defined as ratio of observed output to the corresponding frontier output on the condition of level of input used by the farmer. Hence the technical efficiency of the farm is defined as

$$TEi=\frac{Y_i}{Y^*}=\frac{f(X_{ij}\beta)exp(Vi-Ui)}{f(xij\beta)\exp(Vi)-\exp(Ui)} \text{ ---------- (6)}$$

Where TE_i = technical efficiency of farmer j
Y_i= observed output from i^{th} farm
Y^*= frontier output
X_{ij}, β, Vi, Ui=as explained above
TE ranges between 0 and 1 and maximum efficiency has a value of 1.

2.5.2. Data envelopment analysis (DEA)

The history of efficiency measurement goes back to the influential work of Farrell, 1957, who defined a simple measure of firm efficiency. In the approach, Farrell proposed that efficiency of any given firm is composed of its technical and allocative components. According to Farrell, technical efficiency (TE) is associated with the ability of a firm to produce on the iso-quant frontier while allocative efficiency (AE) refers to the ability of a firm to produce at a given level of output using the cost minimizing input ratios. On the other hand, economic efficiency (EE) is the combination of technical efficiency and allocative efficiency. Thus, it is defined as the

capacity of a firm to produce a predetermined quantity of output at a minimum cost for a given level of technology. For estimation of these efficiencies a number of methods have been developed. These methods are broadly classified as parametric and non parametric Methods. DEA was first introduced by Charnes *et al.* (1978) and it has served as the corner stone for all subsequent developments in the nonparametric approach (Hadi-Vencheh and Matin, 2011).

As discussed by several researchers (Coelli *et al.,* 2005; Headey *et al.,* 2010). The data envelopment analysis has several advantages: it does not require a prior specific functional form for the production frontier, it can handle multiple outputs and inputs and it is also possible to identify the best practice for every farm. Furthermore, it also does not require the distributional assumption of the inefficiency term (Coelli *et al.,* 2005). Regarding its potential disadvantages, the technique is sensitive to extreme observations and a hypothesis testing using DEA is not possible. Moreover, DEA attributes all deviations from the frontier to inefficiency. However, despite its weaknesses, DEA is found appropriate and adopted to estimate efficiency of multiple crop producer farmers. Suppose there are *n* homogenous Decision-Making Units (DMUs), in order to produce *r* number of outputs (*r=1,2,3,…k*) *s* number of inputs are utilized (*s=1,2,3,… m,)* by each DMU *i* (*i=1,2,3,…n*). Assume also that the input and output vectors of *i*th DMU are represented by *xi* and *yi*, respectively and data for all DMUs be denoted by the input matrix (*X*)m×n and output matrix (*Y*)k×n. Accounting for financial limitations or imperfect competitive market effects, the DEA model for variable returns to scale (VRS) was developed by (Banker *et. al.,* 1984). The model allows for a given change in inputs use to result in a non-proportionate change in output. Thus, following Banker *et. al*., (1984), the output maximization process to measure technical efficiency for each DMU can be expressed as:

max, $\hat{Z}$

subject to; $x_{i-} - X\lambda \geq 0$

$-\hat{Z}\, y_{i+} + Y\lambda \geq 0$

$N1'\lambda = 1$

$\lambda \geq 0$

where, in the restriction $N1'\lambda = 1$, $N1'$ is convexity constraint which is an $N \times 1$ vector of ones and λ is an $N \times 1$ vector of weights (constants) which defines the linear combination of the peers of the *ith* DMU. $1 \leq \hat{Z} \leq \infty$ and $\hat{Z} - 1$ is the proportional increase in outputs that could be achieved by the *i*th DMU with the input quantities held constant and $1/\hat{Z}$ defines a technical efficiency score which varies between zero and one. If $\hat{Z} = 1$ then the farm is said to be technically efficient and if $\hat{Z} < 1$ the farm lies below the frontier and is technically inefficient. Similarly, to estimate economic efficiency (EE), a cost minimizing DEA is specified as:

$\min_{\lambda,} x_{i*}\ Wi'\, Xi*$

Subject to;

$-y_i + Y\lambda \geq 0$

$Xi* - X\lambda \geq 0$

$N1'\lambda = 1$

$\lambda \geq 0$

where, *Wi'* is a transpose vector of input prices for the *ith* DMU and *Xi** is the cost-minimizing vector of input quantities for the *ith* farm given the input prices *Wi* and total output level *yi*. Economic efficiency is measured as the ratio of potential minimum cost of production (*Wi'Xi**) to the actual cost of production (*Wi'Xi*) as *EE= Wi'Xi*/Wi'Xi*. Allocative efficiency can be estimated as the ratio of economic to technical efficiencies

as *AE=EE/TE*. In order to generate the technical, economic and allocative efficiency scores DEAP Version 2.1 is the computer program to be used.

2.5.3 Tobit regression model

The Tobit regression model is an econometric model that is employed when the dependent variable is limited or censored at both sides. The concept was first proposed by Tobin (1958) in the research of the demand for consumer durables and then it was first used by Goldberger (1964). If the data to be analyzed contain values of the dependent variable that is truncated or censored, the ordinary least squares (OLS) is no longer applicable to the concept of estimated regression coefficients. If OLS is directly used it will lead to biased and inconsistent parameter estimation whereby the Tobit model, that follows the concept of maximum likelihood, becomes a better choice to estimate regression coefficients (Chu et al., 2010). Thus, Tobit regression model is appropriate for efficiency study based on the following justification regarding the nature of the dependent variable.

It is assumed that farmers in the current study areas operate under the same policy and institutional environments and face exogenous variables denoted as *Zi* and that these conditions determine farmers' decision to choose set of input vector *x* and produce output vector *y*. In the production process a given farmer is considered to be fully efficient if it operates along the boundary of the frontier (*Y**) which also defines the level of technology in the system. The boundary of the frontier represents a locus of output points constructed by best practice farms without a room for further improvement in their production process. In this case the output of efficient firms (*Yi*) to the potential output along the frontier is equal (*Y**=*Yi*). Relative efficiency measures is

computed as the ratio of actual (realized) to the potential (frontier) output level (*Yi* /*Y**) (Karagiannis and Tzouvelekas, 2009), of efficient farms will be unity (*Yi* /*Y**=1). On the other hand, firms which are relatively inefficient operate at points in the interior of frontier and score less than unity (*Yi*/*Y**<1) but greater than zero. In this case unless the farmer loses his/her crop due to complete crop failure as a result of pest and diseases infestation or drought, efficiency score will not be zero. Therefore, while the scores are bounded between zero and one (two-limit) with the upper limit set at one, the distribution is censored at both tails. Thus, following Amemiya, (1985), the two-limit Tobit regression model of the following form can be estimated as follows:

$$U_i^* = \beta_0 + \sum_{i=1}^{k} \beta j Zij + \mu i$$

$$U_i = 1, \text{ if } U_i^* \geq 1$$

$$U_i = U_i^*, \text{ if } 0 < U$$

$$U_i = 0, \text{ if } U_i^* \leq 0$$

where: *i* refers to the *ith* farm in the sample, *Ui* is inefficiency scores representing technical and economic inefficiency of the *ith* farm. *Ui** is the latent inefficiency, β*j* are parameters of interest to be estimated and *μi* is random error term that is independently and normally distributed with mean zero and common variance of *δ2* (*μi*~NI (0, *δ2*)). *Zij* are socio economic, institutional and demographic variables.

2.5.4 Importance and application of efficiency studies in agricultural research

The crucial role of efficiency in increasing agricultural output has been widely recognized by researchers and policy makers. The studies of efficiency are particularly important in the developing countries where resources are meager and opportunity for developing and adopting technology are few (Ali and Chaudry, 1990). If farmers are not making efficient use of existing technologies then effort designed to improved

efficiency would be more cost effective than introducing a new technology as a means of increasing output (Shapiro, 1983). Efficiency measurement is important because it leads to sustainable resource saving which is very important for both policy formulation and farm management. Ogunjobi (1999**)** gave some reason why efficiency measurement is important. First that it is a success indicator and performance measure by which farm production are evaluated. Secondly, it is only in measuring efficiency and separating its effects from the effects of production environment that one can explore hypothesis concerning the sources of efficiency differentials. Thirdly, that by identifying the sources of inefficiency is important to the farmers to improve performance, hence providing a mechanism for monitoring the performance of the production system.

Efficiency is an area of study that has attracted the interest of researchers to a great extent. Many attempts have been made to access peasant farmer's efficiency in the developing countries. Early studies on empirical measurement of efficiency of farm households in developing countries started with researcher like Sahota (1968) who worked on efficiency of Indian agriculture. Lau and Yotopoulos (1971) also used a dual project function model to assess both technical and allocative efficiency of Indian farmers. Brief mentions of recent researchers include Obwona, (2000), Ajibefun and Abdulkadir (1999) estimated the technical efficiency for food crop farmers under the national directorate of employment in Ondo Nigeria. The result indicated wide variation in the level of technical efficiency ranging between 0.22 and 0.88. Other researcher like Moses and Adebayo (2007) used stochastic frontier Cobb-Douglas production function model to find the efficiency of factors determining rainfed rice production in Ganye Local Government Area of Adamawa State Nigeria. The resource productivity analysis indicated that seed was over utilized while land and herbicide were

underutilized. Also Shehu and Mshelia (2007) worked on the productivity and technical efficiency of small-scale rice farmers in Adamawa state. The stochastic frontier Cobb-Douglas production frontier model showed that technical efficiencies for the small scale rice farmer's ranges from 74% to 98.9%. Nwaru and Iheke (2010) studied the comparative analysis of resource use efficiency in rice production systems in Abia State of Nigeria. The result of their multiplicative dummy Cobb-Douglas indicated that the upland rice farmers are technically more efficient than the swamp and inland rice farmers and that there is no difference in technical efficiency between the swamp and inland rice farmers. None of the farmer groups achieved absolute allocative efficiency.

Ogundele and Okoruwa (2004) in their study of a comparative analysis of technical efficiency between traditional and improved varieties of rice farmers in Nigeria using the stochastic frontier Cobb-Douglas production function. The result showed that an average technical efficiencies for the two group of farmers were high (>0.90). Also that land area, hired labour, herbicides and seeds contribute significantly to technical efficiency. Okoruwa, *et. al.*, (2006) used the stochastic frontier production function to study rice farmers in north central Nigeria. The technical efficiency of upland and lowland rice were 81.6 and 96.9 respectively, indicating that the upland rice farmers are more efficient than lowland rice farmers. Amaza and Maurice (2005), studied the production of rice in Nigeria and using Cobb-Douglas stochastic frontier production function revealed that technical efficiencies differ substantially among farmers, ranging between 0.26 to 0.97. The wide differences indicate that there is still room for improvement in rice production. Many examples of technical efficiency are applied in many areas of agricultural research. Okoruwa and Bashaasha (2006) used the stochastic production frontier model to study the technical efficiency of upland and lowland rice

production in Niger state. The result of analysis indicated that upland rice farmers are more technically efficient (81.2%) than lowland rice farmers (76.4%) at $P \leq 0.01$.

2.6 Measures of Profitability

This involves the estimation cost and returns production activities. It was reported that cost and returns analysis serve as a very useful tool to compare enterprise where it indicate the profit and loss Gomez (1975).

2.6.1 Net farm income

This simple refers to the return to farm operators for their labour, management, and capital after all production expenses have been paid. It includes farm income as well as net income attributed to the rental value of farm assets, values of commodities consumed, depreciation and inventory changes. Net farm income can also be define as the difference between gross income and total cost of production (Olukosi and Erhabor, 2005). The net farm income account are designed to provide an annual measure of income returns to the farmer which are usually discounted. The technique emphasizes the (fixed and variable cost) and the returns of any production enterprise.

2.6.2 Gross margin

Gross margin analysis by definition is the difference between the gross farm income and the total variable cost. It involves evaluating the efficiency of two or more farm plans so that comparism can be made between the different farms. It is a very useful tool in a farm plan where fixed capital is negligible, which is the case with small scale rice production in the study area. The procedure for selecting the best farm plan is by determining the gross margin of each farm plan on an hectare basis and the crop enterprise with highest gross margin is selected.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study Areas

The study was conducted in four local government areas of Kaduna State namely Kajuru, Kachia, Lere and Soba selected from each of the Agricultural Administrative zones of Birnin Kwari, Samaru, Lere and Maigana respectively. The State is located between latitudes 09^0 02' and 11^0 32' north of the Equator and longitudes 06^0 15'and 8^0 50'East of prime meridian (KADP, 2011). It has a population of 6,113,503.04 (NPC, 2006). The State is divided into 23 local government areas. It is one of the States of the north western zone of Nigerian. The State is ranked third position in population after Kano and Lagos State as shown in 2006 national census. With the current growth rate of 2.47% the total population of Kaduna State in 2015 is 7,614839.58. The weather condition of the State is marked by two distinctive seasons which are the dry season which is between October and April, while the rainy season is between May and September. The rainfall situation also exhibit marked difference between the northern and southern part of the State which ranges from 150mm to 635mm.The natural vegetation of Kaduna is mainly Sudan savannah in the north and guinea savannah in the southern part. For agricultural administrative purposes the state is divided into four agricultural zones, recording about 600,007 farming families (KADP, 2011). The zones are Maigana, Samaru, Birnin Gwari and Lere. Farming remains the major occupation of majority of the population in the study area. Crops cultivated in the study areas include rice, maize, sorghum, cocoyam, yam, groundnut and ginger to mention a few. The people of the study areas are also known for keeping some livestock animals which mostly serve as quick source of revenue. These animals include cattle, sheep and goat, poultry and pigs.

The four local government areas selected for this study are known for various lowland and upland plains that are mostly use for rice. In Lere local government area there are wide ranges of flat plains that are mostly utilized for lowland rice production. At the uplands are wide field of cultivated upland rice. Villages like Abadawa, Federe, Lagga, Lazuru, Wobba and Krosha are highly involve in upland and lowland rainfed rice production. Soba local government area is a continuation of Saminaka flatlands which is known for their high maize cultivation. However some of these uplands are now use to cultivate upland rice while the fadama areas are used for lowland rice production. Prominent villages involved in rice production include Maigana, Kinkiba, Tamba, Fakachi, Soba and Anguwan Dan isa. In Kajuru Local Government Area wide range of fadama lands can be seen along the road in Kufana and Idon villages which are use for lowland rice production. Important villages involved in both upland and lowland rice are Kasuwan Magani, Kasuwan magani fili, and Rimau, Rafin kunu, and Fadaman kororo. Kachia local government area has many tributaries of river which give rise to many patches of fadama lands that are used for lowland rice production. The upland rice production has recently been given prominence in the area probably due to siting of cottage rice processing factory. The following are the villages mostly involved in rice production, Gumel, Kassan kamanton, Kurmin Baba, Sabon gari and Anguwan/ate.

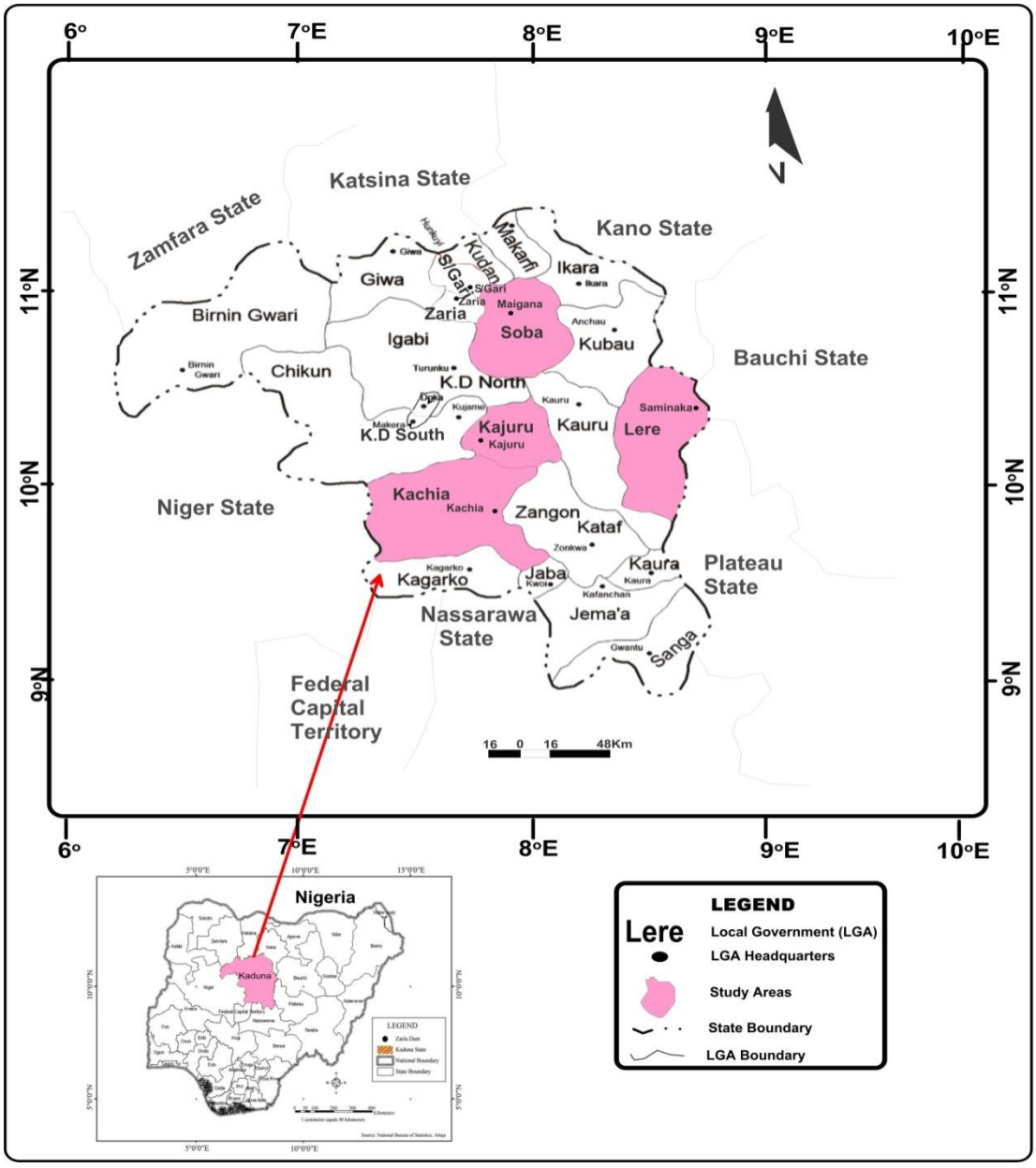


Fig. 1: Map of Kaduna state showing the study areas.

3.2 Sampling Procedure and Sample Size

The study used a multi-stage sampling technique. The first stage was the random selection of four local government areas (LGA) among the ten major rice growing local government areas of Kaduna State. The local government areas selected were Lere, Soba, Kajuru and Kachia. This was achieved by writing the names each of the ten LGAs on separate paper. These papers were squeezed and dropped in a container and shaken well before randomly picking the four LGAs. This was based on the fact that they all fall among the major rice growing local government areas of Kaduna State (KADP , 2011).The second stage involved the purposive selection of two districts in each of the chosen LGA that are mostly involve in growing rice. The list of rice growing districts, villages and farmers were obtained from the fadama desk officers of each local government areas. The third stage was a random sampling of one rice growing village from each of the districts by using the same paper method as below. Finally a random sampling was used to select 50% of the respondents from the sample frame. The choice of 50% was adopted from Krejcie and Morgan (1970) sample size determination table. Therefore the number of respondent in each village will depend on the number of sample frame obtained. However from Table 3.1 at least 17 lowland and 7 upland rice farmers were interviewed in each village and at most 20 and 11 respectively. This gives a total of 150 and 75 lowland and upland rice farmers respectively.

Table 3.1 Sample population and sample size of farmers in each village.

S/N	LGA	Districts	Villages	Sample frame[a]		Sample size[b]	
				Lowland rice	Upland rice	Lowland rice	Upland rice
1	Kachia	Kachia	Angwan Atte	35	18	17.5	9
		Gumel	Kassan Kamanton	35	15	17.5	7.5
2	Kajuru	Kufana	Kufana	39	18	19.5	9
		Kasuwan Magani	Kasuwan Magani	40	22	20	11
3	Lere	Abadawa	Abadawa	40	23	20	11.5
		Lazuru	Lazuru	38	17	19	8.5
4	Soba	Maigana	Kinkiba	37	17	18.5	8.5
		Soba	Fagachi	36	20	18	10
				300	150	**150**	**75**

a= sample frame, is obtained from each of LGA fadama desk offices and department of Agric. b= sample size which is 50% of the sample frame.

3.3 Data Collection

Primary data was used in this study. The primary data was collected by the use of structured questionnaires from selected upland and lowland rainfed rice farmers in the four local government areas of Lere, Soba, Kajuru and Kachia. The questionnaires were used to collect data on the following variables: socio-economic, output, inputs, marketing and constraints variables.

3.4 Analytical Techniques

The data collected from the field were analyzed using the following techniques.

3.4.1. Descriptive statistics

Descriptive statistical tools used include; measurement of central tendency like mean, percentage, frequency distribution and measure of dispersion such as standard deviation. The tool was used to achieve objectives 1 and 5.

3.4.2. Stochastic frontier production function.

The frontier production function is a method of measuring resource use efficiency of each lowland and upland rice farmer. This tool was used to achieve objectives 2, and 3. The empirical model of the stochastic frontier model for rice farmers is specified as follows;

$$InY_1 = \alpha_0 + \alpha_1 InX_1 + \alpha_2 InX_2 + \alpha_3 InX_3 + \alpha_4 InX_4 + \alpha_5 InX_5 + \alpha_6 InX_6 + \alpha_7 InX_{7_7} + V_i - U_i \ldots\ldots\ldots (7)$$

Where *In* = the natural logarithm

Y_1=total farm output of rice (kg)

X_1=cultivated land area for rice (ha)

X_2=family labour (man-hour)

X_3=quantity of seed planted (kg)

X_4= quantity of fertilizer used (kg)

X_5=quantity of agrochemical used (litres)

X_6= quantity of manure (kg)

X_7=hired labour (man-hour)

α_0 =intercept

$\alpha_{1-} - \alpha_7$ = parameters to be estimated

V_j and U_i are as defined below.

3.4.2.1 ***Technical efficiency measurement.***

The model in equation 7 was used for the two groups of farmers. The estimation of equation was accomplished by Maximum Likelihood Estimation available in Frontier 4.1 which has been used by various authors in estimating the technical relationship between the output and inputs of each farm group. The Maximum Likelihood Estimate was equally used to estimate the distribution of technical efficiency among farmers. Many authors have used the traditional method of fitting separate models and then testing the equality of coefficients between the farmer groups in comparative studies (Ogundele and Okoruwa, 2004: 2006; Idiong, 2006; Oladeebo, 2012,). This study adopted the separate fitting for the upland and lowland rice farmers by tabulating their different technical efficiency coefficients and frequency distribution of technical efficiency among the famers for comparism.

The individual farmer's level of technical efficiency (TE_i) is calculated as:

$$TEi=\frac{Y_i}{Y^*}=\frac{f(X_{ij}\beta)exp(Vi-Ui)}{f(xij\beta)\exp(Vi)-\exp(Ui)} \text{ --- (8)}$$

All notation is as stated above,

Such that $0 \leq \ TE \leq 1$

Battese and Coelli (1995), expressed the technical inefficiency as:

$$U_i = R_i\delta + w_{it} \text{ ----------------------------- (9)}$$

Where: w_{it} is the random variable which is defined by the truncation of the normal distribution with zero mean and variance, such that the point of truncation is - $R_i\delta$, i.e. $w \geq R_i\delta$. The inefficiency model was stated as:

$$U_j = \delta_0 + \delta_1R_1 + \delta_2R_2 + \delta_3R_3 + \delta_4R_4 + \delta_5R_5 + \delta_6R_6 + \delta_7R_7 + \delta_8R_8 \text{ - - - ------------------- (10)}$$

Where U_j= the technical inefficiency of the j^{th} farmer

R_1= level of education (Number of years spent in school)

R_2=household size (number of person in the household)

R_3= rice farming experience (years)

R_4= number of contact with extension agent (Number of visits per years)

R_5= sex (1-male, 0-female)

R_6=land ownership (1-owned, 0-otherwise)

R_7=membership of association (1-belong, 0-otherwise)

R_8= access to credit (amount of credit received for rice production in naira)

$\delta 0$-δ_7= unknown parameters which are included in model to indicate possible influence on technical efficiency of the farmers.

The estimation of the technical inefficiency model was accomplished through a joint estimation of the technical efficiency model as specified in Coelli (1996). The comparism of the coefficient of the technical inefficiency of the two production systems therefore follows as that of the technical efficiency.

The variance of the random error $\sigma^2 v$ and that of the technical and allocative inefficiency effect $\sigma^2 u$ and the overall variance of the model are related as follows:

$\sigma^2 = \sigma^2 v + \sigma^2 u$ - -- ----------(11)

$\gamma = \sigma^2 u / \sigma^2$ ----------(12)

γ measures the total variation of output from the frontier which can be attributed to technical or allocative inefficiency and is defined such that $0 \leq \gamma \leq 1$. The σ^2 indicates the goodness of fit and the correctness of the distributional form assumed for the composite error term (Battese and Corra, 1977).

3.4.2.2 *Allocative efficiency measurement*

The allocative efficiency was determined based on individual farm groups of upland and lowland rice production and the calculated allocative efficiency indexes were compared.

The allocative efficiency was calculated using the Cobb-Douglas stochastic frontier cost function stated as follows:

$$\ln Cy = \beta 0 + \beta 1 \ln X_1 + \beta 2 \ln X_2 + \beta 3 \ln X_3 + \beta 4 \ln X_4 + \beta 5 \ln X_5 + \beta 61 n X_6 + \beta 71 n X_7 + \beta 81 n X_8 + Vi + Ui \text{ - ----------(13)}$$

Where:

Cy = Total cost of prodution (Naira)

X_1 = Cost of fertilizer (Naira)

X_2 = Cost of land (Naira)

X_3 = cost of agrochemicals (Naira)

X_4 = cost of manure (naira)

X_5= cost of seed (naira)

X_6= cost of family labour (naira)

$X_{7=}$ cost of hired labour (naira)

X_8 =Total rice output (kg)

β = vector of the coefficients for the associated independent variables in the production function

U_i = are non-negative random variables, assumed to be half normally distributed $|N(0,\sigma U^2)|$ and account for the cost inefficiency in production.

$V_{i\,=}$ are random variables which are assumed to be normally distributed $N(0,\sigma V^2)$, and independent of the Ui

The cost inefficiency model is specified as follows:

$$CE_i = \delta_0 + \delta_1 R_1 + \delta_2 R_2 + \delta_3 R_3 + \delta_4 R_4 + \delta_5 R_5 + \delta_6 R_6 + \delta_7 R_7 + \delta_8 R_8 \text{ ----------(14)}$$

Where: CE_i= Cost inefficiency effect of the i^{th} farmer.

δ_0- δ_7 and R_1- R_8 are as explained in equation 10.

3.4.2.3 ***Economic efficiency, EE****, i*s expressed as the product of technical and allocative efficiencies. The comparism of the economic efficiencies of the two production systems was done when the calculated values of the EE was tabulated.

$$EE = TE \times AE \quad (15)$$

Where: EE = Economic Efficiency, AE = Allocative Efficiency, TE = Technical efficiency.

3.4.3. Profitability analysis

3.4.3.1. *Gross margin analysis*

Gross margin analysis by definition is the difference between the gross farm income and the total variable cost. It is a very useful tool in a farm plan where fixed capital is negligible which is the case with small scale rice producers in the study area. The procedure for selecting the best farm plan is by determining the gross margin of each farm plan per hectare basis and the crop enterprise with highest gross margin is selected. It is reported that gross margin alone cannot give effective decision (Olukosi and Erhabor, (2005). The calculation of the return on investment will further strengthen the decision making on the best profitable investment. Hence to strengthen the gross margin analysis, the return on capital invested in both the upland and lowland rice production was calculated using the following formula in equation 17.

The gross margin analysis was used to achieve objective 4 which is denoted as follows:

$$GM = \sum_{i=1}^{n} P_i Q_i - \sum_{j=1}^{n} P_j X_j \quad (16)$$

Where GM=gross margin

P_i=unit price of paddy rice (₦)

Q_i =quantity of paddy rice (kg)

P_j=unit price of jth input (₦) (j=1…2……7)

X_j =quantity of the jth input (lit or kg) (j= 1…2……7).

Where X_j of 1-7 are as follows;

X_1=cultivated land area for rice (ha)

X_2=family labour (man-hour)

X_3=quantity of seed planted (kg),

X_4= quantity of fertilizer used (kg)

X_5=quantity of agrochemical used (litres),

X_6= quantity of manure (kg)

X_7=hired labour (man-hour)

Return on Investment = GM/TVC …….. (17)

Where:

RI is the return on investment and GM and TVC is as explained above.

3.4.3.2 *The students` t-test.*

The students` t-test was used to compare two distributions which should be approximately normal. The name t-test is given to compare small distributions but it is shown from studies that with higher sample values, the t-distribution will approximates the standard normal values (Udofia, 2008). In this study the two t-distribution samples are the individual farmer's profits from lowland and upland rice production. The interest is to find out whether a significant difference exists in the profitability of lowland and upland rice production.

For the two profit sample test, the students` t-test is given by the following formula:

$$t = \frac{\overline{X} - \overline{Y}}{\sqrt{\left(\frac{\sigma x^2}{Nx}\right) + \left(\frac{\sigma y^2}{Ny}\right)}} \quad \text{……..(18)}$$

Where t = Student t test

$\overline{X}$ = average profit of lowland rice farmers (₦/ha)

$\overline{Y}$ = average profit of upland rice farmers (₦/ha)

σx^2 = variance of X

σy^2= variance of Y

Nx =Sample size of X

Ny = Sample size of Y

The t-value calculated is compared with the t-table value under the degree of freedom .

The decision rule is that Ho is accepted if the calculated value is lower than table value meaning that there is no significant difference in profit level of lowland and upland rice production and vice visa. This will serve as verifying tool to the result of the gross margin.

3.5 Measurement of Variables.

1. Farm output of rice (Y)

This is the physical total output a farmer was able to realize on his plot/s of land. It was measured in kilograms per hectare.

2. Land area cultivated

The average farm size cultivated by a rice farmer irrespective of the technology depends on the availability of land. The land area cultivated was measured in hectares. An apriori expectation of land area in relation to output is directly proportional.

3. Labour

Family or hired labour was measured as the number of man-days used for production per hectare. Eight hours of work equals one man-day. For the peasant farmers in Nigeria labour constitute the most important input. The most important source of labour for most of these small scale rice farmers is the family labour which is often supplemented by the hired labour and group labour which is often rotational among the farmers. The family labour depends on the size of the household the age structure of the household. On the other hand, the amount of hired labour employ in rice production depends on the

availability of the hired labour, the wage rate and nature of farm operations. Rice farming is known to be labour intensive and therefore an apriori expectation is a direct relationship with output all things being equal.

4. Quantity of seed planted

The quantity and types of seed planted by the farmer depend on the production system, suitability of the variety to that particular environment, availability of seed varieties, size of farm, price per unit and available technology to the farmers. The quantities of seeds planted depend on the land area and hence will have a direct relation with the output of rice. This was measured in kilograms per hectare.

5. Quantity of fertilizer applied

This is quantity of fertilizer applied on rice farm. Fertilizer is known as one of the most critical inputs in rice production because of it high response. Two major types are mostly used which include NPK and Urea. The recommended rate of fertilizer application for both upland and lowland production system is 250 - 350kg per hectare (Ogundele and Okoruwa, 2006). Fertilizer as an enhancer of soil fertility gives a direct relationship with the output of rice.

6. Quantity of agrochemicals:

The use of agrochemical has been observed to be on the increase on both upland and lowland rice production. This is because of the scarcity and increasing wage rate of farm labour requirement for weeding. It is expected that application of agrochemicals increases output level. The agrochemical was measured in litres per hectare.

Manure

Manure is an organic fertilizer that helps to boost the soil fertility tremendously due to it complex composition of micro and macro-nutrients. Its application on rice farm therefore increases productivity positively. This was measured in kilograme per hectare.

7. Level of education

This is the number of years of formal schooling of the farm household decision marker. Education enhances the receptiveness and understanding of a farmer about a new technological package and hence improves his efficiency. Level of education is expected to be positive in relation to rice output. It was measured in years.

8. Household size

These include all members of common decision making unit which is usually living within a single residence. Due to increasing cost of hired labour household size is reported to supplying 50% of rice farm labour requirement. Also the impact of household size on productivity depends on the quantity and capacities of the household members and not on sheer numbers (Ogundele, 2003). Household size is in direct relation to the output of rice.

9. Years of upland and lowland rice farming experience

This is the number of years the respondents is involved in rice farming. Since experience is the best teacher, it is expected that the longer the experience in farming, the more likely the person is to be more knowledgeable about rice farming. Therefore a direct relation between years of farming rice and output is expected.

10. Age of farmers

This is the age of the respondents which plays an important role in different farm operations in rice. Hence only those farmers within the productive age group are likely to possess the necessary strength to carry out these operations. An apriori expected relation of age to rice output is therefore indirectly proportional.

11. Number of contact with extension agents

This is the physical number of visit by the extension agent per production season. Such visit enable the extension agent gives the farmer technical advice on rice production. The advice can translate into adoption of new technology to enhance the farmer's production efficiency.

12. Sex

This is the sex of the farmer. Rice production has come an age that it is gender friendly. Because rice is tending towards being cash crop all genders are fully represented. An apriori expected relation of gender participation to rice output is therefore directly proportional. It was measured as a binary variable. 1=male and 0=female.

13. Land ownership

The system of land ownership plays a major role in Nigeria agricultural system. It is the possession of ownership to land specifically for rice production. It was therefore expected to have a positive relation with the output of rice. It was measured as a binary variable.1= owned a land, 0= not owned a land.

14. Membership of association

This refers to belonging to a cooperative society. There are a lot of advantages in belonging to the rice farmers association which can have a direct bearing on total output of the farmer. It was measured in numbers of years of participation.

15. Access to credit

This is the amount of money a farmer was able to generate specifically for the production of rice within one season. This was measured in naira and was expected to have a positive relation with the rice output.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristic of Rice Farmers

The socio-economic characteristics of upland and lowland rice producers in the study area were analyzed and discussed. The results indicate that diverse characteristics are possessed by the farmers and are discussed accordingly.

4.1.1 Distribution of farmers by sex

The analysis recorded that the upland rice had more male farmers than lowland farmers accounting for 89 % and 75 % respondents respectively. The analysis revealed that males are more involve in rice farming than females. A similar result of no female or relatively small number of female indulging in rice farming have been reported in past studies, Okoruwa *et al.* (2009), Quisumbing (1994) and Akinwumi and Djato, (1996). This finding may be attributed to lack of access to productive resources. This may be connected with the tedious nature of the enterprise. Generally, females may not have free access to land which can hinder their involvement in rice farming. That could be why only 8 and 38 of the upland and lowland rice farmers were found to be female, accounting for 10.7 % and 25.3 % of the respondents respectively.

4.1.2 Distribution of respondents according to major occupation

The result on occupation indicates that farming is the major occupation of the respondents. Farming has been highlighted as the major occupation by more of the lowland rice farmers with 89 % than the upland farmers 76 % of upland and lowland rice farmers (Table 4.1). This is similar to report of Mohammad-lawal *et al*., (2013) where they reported over 60% of the respondents with rice farming as their major

occupation. Both groups show that their engagement in farming could bring about long term involvement leading to specialization. Civil servants have been known to engage in agriculture (farming) as part-time occupation. For rice farming in the study area, 16% and 4.7% were engaged in upland and lowland rice farming respectively. Even people involved in other businesses are not left out from farming rice in the area. The result depicts that 2.7% and 5.3% of the upland and lowland rice farmers are also involved in other businesses. This may not give full time concentration in farming. In another way, it is a means of livelihood diversification strategy. Losses from one enterprise are not felt much as diversification is practice. This could also improve livelihood as income is not streamlined to one form or source. Major occupation shows where resources are geared towards. From the result, if most resources are focused to rice farming, the output is bound to increase thereby resulting to high profit and eliminate poverty incidence in the area. The civil servant respondents indicate the transfer of monthly salaries into rice production. This may be inferred that there will be more increase in civil servants' contribution in upland rice production than lowland rice. On the other hand the participation of business men and women, such as market women, tailors, bucklers and so forth, could add more to lowland rice production than the upland rice. Generally with more fund coming from off-farm activities into rice production the expected production output could be met soonest.

Table 4.1: Distribution of respondents according to Occupation

Occupation	**Upland Rice**		**Lowland Rice**	
	Frequency	**%**	**Frequency**	**%**
Farming	57	76.0	134	89
Business	2	2.7	8	5,3
Civil servant	12	16.0	7	4.7
Animal husbandry	3	4.0	1	0.7
Others	1	1.3	0	0

4.1.3 Distribution of respondents according to educational attainment

The farmers in the area had one form of education or the other. General views like those of Amos *et al.,* (2004) and Amaza and Tashikalma (2003), posit that more years in schooling signify higher level of education vi-a-vis understanding of adoption of farming techniques. The result presented in (Table 4.2) shows that 78% of upland rice respondents had 13 and above years of schooling more than their lowland counterpart with only 17% of them had 13 and above years of schooling. This revealed that the upland rice farmers are more educated than their counterpart farming lowland rice. Hence, they could understand various means of improve farming technologies that can help them to be more efficient in their use of resources which could translate to higher outputs. This in agreement with Mohammad-lawal *et al ;*(2009) report that farmers' level of education is expected to influence farmers to adopt new innovations and to make decisions on various aspects of farming. The standard error is indicating the level of variability the farmers' responses to the level of education. The lower standard error of lowland rice farmers implies less spread in the sample distribution and likely accuracy of the sample mean as compared with the population mean.

Table 4.2: Distribution of respondents according to Educational attainment

Educational attainment (years)	**Upland Rice**		**Lowland Rice**	
	Frequency	**%**	**Frequency**	**%**
0	3	4.0	15	10
1 – 6	1	1.3	45	30
7 – 12	12	16.0	65	43.33
13 – 15	33	44.0	17	11.33
16 – 20	26	34.0	8	5.33
Mean (years)	10.9		8.15	
Maximum	18		17	
Minimum	0		0	
Standard Error	0.5020		0.3997	

4.1.4 Distribution of respondents by farm size

Farm land of the respondents is one of the major factors of rice production. The size of the farm shows the capacity of the farmer in rice production. From the analysis conducted, the upland rice farmers sampled cultivate more farm size than their lowland counterpart with an average farm size of 1.46 and 1.30 respectively (Table 4.3). Though, both groups of the farming systems are small-scale producers; the upland rice farmers have larger farms than the lowland rice farmers. This could be due to more available upland farms than the fadama lowland farms which is often limited, couple with the constraints imposed by land fragmentation which was also reported by Ifeanyi and Chris (2009). In their studies Mbanasor and Obioha (2003) attributed small lowland holding to small sizes of fadama lowland area compared to total cultivable land. About (87%) of both upland and lowland rice farmers under study fall into the category of those having between 2 hectares and below. This could suggest that small farm sizes may be as a result of the type of land tenure system practice in rural communities; where family land is divided among all the family members.

Table 4.3: Distribution of respondents according to Farm size

Farm size (Ha)	**Upland Rice**		**Lowland Rice**	
	Frequency	**%**	**Frequency**	**%**
0.01 - 1.0	51	68	106	70.67
1.01 - 2.0	14	18.67	25	16.67
2.01 - 3.0	2	2.67	11	7.33
3.1 and above	8	10.67	8	5.33
Mean (Ha)	1.463		1.301	
Maximum	7		8	
Minimum	0.25		0.2	
Standard error	0.17849		0.12946	

4.1.5 Distribution of respondents according to household size

Household comprise of all members of a house feeding from one source. In other words, it depicts people under the care of one person, who carter for all their responsibilities and are participating in rice production. The result shows that 53 % of the lowland farmers have more household members than the upland farmers with 49 % comprising 7-12 and 1-6 people respectively. The result is similarly reported by Optimum Agricultural Consultant (2007) on a baseline survey of Kano rice value chain where majority of percentage distribution of household size falls between 1-12 members. This indicates that the respondents have fairly large families which can be a source of family labour especially among the lowland rice farmers. The compositions of the members of the household size also affect the output of rice. Where there are more school age children, this could mean that family labour may not be dominant in the area. Children may assist in farming during holidays which may not bring about high output. The level of dependents could result to high expenditure with low savings bringing about high poverty incidence. The respondents with household size of above 18 people constitute 7% and 21% for upland and lowland rice producers (Table 4.4). This could mean that 7% and 21% of the upland and lowland respondents might be facing some managerial challenges of how to manage the meager resources on the farm and the many dependants under control. The negative effect on the efficiency of rice production can lead to lower output.

Table 4.4: Distribution of respondents according to Household size

Household size (No)	**Upland Rice**		**Lowland Rice**	
	Frequency	**%**	**Frequency**	**%**
1 – 6	37	49.3	4	2.7
7 – 12	28	37.3	79	52.7
13 – 18	5	6.7	36	24.0
19 – 24	3	4.0	10	6.7
25 – 30	1	1.3	12	8
31 – 36	1	1.3	5	3.3
37 and above	0	0	4	2.7
Mean (No of people)	8		9	
Maximum	32		47	
Minimum	1		2	
Standard Error	0.687799		0.667232	

4.1.6 Distribution of respondents according to Age

The age bracket of 26 – 45 years is considered an active working age. The upland rice farmers were more in this age bracket than the lowland farmers with 64 % and 53 % of the respondents (Table 4.5). This indicates that most of the farmers are still in their active and energetic period of agricultural engagement. With the full participation of these active groups of farmers, it can translate to increase in rice production. However the age bracket of 56 - 75 years which comprises of 12% of upland rice farmers and 13% of lowland rice farmers could be considered as old age and hence contributing low in the rice production. The finding on age distribution with majority (64 and 53 %) within the class of 26 - 45 years agreed with Idiong *et al*,. (2007), who reported 75 % majority within the same age bracket involved in swamp and upland rice production.

Table 4.5: Distribution of respondents according to Age

Age	**Upland Rice**		**Lowland Rice**	
	Frequency	**%**	**Frequency**	**%**
16 – 25	4	5.3	11	7.33
26 – 35	23	30.7	29	19.33
36 – 45	25	33.3	50	33.33
46 – 55	14	18.7	40	26.66
56 – 65	7	9.33	14	9.33
66 – 75	2	2.7	6	4
Mean (Years)	40.75		43.75	
Maximum	67		71	
Minimum	19		19	
Standard Error	1.2345		0.9408	

4.1.7 Farming experience in upland/ lowland rice farming

Engagement in a specific crop production can lead to higher output as more attention or concentration will be given to its production. The lowland rice farmers were more than the upland rice farmers in number of years of participation in rice production with about 26 % and 20 % respectively, cultivating rice for more than 20 years (Table 4.6). Farming experience is a factor that is reported to enhance agricultural productivity among farming households in Nigeria (Ajani, 2000).

Table 4.6: Distribution of respondents according to Farming experience in rice

Farming experience in rice	Upland Rice		Lowland Rice	
	Frequency	%	Frequency	%
1 – 10	38	50.7	54	36.00
11 – 20	22	29.3	57	38.00
21 – 30	13	17.3	32	21.33
31 – 40	2	2.7	6	4.0
41 – 50	0	0	1	0.67
Mean	13.49		16.44	
Maximum	40		50	
Minimum	2		1	
Stadard Error	1.0413		0.7826	

4.1.8. Credit accessibility by the upland and lowland rice farmers

The farmers who had access to credit represented about 47% and 37% with a mean amount of ₦131867.16 and ₦42200.50 for upland and lowland rice producers respectively. This implies that more of the lowland rice than upland rice farmers was not able to accessed credit which implies that farmers were using their personal savings for the production. The appropriate application of production credit on the farm can lead to increase in rice output as reported by Bifarin *et al*,. (2010) in their study on the determinants of technical, allocative and economic efficiencies in the plantain. The number of farmers who were unable to accessed credit was the majority in both production implying that expansion of rice land and purchase of needed inputs were hindered in both production systems. The high standard errors of both systems of production is implying high spread in the sample distribution of access to credit, which was indicated with many of the farmers not accessing credit. The farmers that accessed credit have high variability with wide ranges of ₦2500.00 - ₦1500000.00 and ₦1000 – ₦500000.00 for upland and lowland rice farmers respectively.

Table 4.7: Distribution of respondents according to access to credit

Variables	Upland rice		Lowland rice	
	Frequency	%	Frequency	%
No access tocredit	40	53	94	63
<10000	20	27	35	23
10001-200000	8	11	14	10
200001-400000	4	05	5	03
400001-600000	2	03	2	01
>600000	1	01	0	0
Mean	131867.16		42200.50	
Maxmum	1500000.00		500000.00	
Minimum	2500.00		1000.00	
Standard Error	302.4130		210.2147	

4.1.9 Reasons for cultivating Rice

The reasons for preference of a particular system over the other differ from respondent to other. The general view is that a farmer should have reasons for engaging in an enterprise. For the upland and lowland rice a set of question was framed to enable the respondents choose reasons why they prefer certain system of production over the other and their response were as shown in Table 4.8. The upland rice farmers gave the highest response of 94.67% that the system can easily substitute many crops; thereby enabling the farmer to switch in and off this production system when the condition is favourable and when is not. This is achievable because upland rice shared the same type of land that is used by many upland crops. On the other hand lowland rice farmers believe that the high grain yield of lowland rice was the most important reason for their choice of that system (97.33%). This was followed by high tillering ability of the lowland system which accounted for 96.67% that could be due to constant moisture on the lowland. An

interesting response of the farmers was in area of less labour where 84% and 57.33 % of upland and lowland rice farmers were recorded respectively.

Table; 4.8: Distribution of respondents according to reasons for cultivating rice.

Reason	Upland rice		Lowland rice	
	*Frequency	%	*Frequency	%
High grain yield	66	88.00	146	97.33
Tillering ability	61	81.33	145	96.67
Easily substitute many crops	71	94.67	119	79.33
Resistance to Pest and Disease	65	86.67	131	87.33
Early maturing	67	89.33	102	68.00
High market value	60	80.00	132	88.00
Less labour	63	84.00	86	57.33
Others	2	2.67	2	1.33

*Multiple responses allowed

4.2 Technical Relationship between the Inputs and Outputs of the Rice Production Systems

4.2.1. Estimation of stochastic frontier production model

The stochastic frontier production model was estimated using the maximum likelihood estimate of Cobb-Douglas stochastic frontier and the result is presented in Table 4.9. The variance ratio defined by equations (11 and 12) which is associated with the variances of the technical inefficiency effects in the stochastic frontier is estimated for the two production systems. The log likelihood ratio value which represents the value that maximizes the joint densities in the estimated model shows values of 67.8 for upland and 147.2 for lowland exceeding the critical chi-square values of 21.666 at 1% level of significance with number of restriction (degree of freedom) of 9. Therefore, the Cobb-Douglas functional form adequately represents the data. Similarly, the gamma statistics of 0.97985 and 0.98734 for upland and lowland rice systems of cultivation indicated that 97.99% and 98.73% of the variation in farm output are attributed to

inefficiency of the farmers cultivating upland and lowland rice respectively. Thus, it shows that technical inefficiency effects were present in rice farming in the area of study. Therefore, the parameter estimate of $\gamma = 0$ is hereby rejected for the two groups of farmers. In the same vein, the significant level of these variances depicts the presence of one-sided error component, Vi in the specified model. As a result of this one-sided error component, estimation by the Ordinary Least Square (OLS) cannot represent the data adequately. Hence, using Stochastic Frontier function estimated by the Maximum Likelihood Estimation is appropriate for the data. Therefore, the assumption, which states that the inefficiency effects are not stochastic, is rejected. The correctness of the specified assumption of the distribution of the component error terms is tested by the significant levels of the sigma-square ($\sigma 2$). The 1% levels of statistical significance shows the appropriateness of the assumption for the distribution of the component error term. The result of the maximum likelihood estimates of the production function showed diverse relationship among the two systems of rice production in the study area which are hereby discussed.

Farm Size: The coefficients of farm size portray positive values for both systems (0.53810 and 0.31356); implying that the higher the sizes of the farms the higher the output of rice obtained in the area. This means that, rice farmers with larger farm sizes tend to produce higher quantity of rice than their counterparts with smaller farm sizes, other factors held constant. This agrees with the *a priori* expectation that farm size conform to increased output which is consistent with result of Amaza and Maurice (2005) and Ogundele and Okoruwa (2004). Farm size which is an immobile factor of production tends to diminish alongside infrastructural development. From the analysis

of technical efficiency, it indicates that, farm size is an important factor of production based on its significant levels at 1% for both production systems.

Table 4.9: Maximum likelihood estimate (MLE) of frontier production function for upland and lowland rice producers.

Variable	Upland rice			Lowland rice		
	Coefficient	**Standard error**	**t-ratio**	**Coefficient**	**Standard error**	**t-ratio**
Production model						
Constant	17.62301***	0.85243	20.67385	4.16472***	0.26158	15.92140
Farm size	0.53810***	0.09836	5.47072	0.31356***	0.07375	4.25106
Family labour	0.00138**	0.00062	2.22581	0.07375***	0.01513	4.87442
Quantity of seed	0.12384***	0.02015	6.14591	0.36211***	0.08043	4.50218
Fertilizer used	0.10216***	0.02214	4.61427	0.10085*	0.05889	1.71251
Agrochemicals	0.00258***	0.00076	3.39474	0.00371	0.24360	0.01523
Manure	0.02123***	0.00302	7.02980	0.09421	0.77744	0.12118
Hired labour	0.05238***	0.00574	9.12544	0.00951	0.00746	1.27480
Technical inefficiency model						
Constant	4.27621***	0.40151	10.65032	1.05624***	0.08607	12.27187
Education	-0.01035***	0.00173	-5.98266	0.01072	0.00690	1.55362
Household size	0.31098**	0.13291	2.33978	-0.30021***	0.02958	-10.14909
Farming experience	-0.04211***	0.01232	-3.41802	-0.00935	0.00534	-1.75094
Extension contact	-0.01021**	0.00512	-1.99414	-0.00932	0.04667	-0.19970
Sex	-0.04231***	0.00812	5.21059	0.07075**	0.03212	-2.20268
Land ownership	-0.00261***	0.00092	-2.83696	0.01635*	0.00932	1.75429
Association	0.01071***	0.00251	4.26693	0.00792	0.01275	0.62118
Credit	0.34265***	0.02894	11.84001	0.12508***	0.02448	5.10948
Variances						
Sigma-squared	0.07925***	0.02094	3.78462	0.42152***	0.05805	7.26133
Gamma	0.97985***	0.04418	22.17859	0.98734***	0.03063	32.23441
log likelihood function	-67.825			147.235		

******* P < 0.01, ** P < 0.05 and * P < 0.10.

Family Labour: The coefficients of the estimated variable, family labour were positive for both upland and lowland rice. This positive relationship implies that 1% increase in family labour will lead to an increase in rice output by the values of the coefficients of both production systems. The two production systems are significant at 5% and 1% for upland and lowland rice farms respectively. This could be so because using family

labour mostly translates into saving of income meant for hired labour. This result agrees with the study of Amaza and Maurice (2005) where they identified factors that influence technical efficiency in rice base production system in Nigeria. The strongly significant family labour in lowland than upland implies that they engaged more family labour than upland farmers.

Hired Labour: Hired labour recorded a positive sign for upland and lowland groups of rice farming systems (0.05238 and 0.00956). It revealed that the use of hired labour will result to higher output of rice in the area; it was significant in the upland rice farming system at 1% level of probability. This is in agreement with the general opinion that labour adds significantly to output. Tchale (2009) reported that hired labour is one of the key factors in the production of major crops grown by the majority of small holder farmers. This is obvious that labour is a key factor of production, but when it is not adequately and appropriately used, it could lead to poor output. The non significant of hired labour is in line with Kaine (2011) finding in a study of technical efficiency of Akpu processors in Delta state, south-south Nigeria. The insignificant influence of hired labour in the lowland rice production could also be due to unwillingness of labourers to work in the waterlogged farm land. Therefore, this group of farmers resorts to the use of family labour which shows significant influence.

Quantity of seed: Quantity of seed for rice producers showed a positive relationship of 0.12384 and 0.36211 for the upland and lowland systems respectively. This relationship implies that the higher the quantity of seed used for the cultivation of rice the higher the output. This conformed to the general expectation that higher quantity of seed will result to increased yield. A contrary result of negative coefficient was obtained by Shehu and

Mshelia (2007) in their work on productivity and technical efficiency of resource use among small-scale rice farmers in Adamawa State. Quantity of seed used by the two systems of farmers was positively significant at 1% level of probability; indicating the importance of the variable to rice production.

Fertilizer: In the cultivation of rice by the two (upland and lowland) systems of cultivation, the estimated coefficients of the variables were positively (0.10216 and 0.10085) signed for the upland and lowland systems respectively. The result depicts that higher and appropriate usage of fertilizer by the upland farmers would bring about increased output of the crop. Fertilizer was significant in both production systems. The result is conforming to the report of Dipeolu and Akinbode, (2012) where fertilizer was reported significant in pepper production in South Western Nigeria. Quantity of fertilizer used was significant at 1% and 10% level of probability for the upland and lowland rice farmers respectively. The significance of the variable implies that fertilizer application is relevant in the production of rice in both systems. The 1% significance for upland indicates the good absorption of fertilizer due to the conducive environment in the upland area than in the lowland area.

Agrochemical: Estimated coefficient for agrochemicals used in the production of upland and lowland rice revealed a positive sign (0.00258 and 0.00371) respectively. The signs indicate that as agrochemicals used by the upland and lowland rice farmers' increases, quantity of rice produced by the farmers' increases as well. Agrochemical was significant at 1% level of probability for the upland system of production. This could be due to the conducive factors for agrochemical application in the upland. That makes the agrochemical more effective on upland rice system than lowland which is

often moist and waterlogged. The insignificance of agrochemicals in lowland was also reported by Amaza and Maurice (2005) in their study of identification of factors that influence technical efficiency in rice base production systems in Nigeria.

Manure: Manure was noticed to be positively signed (0.02123 and 0.09421) for the upland and lowland rice of cultivation systems respectively. This is in line with the expectation. Manure is mostly organic substances that are added to the soil to increase its fertility. The analysis implies that if quantity of manure used by upland rice farmers increases, rice output tends to increase as well. The result implies that farmers who use smaller quantity of manure are bound to harvest smaller quantity of rice from the farm. Manure was found to significantly affect upland production at 1% level of probability. This is so because of the poorer nature of upland soil fertility and so manure will give a boost to the soil fertility. On the other hand lowland farmers need little or no applications of manure since it is often fertile from the rainfall wash off from the upland to the lowland, hence the insignificant coefficient. Ogundele and Okoruwa (2004) reported that small scale farmers do switch off from inorganic fertilizer to organic manure due to high cost of the former.

4.2.2 Return to scale in upland and lowland rice production

The return to scale (RTS) analysis, which serves as a measure of total resource productivity, is given in Table 4.10. The maximum likelihood estimates (MLE) of the Cobb-Douglas based stochastic production function parameter of 0.84167 and 0.95770 for upland and lowland farmers respectively were obtained from the summation of the coefficients of the estimated inputs (elasticities). It indicated that, rice production in both systems were in the stage II of the production surface. Stage II is the stage of

decreasing positive return-to scale, where resources and production were believed to be efficient, called the rational stage. This is in conformity with the report of Tsoho *et al.*, (2012) where they showed a decreasing positive return to scale among dry season vegetable farmers in Sokoto state, Nigeria.

Table 4.10: Return to scale in upland and lowland rice production

Variables	**Elasticities**	
	Upland rice	**Lowland rice**
Farm size	0.53810	0.31356
Family labour	0.00138	0.07375
Quantity of seed	0.12384	0.36211
Fertilizer	0.10216	0.10085
Agrochemicals	0.00258	0.00371
Manure	0.02123	0.09421
Hired labour	0.05238	0.00951
Return to scale	**0.84167**	**0.95770**

4.2.3 Estimation of technical inefficiency model

Technical inefficiency of rice production was analyzed; the result shows that various impacts were recorded. A negative value for the production inefficiency variable implies a positive effect on the technical efficiency and vice versa. The significant level indicates the importance of the variable on the technical efficiency of rice.

Years of Education: The negative estimated coefficient for years spent for education for upland rice producers implies that the respondents with greater years of schooling tend to be more technically efficient, because technical efficiency tend to increase as schooling years increases. The coefficient of education is in consonance to the

hypothesized expected sign. This agrees with the finding of Coelli and Battese (1996), Seyoum *et al.* (1998), Amaza and Tashikalma (2003), Amos *et al*. (2004), Amaza and Maurice (2005) and Shehu and Mshelia (2007). It is believed that with more years of formal education, new technologies could be better understood and adopted, which subsequently make it possible to move closer to the production frontier. Education coefficient was found to be statistically significant at 1% level of probability for upland. The insignificant and positively signed coefficient for lowland rice producers indicated that the farmers depend on their personal knowledge rather than the formal knowledge. The significance of educational attainment implies that education is an important variable for rice production under the upland system of cultivation. This is because education facilitates adoption of innovation.

Household Size: Household size coefficient was positively (0.31098) and negatively (-0.30021) signed for upland and lowland farmers. An increase in the number of people in a household will lead to a decline in technical efficiency of the upland rice farmers. Therefore, upland rice respondents with larger household sizes tend to be more technically inefficient than households with lesser people. This agrees with the finding of Latifat *et al*., (2013) and Asogwa *et al.,* (2011). On the other hand, the lowland rice producers' negative relationship with household size signifies an increase in technical efficiency. This means that lowland rice farmers with more number of people in the house tend to be more technically efficient in rice production. This could be that farmers tend to substitute hired labour with family labour thereby, reducing the cost of production. Moreover, these household members may have been working together for some time which can bring about specialization and effective use of productive resources. Household size significantly affects technical inefficiency of rice production

in the area at 5% and 1% level of probability for upland and lowland rice farming system practitioners.

Farming Experience in Upland and Lowland Rice Production: Farming experience for the cultivation of upland and lowland rice production coefficients revealed an inverse relationship with technical inefficiency vis-à-vis positive relationship with technical efficiency. This inverse relationship indicates that more years dedicated to rice farming results to increased technical efficiency leading to higher output. Hence, rice farmers with few years of experience tend to be less efficient than those with higher years of cultivating rice using the two systems. This is because with more years of experience in the production, the farmer gained more knowledge on how to process information on inputs prices and technology. The coefficient of farming experience was found to be significant for the upland rice production system at 1%. This result is consistent with the finding of Bakari (2010) and Ojo and Ajibefun (2000).

Extension Contact: Access to extension contact revealed negative relationship for the upland and lowland systems of cultivation by the respondents in the area. The negatively signed coefficients of extension contact for both systems portrayed a reduction in technical inefficiency with increased contact of the farmers with extension agents. This implies that upland and lowland rice farmers with more extension contacts tend to be more technically efficient than those with fewer extension contacts. This is in line with the general opinion concerning extension services which serves as the medium for educating farmers on new innovations before adoption of the technology. This result support the finding of Bravo-Ureta and Evenson (1994), Bifarin *et al*. (2010) in their separate studies that reported that there is a positive connection between farm

level efficiency and availability of extension services. The 5% level of significance of extension contact on upland rice production imply that extension contact could facilitate the output of upland rice production through adoption of new technologies provided by various organizations. The insignificant coefficient of extension contact in lowland rice could be either the extension services programme is not adequately designed to inculcate a particular innovation or system of farming or untimely delivering of the extension services.

Sex: The variable, sex, had negative value for the upland rice production and positive coefficient for the lowland rice farmers. The negative coefficient of the variable for the upland rice producers' implies that males are more technically efficient than the females. Whereas, for the lowland rice farmers, the positive sign of the coefficient depicts that females tend to be more technically efficient than their male counterparts, agreeing with the finding of Asogwa *et al.*, (2011). This result is obvious because men have more ability to endure the arduous task associated with farm work more than women; hence, they are likely to dominate the upland rice production more efficiently. Sex was found to be significant at 1% and 5% level of probability for upland and lowland farmers respectively. This is indicating that the participation of both sex are important towards the increase of rice production in the area and therefore a fair level ground should be provided to all in terms of access to inputs of rice production.

Land ownership: The coefficient of land ownership was found to be negative and positive to upland and lowland rice production systems respectively. The result reveals that land ownership for the upland rice producers is negatively signed, indicating that land owners tend to be more technically efficient than those who do not own land. The

work of Dipeolu and Akinbode (2012) also showed similar finding. This could be that the land owners value the land therefore they make full use of the land. Contrary, land ownership add positively to technical inefficiency of the lowland farmers, implying that rice farmers who own land on their own tend to be more technical inefficient than those who do not own it; that is those who lease, rent, or borrow. This is obvious as farmers who have their own land may not put in much effort to exploit all the uses of the land. The farmers who lease, rent or borrow land may want to use all avenues to attained maximum profit from the land. For upland rice sampled farmers, land ownership was found to be significant at 1% level of probability; indicating the relevance of land ownership to technical efficiency in the production of upland rice. The coefficient of lowland production was significant at 10%.

Membership of Cooperative Association: Coefficients for membership of Association for the upland rice farmers had a positive value implying that it has negative effect on technical efficiency. This suggests that farmers' technical inefficiency would increase the longer rice farmer stays in Association. This collaborate the work of Shehu *et al*., (2010), where they stated that membership of association has positive effect on technical inefficiency in yam production in Benue State, Nigeria. The negative effect of membership of association on technical efficiency is an indication that those who belong to Association tend to be more technically inefficient than those who do not belong to rice farmers association. Membership of association was significant at 1% in the upland rice indicating the supposed importance of belonging to an association. Association enhances efficiency among farmers as association serve as a medium for information on input and output exchange to improve yield.

Access to Credit: The coefficients of access to credit were positively signed for both system of production and were significant at 1% level of probability. The positive sign is implying that credit increases the inefficiencies of upland and lowland rice farmers. This is in corroborating the finding of Bifarin *et al.*, (2010), who showed that receiving credit contributed to farmers' economic inefficiency. If production credit is invested on the farm, it is expected to lead to higher levels of output, but in case the credit is not accessed on time, it may lead to misapplication of funds. Hence, the expected impact of such funds will not be felt on the farm. If, however, the credit is invested in consumption purpose (as common with most farmers), credit may likely not lead to an improvement in the level of technical efficiency.

4.2.4 Estimation of the allocative stochastic frontier model

The variances of the allocative model shown in Table 4.11 indicate positive and significant values for sigma squared designating the presence of a one-sided error component in the models. This is in conformity with the assumption of the stochastic frontier on error components. Similarly, the Gamma coefficients were positive, very high and statistically significant at 1% level of probability, thereby, fulfilling the assumption of the model on presence of inefficiency factors. The gamma parameter estimate for upland and lowland rice were 0.9999 and 0.9798 respectively implying that 99.99% 97.98% of the variation in the total cost of producing rice in the area by the respondents were due to differences in their cost efficiencies. This depicts that cost inefficiency contribute significantly to the total cost of rice production by both groups of farmers in the study area**.** So, the assumption that the parameter estimate of gamma (γ) = 0 is rejected. In the same manner, the log likelihood ratios of 24.26 and 136.11 for upland and lowland rice respondents; exceeding the chi-square critical values

at 5% and 1% level of probability with number of restriction (degree of freedom) of 9, χ^2(5%,9) and χ^2(1%,9) which are 16.919 and 21.67, showing the presence of allocative inefficiency. Thus, the assumption that the inefficiency effects are absent from the model, is therefore rejected. From the result, various factors are accountable for the total cost of producing rice in the area.

Cost of Fertilizer: Cost of fertilizer recorded positive estimated coefficients. The variable therefore contributes positively to the general allocative efficiency in rice production. This shows that cost of fertilizer have a direct effect on cost allocation. The positive relationship of this variable on allocative efficiency indicates that an increase in the cost of fertilizer will result to an increase in total cost of producing rice by the farmers. Cost of fertilizer was found to be significant at 1% level of probability for the upland rice producers which agree with the finding of Asogwa *et al.,* (2011) and Oniah *et al.,* (2008). The cost of fertilizer not being significant in lowland rice is against the expectation. The insignificance of fertilizers could be attributed to their scarcity at the time they are needed most. Hence, farmers resort to using quantities that are far below the recommended doses. Thus, increasing the use of fertilizer will add to the total profit by minimizing it cost in an efficient manner. This is in agreement with Ogundari (2008), in his analysis on resource productivity, allocative efficiency and determinants of technical efficiency of rain-fed rice farmers in Ondo State found that 64% of his respondents under-utilize fertilizer while 36% over-utilized it. It may be connected with the topography of the farms. Lowland rice production is carried out in water-logged environments whereby application of fertilizer may be challenging and might not be appropriately applied by some of the farmers. More over the lowland soil could be more

fertile due to deposit of manure by flood during the rainy season, and hence requiring little amount of fertilizer.

Table 4.11: Maximum Likelihood Estimate (MLE) of Cobb-Douglas Frontier Cost Function for Upland and Lowland Farmers

Variable	Upland Rice			Lowland Rice		
	Coefficient	S/Error	T-ratio	Coefficient	S/Error	T-ratio
Constant	2.74251***	0.23621	11.61047	6.02153***	0.35212	17.10079
Cost of fertilizer	0.28603***	0.03482	8.21453	0.00147	0.00271	0.54244
Cost of land	0.19725***	0.04057	4.86197	0.00217***	0.00077	2.81818
Cost of Agrochemicals	0.01308*	0.00738	1.77236	0.01239	0.02061	0.60116
Manure cost	0.01410 **	0.00671	2.10134	0.00721	0.00871	0.82778
Cost of seed	0.15232***	0.05833	2.61135	-0.08211*	0.04873	-1.68500
Cost of family labor	-0.07251*	0.04350	-1.66690	-0.10052***	0.03258	-3.08533
Cost of hired labor	0.41322***	0.07881	5.24324	0.052110	0.03348	1.55645
Output	0.08701***	0.01224	7.10866	0.20143***	0.03950	5.09949
Allocative inefficiency						
Constant	0.76741***	0.09280	8.26950	0.29516***	0.06523	4.52491
Education	-0.03015***	0.00331	-9.10876	-0.00152	0.00286	-0.53147
Household size	-0.00212*	0.00121	-1.75207	-0.00324***	0.00037	-8.75676
Farming experience	-0.00310***	0.00078	-3.97436	-0.01021***	0.00101	-10.10891
Extension contact	0.01257	0.00830	1.51446	0.00572	0.02097	0.27277
Sex	-0.00889**	0.00418	-2.12679	0.07325	0.06519	1.12364
Land ownership	-0.04158***	0.00739	-5.62652	-0.00917***	0.00118	-7.77119
Association	0.00215	0.00187	1.14973	-0.01361***	0.00202	-6.73762
Credit	0.10042**	0.04240	2.36840	0.08121	0.08111	1.00123
Variances						
Sigma-squared	0.06214***	0.00837	7.42413	0.28151***	0.03120	9.02276
Gamma	0.99999***	0.00099	1010.09	0.97988***	0.00389	251.8972
Log likelihood function	24.2615			-136.11		

*** $P < 0.01$, ** $P < 0.05$ and * $P < 0.10$.

Cost of Farm Land: The estimated coefficients for cost of farm land for the upland and lowland rice respondents showed a direct relationship with allocative efficiency and that corroborate the finding of Dipeolu and Akinbode (2012) where they reported a positive and significant cost of land in pepper production in south western Nigeria. This relationship implies that an increase in the cost of farm land will result in reduction of

allocative inefficiency. It is plausible that, the farmers are able to manage the size of their farms effectively thereby resulting to appropriate allocation of scarce resources for the production of rice. The variable showed direct effect on cost allocation. The positive correlation between cost of farm land and cost allocation indicates that an increase in cost of farm land will result to an increase in total cost of production of rice. Cost of farm land was significant at 1% levels of probability for the upland and lowland rice producers. This means that cost of procuring farm land significantly affects rice producers' cost allocation.

Cost of Agrochemicals: The coefficients of the cost of agrochemicals would bring about increase in the total cost of production for both systems of cultivating rice in the area. This emanated from the positive signs of the coefficients for both groups of farmers. This is implying that a rise in the cost of agrochemicals can increase the total cost of rice production by the same amount of the coefficients all things being equal. This showing similar report to that of Dia *et al*.,(2010) they reported positive and significant coefficient of agrochemicals among small scale maize farmers in Mubi, Adamawa state Nigeria. Hence, price of agrochemicals could affect production cost positively vis-a-vis income being negatively affected as a result of high production cost. Agrochemicals' cost was significant at 10% level of probability for the upland rice respondents but not significant for the lowland rice sampled farmers. It implies that allocative efficiency is significantly affected by the cost of agrochemicals incurred by the upland rice respondents. This could be due to more usage than in lowland system because of the environmental convenience in it application.

Cost of Manure: The coefficient for manure cost was positive in both upland and lowland rice production, this means that increasing the cost of purchasing manure will result to an increase in the total cost of production and giving rise to allocative efficiency. It is easier to fertilize upland areas than the lowland. This is because the lowland areas are majorly water-logged; hence, difficult to add manure which may be wash off by flood thereby not having much effect on the soil. If more income is save from the purchase of fertilizer, and used for manure, it could lead to lower total cost of production. The cost of manure was found to be significant at 1% level of probability for the upland rice farmers. This conform to the finding of Ogundele and Okoruwa (2004) where they asserted that small scale farmers do switch from inorganic fertilizer to manure when the cost of the former rises.

Cost of Seed: The coefficient for cost of seed was observed to be positive for upland rice producers, showing a positive relationship with total cost of producing upland rice in the area which agrees with finding of Dia *et al*., (2010). This implies that a rise in the cost of upland rice seed would result to increase in the total cost of production. This could be resulting from high cost of improved seeds. Cost of seed for the upland rice production was significant at 1% probability level, indicating the relevance of cost of seed to the production of upland rice. This is obvious as seed is the variable that is transformed into output, hence output cannot be realized without seed. On the other hand, the coefficient of lowland rice producers for cost of seed was negatively signed and significant at 10%. This means that an increase in the cost of lowland rice seed will cause a reduction in the total cost of production and affects allocative efficiency negatively.

Cost of Family Labour: Upland and lowland rice production recorded similar signs for the cost of family labour. The result shows that upland rice production has a negative relationship with total cost of production and this conform to the finding of Asogwa *et al*.,(2011). This means that 1% increase in the cost of family labour will bring about a decrease in the total cost of production by 0.0725% of upland rice in the area. This could be so as labourer from the family may be very knowledgeable to the farming practices and how to use the inputs effectively thereby leading to proper use of resources which can decrease cost of production. The ability of a farmer to manage resources effectively depends on his knowledge on management practices. Similarly, the result of the sampled lowland rice farmers revealed that the coefficient of the cost of family labour do reduce total cost of lowland rice production. This is due to the negative sign of the variable which means that an increase in the price of the variable do result to total cost of production decrease; hence, affecting allocative efficiency positively. The variable was significant at 10% and 1% for the upland and lowland rice systems of rice cultivation respectively. The significant level of the variable indicates its relevance to the production of rice by the farmers.

Cost of Hired Labour: Cost of hired labour for the upland rice showed a positive sign and significant at 1% level of probability, indicating a positive impact on total cost of production showing similar finding by Tijani and Bakari (2014) in their study on the determinant of allocative efficiency of rain fed rice production in Taraba state, Nigeria. The outcome of their high knowledge and time devoted to the production of upland rice could translate into ineffective and wasteful production period. On the other hand, cost of hired labour for the lowland rice was positive, meaning it adds to the total cost of producing lowland rice. The impact of cost of hired labour on lowland rice production

in the area was not significant. This is possible because, hired labour could be substituted by family labour which the lowland farmers possessed higher than in upland as showed earlier in the socio-economic characteristic analysis and viewed as a cheaper source of labour, thereby affecting allocative efficiency positively.

Output: From the analysis, output recorded positive values among the sampled rice respondents. The positive correlation indicates that both systems of rice cultivation contribute positively to the total cost of production; meaning that, increased output results to increased total cost of production. It was also noticed that output realized significantly affect total cost of production at 1% level of probability. It is likely so, because higher output always result from good use of resources and increased farm size. The result of this research agrees with the findings of Ogundari *et al.*, (2006) where they observed a positive effect of output on total cost of production in their study on economies of scale and cost efficiency in small scale maize production in Nigeria.

4.2.5 Estimation of allocative inefficiency model.

Years of Education: The coefficient of educational attainment represented by the years of schooling was observed to be negatively signed for the upland rice farmers; signifying an direct relationship with cost efficiency due to negative correlation with allocative inefficiency. The implication of this result is that as educational attainment of the respondents increases by 1%, allocative efficiency will increase by the value of the coefficient of the variable. This means that rice farmers with higher level of schooling tend to allocate their inputs more efficiently than their counterparts with lower schooling years. The result is confirming the assertion that educational attainment affects financial planning of an individual, bringing about understanding of the

enterprise, which invariably affects cost efficiency positively. The result revealed that educational attainment has significant effect on cost allocation of upland rice respondents under study at 1% level of probability. This indicates that education is vital in decision-making that affects input cost allocation when cultivating rice using upland system of farming. In like manner, the lowland rice system of production recorded an inverse relationship with allocative inefficiency. This means, farmers with more years of schooling tend to be more efficient in the allocation of their financial resources. This finding is conforming to the a priori expectation agreeing with the report of Asogwa *et al.*,(2011) in their study on technical and allocative efficiency analysis of Nigerian rural farmers.

Household Size: The coefficient for the household size of the upland rice producers was negatively signed; implying a negative effect on allocative inefficiency of the respondents. Upland rice farmers with larger household sizes tend to be more cost efficient than their counterparts with smaller household sizes. This may be attributed to the cheap family labour and services sorted from the family members which lead to reduction in total cost thereby increasing the allocative efficiency. The lowland rice farmers' household size also had a negative sign showing an inverse correlation with allocative efficiency thereby increasing efficiency. 10% and 1% levels of significance were obtained for household size for both groups of systems of cultivation, indicating the relevance of the variable in cost allocation among respondents. This finding is conforming with Nwachuku and Oyenweaku (2007) in their study of allocative efficiency among fadama fluted pumpkin farmers in Imo state, Nigeria.

Rice Farming Experience: The coefficient for farming experience for both systems were negatively related to cost inefficiency, indicating an inverse effect on allocative inefficiency which is consistent with Dipeolu and Akinbode (2012). This means if farmers' farming experience increases there would be a fall in the farmers' allocative inefficiency. The negative relationship with allocative inefficiency is in agreement with the expectation, signifying that as farming experience increases, allocative inefficiency also decreases. This effect could be that, as farming experience increases strict adherence to methods of financial and resource allocation are consistently adhered to. The farmers also will have better ability to obtain information about prices and technology. The probability level was significant at 1%, implying that farming experience is very pertinent in the production of rice through upland and lowland rice production.

Extension Contact: Access to extension contact estimated coefficient was positively related with allocative inefficiency of both groups of respondents confirming the finding of Ifeanyi and Chris (2009). Respondents with access to extension contact tend to be less cost efficient than their counterparts without extension contact. The result contradicts the assertion that extension agents serve as educators and information bearers on new innovations to clientele. It may be suggested that because rice farmers in the area sort for information from various sources, other than extension agents, hence the extension agents' information is not seen as new. The extension contact accessibility for the upland and lowland rice producers were insignificant, indicating the weak extension agents' information to upland and lowland rice production.

Sex: The coefficient of the variable sex, possess a negative sign for the upland rice production and a positive sign for the lowland rice production. The result of the upland rice respondents showed that males are more cost efficient than their females counterparts. This is also in agreement with the finding of Ifeanyi and Chris (2009). Conversely, the lowland rice production allocative efficiency revealed a positive relationship of the variable with allocative inefficiency, portraying that male farmers are more cost inefficient than their female counterparts. This could be plausible as females prefer using manual or family labour for operations like weeding, harvesting, which is considered as a cheaper source of labour than other means such as agrochemicals, hired labour. This could also be attributed to the prudent nature of women in terms of income spending. This is thinkable because the males are not careful in their spending in the lowland rice production as a result of its water-logged environment which males are unwilling to work in resulting to appropriate use of the financial resources. Sex revealed a 5% level of significance for the upland rice, implying that for the production of upland rice, sex is a factor determining allocative efficiency.

Land Ownership: The coefficient of land ownership was found to negatively affect allocative inefficiency for both groups of rice cultivation under study. This implies that respondents without land ownership tend to be more cost efficient than those who own land. It is likely so, as those who rent, borrow or lease land for rice cultivation try to maximize high profit from the land. This makes them cautious of their spending of financial resources. Land is the major factor of production as it is immobile thereby making it an expensive factor as not all people can afford it. Therefore, for those who own it, they may not fully utilize the potentials of the land based on their low value use. Land ownership revealed 1% level significance for both groups; showing the high

relevance of the variable for rice production in the area. Furthermore, the result implies if farmers consider land ownership in rice production using the two systems of cultivating rice as a factor for efficient allocation of resources, they will be high in cost efficiency leading to low total cost of production and high output. This is agreeing with the work of Dipeolu and Akinbode (2012) who reported that the non indigenes who mostly don't own land were more cost efficient in pepper production in south western Nigeria.

Membership of Cooperative Association: The coefficient of membership of cooperative association had negative values for lowland rice producers, implying that it has negative effect on allocative inefficiency which agreed with finding of Ifeanyi and Chris (2009). This suggests that cost efficiency would be lowered for rice farmers who do not belong to Association. Membership of cooperative groups enables the farmer to interact and share information with each other on processing and input sourcing. The signs of the coefficient estimated signify that the members of associations tend to have higher cost efficiency. This result conforms to the expectation; because information on price of inputs flows among members of Association; and benefits are granted to members, thereby, improving cost efficiency. Association membership for the lowland rice producers was significant at 1% level of probability, showing its importance in the cultivation of rice through lowland technology in the area. However the coefficient of membership of association for upland rice were positive and insignificant which could be attributed to corrupt leaders of the association thereby leading to increase in total cost of production and decrease allocative efficiency.

Access to Credit: The coefficients of access to credit in both production systems were positively signed and significant at 5% in the upland rice. The result is similar to Bifarin *et al.,* (2010) findings where they reported positive signed coefficient of access to credit in cost inefficiency of plantain. This is implying that the more a farmer access credit the more cost inefficient and thereby increasing the total cost of production. Credit is suppose to increase allocative efficiency, but the numerous problems associated with accessing credit such as late disbursement and the cumbersome procedure often lead the farmer to misappropriate production credit for consumption.

4.3 Technical, Allocative and Economic Efficiencies of the Rice Production Systems.

4.3.1 Technical efficiency distribution

The distribution of rice farmers' efficiencies presented in Table 4.12 showed that the technical efficiency distribution of the upland rice producers is skewed in the class of less 0.61 and representing about 64% while appendix I showed the differences in the technical efficiency distribution for the two production systems. Upland rice famers' technical efficiency mean was 0.561. This finding is in conformity with the result of Bifarin *et al*. (2010) where they indicated that over 72% of the plantain farmers in Ondo State were operating above 0.50 technical efficiency. The mean technical efficiencies of 0.561 and 0.699 for upland and lowland rice production in the area of study implies that the upland and lowland rice farmers have 44% and 30 % range for improving their production efficiency using the existing technology. This conclusion agrees with the findings of Nwaru (2003) and Nwaru and Iheke (2010). Mean technical efficiencies of 0.561 and 0.669 for upland and lowland rice producers ranging from 0.0871 to 0.982 and 0.254 to 0.953 respectively. This signify that if the average upland rice farmers in the sample was to achieve the technical efficiency level of its most efficient counterpart,

the average upland famer could realize 43% cost saving (1 − [0.561/0.982])100 whereas, the most technically inefficient upland rice farmers could experience cost saving of 91% if the efficiency position of the most efficient farmer in the group is achieved (1 − [0.087/0.982])100. On the other part, the lowland rice sampled farmers technical efficiency indices suggested that for the average farmer among the lowland producers to attain the same technical efficiency position as the most efficient lowland rice producer, the average farmers will be saving 27% cost saving (1 - [0.699/0.953])100. Meanwhile, the least technically efficient farmer among the lowland group of rice producers will be saving 74% (1 - [0.254/0.953])100 of the cost of producing rice.

4.3.2 Allocative efficiency distribution

The distributions of rice farmers' allocative efficiencies showed that the upland and lowland rice producers were skewed in the class of more than 0.61 and representing about 60% as shown in Table 4.12 and appendix II showed the differences in allocative efficiency distribution at a glance. Allocative efficiency distribution indicates that the sampled upland and lowland rice farmers in the area allocated their financial resources below the optimum production cost price. The result depicts that the farmers are not efficient in their allocation of financial resources. The findings of this research is in conformity with the result obtained by Oniah *et al*., (2008) where they reported that farmers were generally inefficient in the allocation of their resources in swamp (lowland) rice production in Obubra Local Area of Cross River State, Nigeria. From the table the mean allocative efficiencies of upland and lowland rice producers were 0.897 and 0.648 ranging from 0.420 to 1.00 and 0.352 to 1.00 respectively. This signify that if the average upland rice farmers in the sample was to achieve the allocative efficiency

level of its most efficient counterpart, the average upland famer could realize 10% cost saving (1 − [0.897/1.00])100, whereas the most allocatively inefficient upland rice farmers could experience cost saving of 58% if the efficiency position of the most efficient farmer in the group is achieved (1 − [0.42/1.00])100. On the other part, the lowland rice sampled farmers allocative efficiency indices suggests that for the average farmer among the lowland producers to attain the same allocative efficiency position as the most efficient lowland rice producer, the average farmers will be saving 35% cost saving (1 - [0.648/1.00])100. Meanwhile, the least allocative efficient farmer among the lowland group of rice producers will be saving 65% (1 - [0.352/1.00])100 of the cost of producing rice.

4.3.3. Economic efficiency distribution

The product of technical and allocative efficiencies gave rise to economic efficiency. Table 4.12 indicates the different economic efficiency spread among the respondents of the two systems of cultivation while appendix III showed the economic efficiency differences at a glance. The economic efficiency spread of the farmers showed the maximum values of 0.853 and 0.910 for upland and lowland averaging 0.503 and 0.453 for the two groups of farmers respectively. Majority (80% and 72%) had economic efficiencies of less than 0.61. The mean level of economic efficiency indicates that farmers could increase current average cost of production by 50% and 55% in upland and lowland rice production respectively to achieve the potential minimum cost of production relative to the efficient farmers given the current output level. These efficiency results suggest that there is considerable potential for increasing output and reducing cost of production. The mean economic efficiencies of upland and lowland rice producers were 0.503 and 0.453 ranging from 0.044 to 0.853 and 0.081 to 0.910

respectively. This signify that if the average upland rice farmers in the sample was to achieve the economic efficiency level of its most efficient counterpart, the average upland famer could realize 41% cost saving (1− [0.503/0.853])100, whereas, the most economically inefficient upland rice farmers could experience cost saving of 95% if the efficiency position of the most efficient farmer in the group is achieved (1 − [0.044/0.853])100. On the other part, the lowland rice sampled farmers economic efficiency indices suggests that for the average farmer among the lowland producers to attain the same economic efficiency position as the most efficient lowland rice producer, the average farmers will be saving 51% cost saving (1 - [0.453/0.910])100. Meanwhile, the least economically efficient farmer among the lowland group of rice producers will be saving 91% (1 - [0.081/0.910]) of the cost of producing rice.

Table 4.12: Distribution of Efficiencies between Upland and Lowland rice production

Efficiencies	**Upland Rice**						**Lowland Rice**					
	Technical		**Allocative**		**Economic**		**Technical**		**Allocative**		**Economic**	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
0 – 0.20	25	33.33	10	33.33	20	26.67	15	10.00	11	07.33	44	29.33
0.21 –0.40	10	13.34	09	12.00	15	20.00	20	13.33	30	20.00	16	10.67
0.41 –0.60	13	17.33	11	14.67	25	33.33	38	25.33	20	13.33	48	32.00
0.61 –0.80	13	17.33	15	20.00	10	13.33	42	28.00	49	32.67	35	23.33
0.81 –1.00	14	18.67	30	40.00	5	6.67	35	23.34	40	26.67	7	4.67
Total	**75**	**100.00**	**75**	**100.00**	**75**	**100.00**	**150**	**100.00**	**150**	**100.00**	**150**	**100.00**
Maximum		0.982		1.00		0.853		0.953		1.00		0.910
Minimum		0.087		0.420		0.044		0.254		0.352		0.081
Mean		0.561		0.897		0.503		0.699		0.648		0.453

Source: Computed from MLE result of the Survey.

4.4 Profitability Analysis for Upland and Lowland Rice Production

The result of the profitability analysis conducted is presented in Table 4.14. The Total Variable Cost (TVC) for the upland rice production recorded ₦137,612.35 per hectare

against ₦201,027.41 for the lowland rice production. This indicates that the lowland farmers seem to incur more as production cost than the upland farmers. Among the variable costs recorded by the upland rice producers, cost of fertilizer was the highest with 31% of the total cost of production. This was followed by cost of hiring labour and cost of family labour which recorded 25% and 22% of the total cost of production. Lowland rice producers' highest cost was that of family labour followed by cost of hired labour and cost of acquiring fertilizer; these accounted for about 54%, 21% and 12% of the total cost of production respectively. It could be plausible that lowland rice farmers sampled relied on manual (Hired and Family) labour while the upland rice farmers sampled used more of the improved technology such as fertilizer and agrochemicals. For the two systems of cultivation, cost of manure was the least among the variable inputs. Depreciation accounted for about 4% and 2% for upland and lowland rice production cost. The difference in the average total fixed cost is due to the variation in number of these assets acquired by the group of farmers. Some of these assets are continuously put to use on the farm depending on the condition of the soil. From the two ecological environments, the upland rice has favourable condition for many assets to be used than the lowland rice. For example the uses of hoes are continuous on upland than lowland, also wheel barrows and knapsack sprayers are use favourably on upland than lowland. Therefore the more of these assets acquired by the upland rice farmers could have been the reason behide the difference in fixed cost.

Table 4.13: Gross Margin analysis for Upland and Lowland rice production in Naira/ha

Item	Upland		Lowland	
	Amount (₦)	**%**	**Amount (₦)**	**%**
Average Variable Cost				
cost of fertilizer	44,304.97	30.85	24,273.27	11.82
Agrochemicals	5677.05	3.95	1,418.98	0.69
Other cost	6,926.53	4.82	11,597.37	5.65
Cost of seed	9,186.04	6.40	7,801.06	3.80
cost of family labour	31,991.06	22.27	111,417.00	54.29
Cost of acquiring land	2,395.06	1.67	1,420.67	0.69
Cost of manure	561.62	0.39	632.56	0.30
cost of hired labour	36,570.02	25.46	42,466.50	20.67
Average Total Variable Cost	**137,612.35**	**95.82**	**201,027.41**	**97.91**
Fixed Cost (Depreciation)				
Hoe	2,189.56	1.52	1,782.29	0.87
Cutlass	558.97	0.39	535.54	0.26
Wheel barrow	908.59	0.63	573.97	0.28
Knapsack sprayer	1,381.63	0.96	1,011.65	0.49
Spade/shovel	971.63	0.68	381.72	0.19
Average Total Fixed Cost	**6,010.38**	**4.18**	**4,285.17**	**2.09**
Average price per kilogramme of rice	65.20		65.20	
Average quantity of rice produced (Kg)	3,608.68		4,375.85	
Average Total Cost (A + B)	143,622.73	100	205,312.58	100
Average Gross Farm Income (CxD)	235,285.93		285,305.42	
Average Gross Margin (AGM) (F – A)	**97,673.58**		**84,278.01**	
Return on investment (RI= G/E)	**68k**		**41k**	

From the analysis, the average gross farm income realized by the farmers under study revealed that the upland rice producers earned ₦235, 285.93; whereas the lowland rice

farmers earned ₦285, 305.42 per hectare of land cultivated. Computing the Gross margin for the two methods of farming rice, the sampled upland rice farmers recorded a 9 gross margin of ₦97, 673.58 which is slightly higher than Kudi *et. al., (*2010) finding, while the sampled lowland rice farmers earned ₦84, 278.01. This shows that the upland rice producers earn more profit than the lowland rice farmers. The difference in the gross margin of upland and lowland rice production could have been derived from their efficiency use of the inputs of production.

Looking at the wide differences in the variable cost of upland and lowland rice production, it can be inferred that lowland rice producers are more inefficient in the allocation of resources than the upland farmers. This was reported in the study that upland farmers are more allocatively efficient than the lowland farmers. In table (4.14), the lowland rice farmers spent more of the variable cost than the upland rice on the same land area. This is an indication that the lowland farmers do not consider equating the marginal value of product of additional inputs to their prices which is a condition to profitability. This could be the reason for the low gross margin of lowland farmers than that of upland farmers. The returns on investment were 68kobo and 41kobo for upland and lowland rice. This means that for every one naira invested the upland rice farmer got extra 68 kobo while the lowland rice farmer earns extra 41kobo.

Hypothesis Testing

Hypothesis I: There is no significant difference in the profitability of rice production among the two production systems.

The result of the hypothesis tested is presented in Table 4.15 which showed that the calculated value of t (-0.96479) was less than t-critical values at two-tail test, hence

accepting Ho. The rule of rejecting Ho is when the calculated value of t is greater than the t-critical value at probability value of less than 0.05.This shows that there is no significant difference in the profit obtained by upland and lowland rice producers. This indicates that input-output prevailing price affects both groups of farmers. Although, it was observed that the profit realized by the upland rice respondents in the gross margin analysis was higher than that of the lowland rice producers. It could be connected to the high cost of labour encountered by the lowland rice farmers due to the water-logging environment which labourers find difficult accessing and working effectively. Thus, resulting to high charges for labour, higher man days coupled with low usage of agrochemicals, manure and fertilizer due to lesser condition of their application. This caused reduced profit among the lowland rice farmers. From the result, if the lowland rice producers effectively allocate their resources in addition to good management plans; the profit realized would off-shot to cover the difference in net profit recorded by the upland rice respondents.

Table 4.14: Test for profitability significant difference between upland and lowland rice production

	Lowland	**Upland**
Mean	14278.01	97673.58
Variance	7.43E+10	1.93E+10
Observations	150	75
Hypothesized Mean Difference	0	
Df	223	
t Stat	-0.96479	
P(T<=t) two-tail	0.335693	
t Critical two-tail	1.970659	

Testing of Hypothesis II: There is no significant difference in the mean efficiencies of upland and lowland rice Production.

The interest is to compare the mean efficiencies of rice farmers across the lowland and upland production systems. Due to the difference in sample size of the lowland and upland rice farmers, the unequal variance t-test was used and the result was as presented in Table 4.16. The decision rule for the two tail t-test is that if t stat is greater than t-critical or if p-value is less than 0.05 level of significant, the null hypothesis is rejected. From the table all the results for comparing mean of technical, allocative and economic efficiencies indicated the rejection of the null hypothesis and accepting the alternative hypothesis showing that there are significant differences in the mean efficiencies of the farmers in the two systems of production.

Table 4.15: Test of significant difference between the mean efficiencies of Upland and lowland rice production

	Technical efficiency		**Allocative efficiency**		**Economic efficiency**	
	Lowland rice	**Upland rice**	**Lowland rice**	**Upland rice**	**Lowland rice**	**Upland rice**
Mean	0.69937	0.56046	0.64768	0.89652	0.45300	0.50246
Variance	0.03231	0.08444	0.09286	0.07723	0.11018	0.19435
Observation	150	75	150	75	150	75
Hypotheses mean difference	0		0		0	
Df	103		161		117	
t-stat	7.83260		2.60790		7.90019	
P(T<=t) two tail	4.475E-12		0.0100		1.691E-12	
t-critical two tail	1.98326		1.97481		1.98045	

4.5 Constraints in Upland and Lowland Rice Production.

The analysis of constraints recorded in Table 5.16 and depicted in bar chart in appendix V revealed that the respondents had various impediments to their rice farming systems in the area. The highlighted constraints were ranked according to severity. It was noticed that insufficient finance was ranked 1st among the respondents of both farming groups. This ranking showed that finance could hinder production of rice using any method of farming. This could be as a result of the inability to purchase farming inputs. The result is conforming to the few percentages of farmers accessing credit as earlier shown in the analysis of the socio-economic variables. If this constraint is adequately handled, rice production could be higher in the area. In the same manner, high cost of fertilizer was ranked 2nd among the respondents. The ranking of this constraint have negative effect on the production of rice in the area. If fertilizer is scarce, it could lead to high cost of the input. Fertilizer is expected to increase yield resulting from improve fertile soil. High cost of this input could lead to under-utilization by the farmers, who are mostly peasant. On the other hand, farmers could reduce their farm holdings as a result of insufficient fertilizer emanating from the high cost of the input. Pest and diseases was ranked 3rd among the farmers. The ranking showed the negative impact of pest and diseases to rice production in the area. This indicates that rice production is affected negatively in the area by pest and diseases. The high rise of pests and diseases could reduce the amount of profit realized by the farmers as much of the finance is used in the tackling of pest and diseases. The effect of pest and diseases could result to crop losses leading to food insecurity and poor health among the farming households. In ameliorating this, the farmers may be investing on agrochemicals with their low financial position, thereby further degrading their living standard. However, high cost of labour and inadequate seed were ranked 4th by upland rice farmers and lowland rice

farmers accordingly. The situation of high cost revealed that available labour is insufficient. This could be that most energetic youths have migrated out of the area in search of white-collar jobs. This could affect farming household by low rate of production. Meanwhile, inadequate seed was ranked 4th by lowland rice farmers. This indicates that, the seeds are affecting output adversely. This constraint could affect the input supply in terms of land size. The farmers could reduce the size of their holding to conform to the size they could plant. This affects holdings and standard of living.

Ranked 5th was high cost of agrochemicals by both upland and lowland rice farmers. This collaborate the pest and diseases constraint. With high cost of agrochemicals, farmers will be unable to purchase enough chemicals to off-set the pest and diseases infestation in the area. This reduces output. While inadequate seed was ranked 6th by the upland rice producers, their lowland counterparts ranked land inadequacy as their 6th constraint. This shows that, when the seed is not enough on one part, the land is also inadequate on the other side; both leading to small-holdings of farms, leading to low production, low income and food insecurity in the area. Poor market pricing was ranked 7th by the upland rice farmers while high cost of labour was ranked 7th by the lowland rice farmers. Market pricing is a factor that boosts production. The main aim of production is for consumption and sale. If the market price is poor, it brings about low profit margin leading to low standard of living among farmers and vice-versa. The production of rice depends on the market price which serves as a motivating factor to farmers. High cost of labour could hinder high price margin; leading to low revenue. This implies that, the labour available as family and hired were insufficient for rice production in the area. In the same vein, rice production is a labour intensive venture; hence, the absence of mechanized equipment for production could lead to high cost of

labour as the last option for the farmers, resulting to high payment to achieve the objectives. The constraint ranked 8th by the upland rice farmers was land inadequacy, while their counterparts – lowland rice farmers ranked poor transportation system as the 8th constraint. Land inadequacy could bring about small scale farming resulting from fragmented land holdings, giving rise to low level of production. This may be responsible for the poor mechanization of rice farming in the area. Poor transportation system could lead to high cost of transportation, thereby affecting gross margin negatively as a result of the increased total cost of production. The 9th and 10th rankings for upland rice producers were weed problems and poor transportation systems respectively. Weed infestation could bring about poor output as a result of crop loss to weed. Weed could be handled by agrochemicals and manual weeding. In this case, there is high cost of agrochemicals and high cost of labour; hence, the peasant farmers may not be able to hire sufficient labour or buy adequate agrochemicals, thereby leading to high weed problems. On the other hand, poor transportation system could lead to high marketing impediments resulting from damages in the process of conveying the produce. This often times leads to crop losses in addition to increase in total cost due to exorbitant transportation cost. Similarly, the 9th and 10th ranked constraints by the lowland rice farmers were poor market pricing and weed problems. The lowland farmers could be further confronted with stubborn weeds on the often moist fadama land. This might require extra labour, leading to increase in the cost of production.

Table: 4.16: Constraints of Upland and Lowland Rice Production

	Up Land			Low Land		
Constraints	***Freq**	**%**	**Rank**	***Freq**	**%**	**Rank**
Insufficient finance	66	24.5	1st	35	19.02	1st
High cost of fertilizer	41	15.2	2nd	20	16.30	2nd
Pest and diseases	35	13.1	3rd	29	15.76	3rd
High cost of labour	33	12.3	4th	17	9.24	7th
High cost of agrochemicals	23	8.6	5th	16	8.70	5th
Inadequate seed	20	7.4	6th	15	8.20	4th
Poor market pricing	19	7.1	7th	12	6.50	9th
Farmland inadequacy	17	6.3	8th	11	6.00	6th
Weed problems	9	3.3	9th	10	5.43	10th
Poor transportation system	6	2.2	10th	9	4.90	8th
Total	**269**	**100**		**184**	**100**	

* Multiple responses allowed

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This dissertation was carried out with the sole aim of comparing the profitability and economic efficiency of resource use in upland and lowland rainfed rice production in Kaduna State, Nigeria. The study used multistage sampling techniques to select rice farmers in upland and lowland rainfed rice production. Data were collected through administration of questionnaire and interview. Analysis conducted include: descriptive statistics, gross margin, stochastic frontier and Student T-test to achieve the stated objectives.

The result on socio-economic characteristics of rice producers indicates that there are more male farmers in upland than lowland constituting 89% and 75% respectively. Many of the upland farmers (78%) had educational level of 13 and above years of schooling than the lowland farmers (17%). The upland farm sizes were more than lowland with average values of 1.46 and 1.3 hectares respectively. Lowland are more than upland farmers with mean household size of 9 and 8, average age of 44 and41 years, mostly having farming experience of 30 and 11 years respectively. The technical efficiencies for upland and lowland rice producers were observed to meet all the criteria using Cobb-Douglas stochastic frontier. In the upland and lowland rice production the technical efficiency analysis showed that all the variable inputs were positively signed. The upland rice had all significant variables at 1% except family labour at 10%. The lowland rice had only farm size, family labour and quantity of seed significant at 1% and fertilizer at 10%, while agrochemicals, manure and hired labour were insignificant.

The technical inefficiency of rice production under the upland system of cultivation showed that educational attainment, rice farming experience, extension contact, sex and land ownership were negatively signed and only farming experience, extension contact and household size were signed negatively in lowland rice production. The upland rice had household size, membership of association and credit were positively signed. The lowland on the other hand had sex, land ownership, membership of association and credit were positively signed. All the variables of technical inefficiency model of the upland rice were significant at various levels of probabilities, but only household size, sex, land ownership and credit were significant in the lowland rice. Allocative efficiency result revealed that cost of fertilizer, cost of land, cost of agrochemicals, cost of hired labour, and output recorded positive estimated coefficients for both systems of cultivating rice in the area. The variables therefore contribute positively to the general allocative efficiency of rice production. The cost factors in upland rice were all significant at various probability levels, but only cost of land, cost of seed, cost of family labour and output were significant in lowland rice production. The allocative inefficiency variables were all significant in the upland rice except extension contact and membership of association, while only household size, farming experience, land ownership and membership of association were significant in lowland rice.

The distribution of rice farmers' efficiencies showed that the technical efficiency distribution ranges between 0.0871 and 0.982, with a mean of 0.561 for the upland rice; while their counterparts cultivating lowland rice recorded technical efficiencies of between 0.254 and 0.953 with a mean efficiency of 0.699. In the same manner, allocative efficiency distribution indicated that the upland and lowland rice farmers in the area allocate their resources below the optimum cost of production with means of

0.897 and 0.648. Similarly, economic efficiencies spread of the respondents, the maximum values were 0.853 and 0.910 for upland and lowland averaging 0.503 and 0.453 for the two groups of respondents' respectively.

The respondents could save some cost if all of them could attain the efficiency positions of the best farmers at various groups. The average technically efficient upland and lowland rice farmers could save 43% and 27% while the least technically efficient farmers experienced cost saving of 91% and 74%, if the position of the most efficient farmer in the group is achieved respectively. The average allocatively efficient upland and lowland farmers could save 10% and 35%, and the least allocatively efficient farmers could save 58% and 65% respectively. The overall performance of rice production revealed that if the economic efficiency level of the most efficient farmers is obtained; then the averagely efficient farmers could experience cost savings of 41% and 51%, while the least economically inefficient could saved 95% and 91% if the position of the most efficient upland and lowland rice producers were to be attained respectively.

The profitability analysis showed that the average gross farm income realized by the farmers under study by the upland and lowland rice producers were ₦235, 285.93 and ₦285, 305.42 per hectare of land respectively. Thus, the gross margin for the two methods of farming rice, were ₦97, 673.58 and ₦84, 278.01 for upland and lowland respectively. This shows that, the upland rice producers earn more profit than the lowland rice farmers. The return on investment for upland and lowland rice production indicated 65 kobo and 41 kobo respectively. This is indicating more profitable investment in upland rice than lowland rice. The test for hypothesis for the difference in the profit were not significant.

The constraints recorded revealed that the respondents were mostly affected by insufficient finance, high cost of fertilizer and pest and diseases. However, high cost of labour and inadequate seed were ranked 4th by upland rice farmers and lowland rice farmers accordingly. These constraints could affect the inputs supply in terms of land size. The farmers could reduce the size of their farm holding to conform to the size they could plant. Agrochemicals which help in alleviating the shortage of labour was ranked 5th by both production systems, hence worsening the constraints of pest and diseases control and high wage rate.

5.2 Conclusion

Based on the finding of the study the following conclusions were drawn. The statistically insignificant profitability test among the farmers of both production systems implies that the choice for going into any of the rice production systems is not influence by profitability level alone. The statistically significant result of efficiencies level is indicating that the farmers in both rice production systems do not produced at frontier level therefore indicating presence of inefficiency. The result of return to scale is concluding that both systems of rice production have more room for adjustment in their present production technology at stage two of production cycle. The study also found out that there are four major inputs that are significant in both rice production systems namely: farm size, seed, fertilizer and family labour. This implies that for increase in both rice production output, the four inputs most be harnessed and efficiently utilized.

5.3 Recommendation

The study showed the numerous problems associated with the production of upland and lowland rice. Nevertheless, with the right policy recommendation judiciously executed,

rice production can be the back bone of development in the study area and Nigeria at large. The following recommendations are hereby proposed to aid the production of rice which is never exhaustive.

1. Credit being a significant determinant of rice production efficiency and a major constraint in both production systems needs the farmer to create a saving culture. It is hereby recommended that the farmers form group contribution locally known as *adashi*. Farmers are also advised to enter into contract farming with trusted buyers of their produce to raise credit for their production at the right time.
2. Seed was found to be significant and also a constraint to both systems of rice production. It is recommended that the extension agent should intensify effort to train farmers on how to multiply and store seeds at their farm through the method of selection.
3. Belonging to association was found to be important. Therefore it is recommended that the farmers should form association. Through this association they can seek the intervention of government organizations (GO), non – government organizations (NGO) and other development agencies for assistant. They can pull their resources for bulk supply of inputs at low cost, hence reducing production cost.
4. Fertilizer was significant at both upland lowland rice production and also a major constraint. The fertilizer Growth Enhance Scheme of the former PDP government should be encouraged by the present APC government. However it is recommended that government agencies responsible for execution of the

policy should identify farmers with more need of fertilizers to avoid farmers buying more in the open market.

5. To reduce the problem of high cost of labour, it is recommended that the farmers association can go into partnership with the department of agricultural engineering of our national universities to supply labour- saving technologies to reduce production cost, such as promoting more efficient use of herbicides and to promote small – scale mechanization.
6. The farmers association is recommended to have vibrant activities including community development that can attract all tiers of government to provide rural areas with modern infrastructures like good roads, water, electricity and so forth, to avoid the able bodied youth migrating to cities.

5.4 Contribution to Knowledge

The following are the contributions of this study to knowledge in general and especially to the areas of study.

1. The study revealed that the upland and lowland production systems showed no significant difference in their profitability level. Though upland showed a higher profit of ₦97673.58/ha than the lowland ₦84278.01/ha and return on investment were 68k and 41k respectively.
2. The study revealed that there was significant differences in the mean of economic efficiencies of the upland and lowland rice farmers ($p<0.05$).The upland land farmers were shown to be more economically efficient with mean of 0.5025 compared with that of lowland mean of 0.4530.

3. The study also shows that both production systems are operating in stage II of production with return to scale of less than unity (0.84167 and 0. 95770) for upland and lowland rice respectively.
4. The study revealed that the major drivers of the rice output in upland (n=75) and lowland(n=150) production were farm size, quantity of seed, family labour and fertilizer which were significant at 1% except fertilizer that indicated significant level of 5% in the lowland production.

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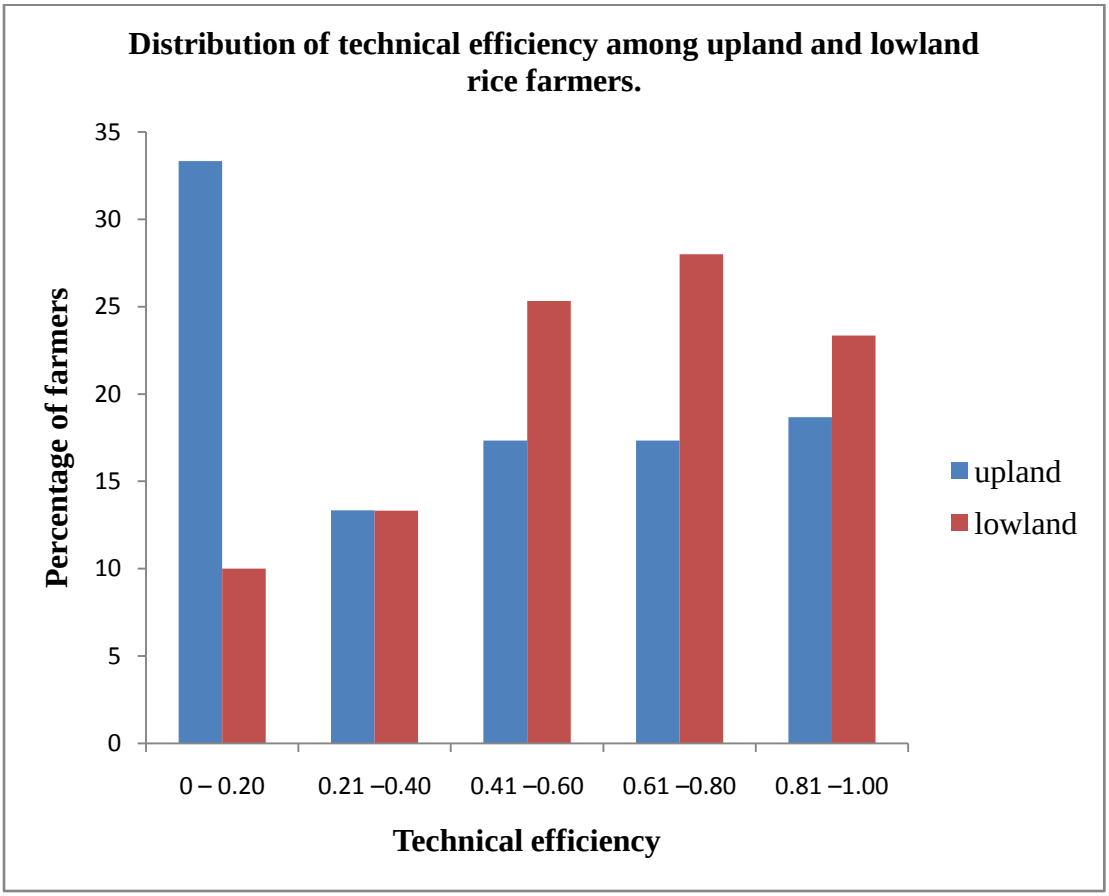
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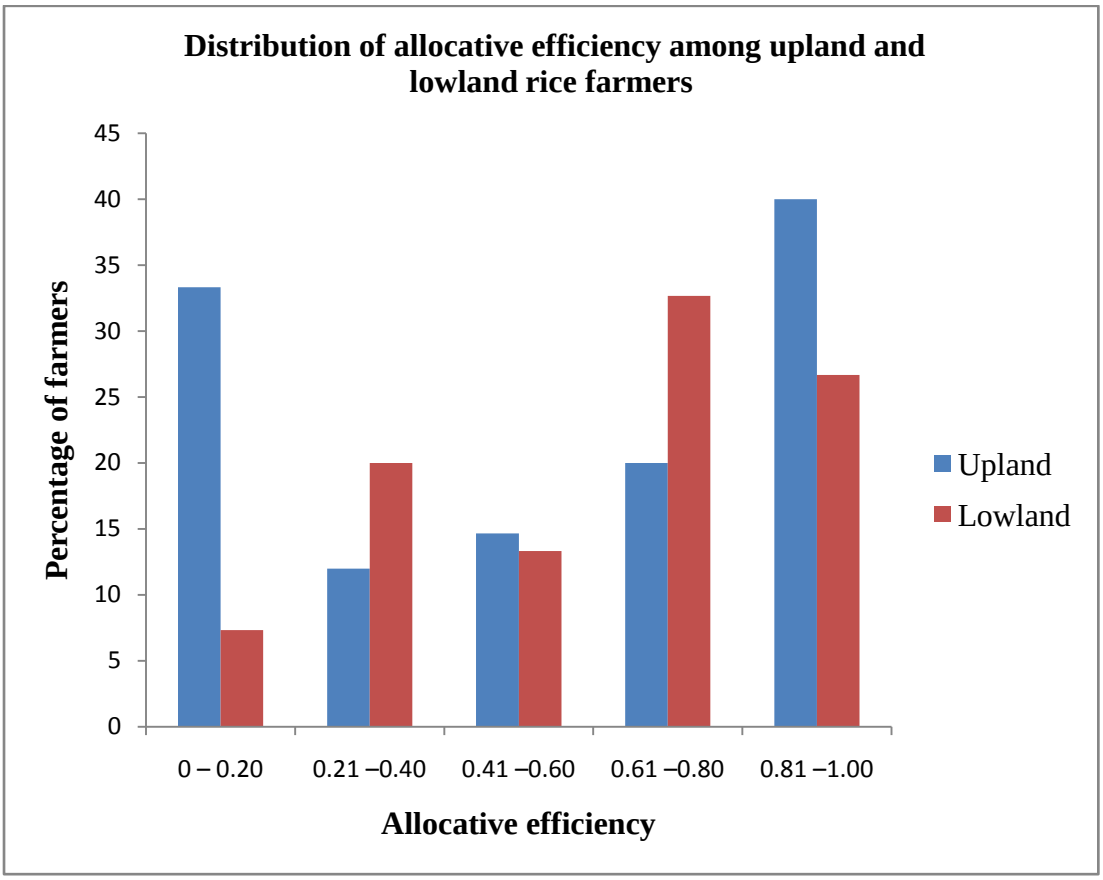
APPENDIX I

CHARTS AMONG UPLAND AND LOWLAND RICE FARMERS

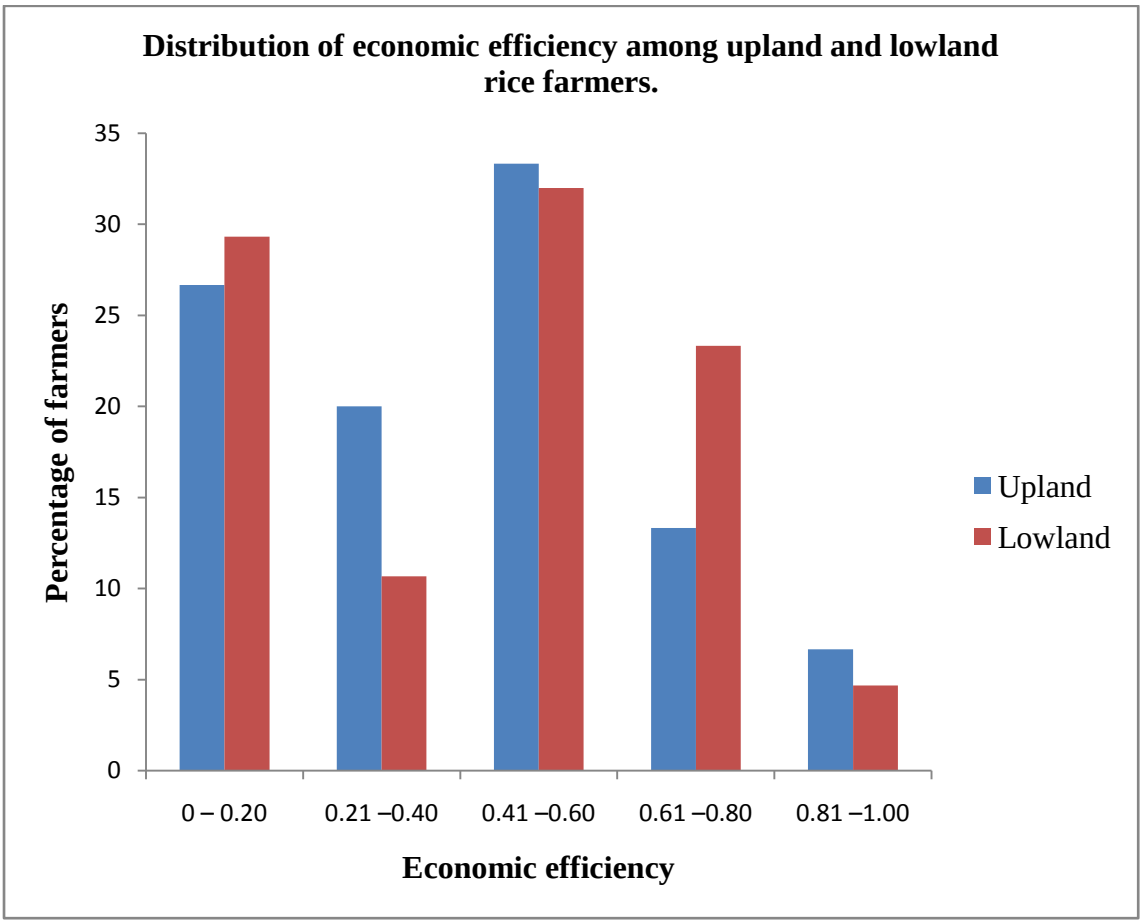
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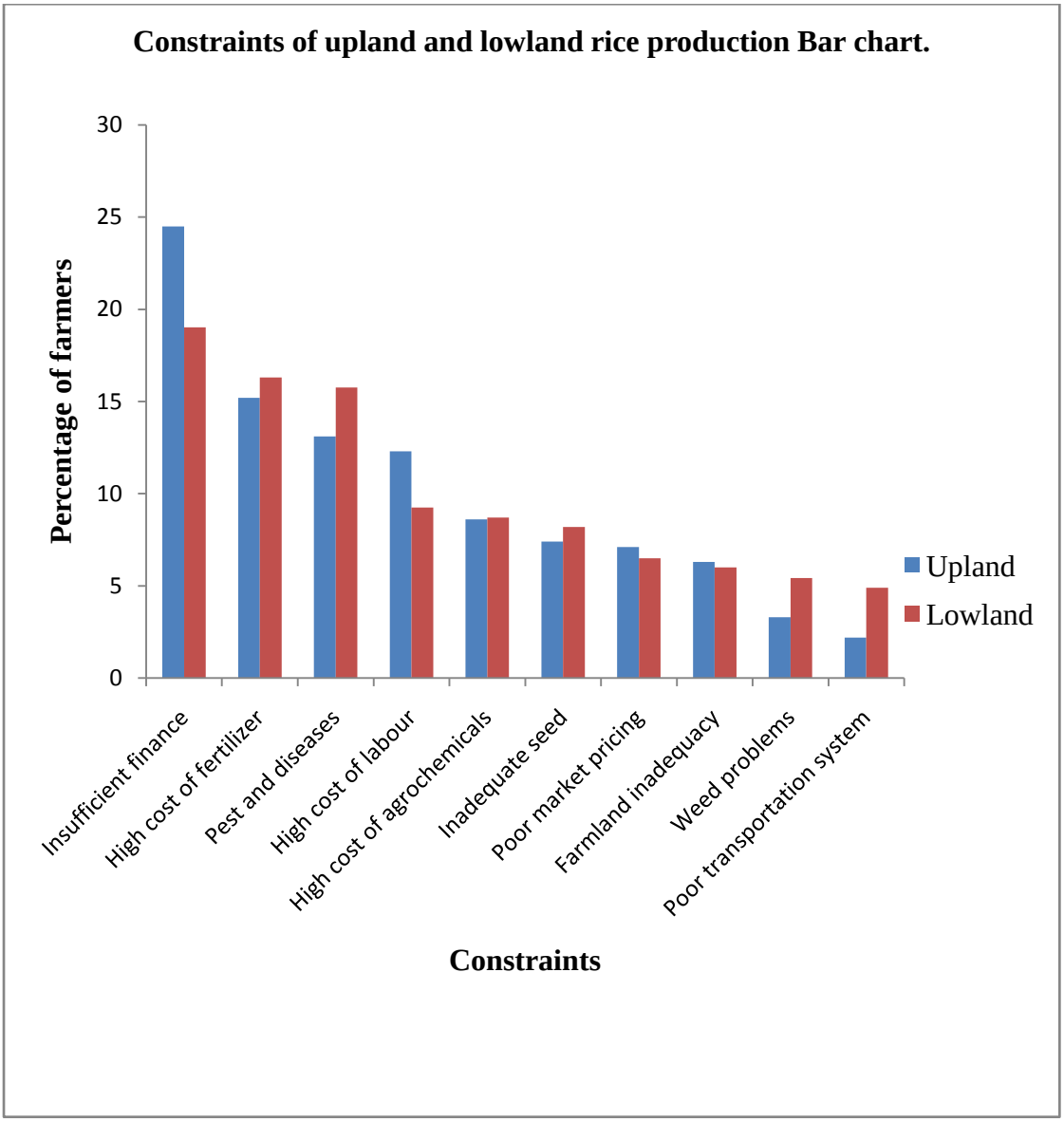
2


Distribution of allocative efficiency among upland and lowland rice farmers
Percentage of farmers
45
40
35
30
25
20
15
10
5
0
0 – 0.20
0.21 –0.40
0.41 –0.60
0.61 –0.80
0.81 –1.00
Allocative efficiency
Upland
Lowland

3


Distribution of economic efficiency among upland and lowland rice farmers.
Percentage of farmers
35
30
25
20
15
10
5
0
0 – 0.20
0.21 –0.40
0.41 –0.60
0.61 –0.80
0.81 –1.00
Economic efficiency
Upland
Lowland

4


Constraints of upland and lowland rice production Bar chart.
Percentage of farmers
30
25
20
15
10
5
0
Upland
Lowland
Insufficient finance
High cost of fertilizer
Pest and diseases
High cost of labour
High cost of agrochemicals
Inadequate seed
Poor market pricing
Farmland inadequacy
Weed problems
Poor transportation system
Constraints

APPENDIX II

QUESTIONNAIRE FOR LOWLAND RICE FARMERS'

COMPARATIVE ECONOMICS ANALYSIS OF UPLAND AND LOWLAND RAINFED RICE PRODUCTION IN SELECTED LOGAL GOVERNMENT AREAS OF KADUNA STATE

Dear respondent,

This questionnaire will be used to generate data for a PhD research in the Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University Zaria. All information will be treated with utmost confidentiality and will be strictly used for the purpose of the research. Thanks for your cooperation.

Village…… L.G.A…….. Questionnaire No.....

Name of respondent…… ……

Phone number …….

1.0. Socioeconomic characteristics

1.1. Age of respondent…….Years

1.2. Sex of respondent…… 1 = Male; 0 = Female

1.3. Marital status ……1 = Married; 2 = Divorced; 3 = Widowed; 4 = Single

1.4. Household headship……..1 = Yes ; 0 = No

1.5. If respondent is a man, Number of wife/wives…….

1.6. Number of schooling years (including primary school)……years

1.7. Provide information on the number of people living in your household.

	Male			Female		
	< 15 years	> 15 years	< 60 years	< 15 years	> 15 years	< 60 years
Number						

1.8. What is the main occupation of the respondent? (Use code) …….

Code of occupations: 1 = Farming; 2 = Trade/business; 3 = Civil Servant; 4 = Agent in private sector; 5 = fishing; 6= animal raising; 7 = retired; 8 = others (specify)……

1.9. If the main activity is not farming (1), what proportion of household income was obtained from other activities last season? …… (%)

1.10. How many years has the respondent been farming? ……..Years

1.11. How many years has the respondent been cultivating Lowland rice? .....Years

1.12. Please fill in the table below on land allocation to farming.

Plot No	Sources of land acquisition (*enter code*)	Plot size/ha	Crop(s) planted
1			
2			
3			
4			

Code of sources of land acquisition: 1= Family, 2= Hired, 3= Lease 4=purchased

1.13. How much does it cost to hire one hectare of land per season in your village? (₦)…….

1.14. Are you a member of any association …… 1 = Yes; 0 = No

1.15. If yes, provide information on the following

Association	Membership 1 = Yes, 0 = No	For how long? (years)	Benefit of joining the association. (*enter code*)
Producers cooperative			
Marketing cooperative			
Farmers association			
Community development			
Contribution (esusu, adashe etc.)			

Codes of benefit: 0= not beneficial, 1= somehow beneficial, 2= beneficial, 3= very beneficial

1.16. How many times did extension agents visit you in the last cropping season? .....

1.17. Have you participated in any training/demonstration related to improve lowland rice technology in the last two years? 1 = Yes, 0 = No

1.18. If 1.17 is yes, please provide information on the following.

Type of training/demonstration	**Involvement 1= Yes, 0= No**	**Benefit of training/ demonstration *(enter code*)**	**Did you adopt the technology? 0=No, 1 =Yes**
Improved crop varieties			
Agronomic practices			
Weed control technologies			
Fertilizer use/application			
Soil fertility management			
Storage			
Pest control			
Others specify…..			

Codes for benefit of training/demonstration: 0=not beneficial, 1=somehow beneficial, 2=beneficial 3=very beneficial

1.19. What are the 4 major crops the household cultivated in order of preference in the last season?

	Main crop 1	Main crop 2	Main crop 3	Main crop 4
Crop				
Farm size/ unit				
Purpose of cultivation (enter code)				

Codes for purpose of cultivation: 1= mainly for food, 2= mainly for cash, 3= for both food and cash

1.20. Which was your main source of capital for farming last season? (1= *personal saving, 2= borrowed 3= Gift, 4= others specify……..)*

1.21. If your response in 1.20 is borrowed provide information on the following.

Purpose of borrowing	Amount	Interest (%)	Sources of borrowing (*enter the code(s)*	Have you paid back? (0=No, 1=yes)
For personal purposes (food, medical)				
To buy fertilizers				
To buy seeds				
To buy Herbicides				
To hire labour				

Code of sources: 1= bank/micro-finance, 2 = cooperative, 3 = friends/relation, 4 = government/credit scheme, 5 = ADP, 6 = Moneylenders, 7=input/output dealers, 8= others (specify……..),

1.22. If you used the credit for farming activities, how much of the money did you spend on cultivating lowland rice? …….. ₦

1.23. How do you get to your farm (Tick the appropriate?)

(i) On foot (ii) on bicycle (iii) on motorcycle (iv) animal (v) Vehicle (vi) others (specify)…

1.24. How do you evacuate your farm product from the farm? (i) Head load (ii) on bicycle

(iii) On motorcycle (iv) animal (v) vehicle (vi) others (specify)……

2.0. Resource allocation.

2.1 Please give the information relating to the following inputs used for the cultivation of lowland rice last year.

Types of inputs	**Quantity used per unit**	**Price per unit**	**Availability (*use code*)**
NPK fertilizer (50kg bag)			
Urea fertilizer (50kg bag)			
Manure (50kg bag)			
Herbicides (litre)			
Pesticides (litre)			
Seed (local variety) (kg)			
Seed (improved variety) (kg)			

Code for availability; 0=Not available, 1=Very scarce, 2=fairly available, 3=Available

2.2. What are the problems associated with accessing farm inputs for cultivating lowland rice last season?

Farm inputs	Problems	Coping strategies
NPK fertilizer		
Urea fertilizer		
Manure		
Herbicides		
Pesticides		
Seed (local variety)		
Seed (improved variety)		

2.3. Do you have a sprayer? Yes ( ), No ( )

2.4. How much does it cost to rent a sprayer per day in your village? ……. ₦

2.5. Did you hire someone to spray for you? Yes ( ), No ( ). If yes how many load? ……..

2.6. How much were you charged per load? …… ₦

2.7. How many times did you spray your lowland rice farm last season? ……

2.8. Fill the following information relating to the family labour used for lowland rice production last season.

	ADULT MALE		ADULT FEMALE		CHILDREN	
	No of persons	No of days	No of persons	No of days	No of persons	No of days
Land preparation						
Planting						
Weeding						
Spraying						
Harvesting						
Threshing						
Others (Specify …)						

2.9. Fill the following information relating to the hired labour used for lowland rice production last season.

	ADULT MALE		ADULT FEMALE		CHILDREN	
	No of persons	No of days	No of persons	No of days	No of persons	No of days
Land preparation						
Planting						
Weeding						
Spraying						
Harvesting						
Threshing						
Others (Specify ……						

2.30. What does it cost to hire one adult male per day in your village last season? ……₦

2.31. What does it cost to hire one adult female per day in your village last season? ……₦

2.32. What does it cost to hire one child per day in your village last season? ……₦

3.0. Productive assets

3.1. Provide information on the implements used during the last season.

S/no	Implement	Number owned	Number rented	Cost ₦		Life span	Years of usage	Salvage value (₦)
				owned	Rented			
1.	Hoe							
2.	Cutlass							
3.	Spade/ shovel							
4.	Wheel barrow							
5.	Knapsack							
6.	Tractor							
7.	Others (specify) ……							

4.0. Output and marketing

4.1. What quantity of lowland rice did you harvest from all your rice plots last season?

Plot number	Quantity harvested (paddy)	Unit (mudu, tiya, bag)
1		
2		
3		
4		

4.2. Please provide information on the distribution of lowland rice harvested last season.

S/No	Distribution of lowland rice	2012	
		Quantity	Unit
a.	Household consumption		
b.	Sold		
c.	Kept as seeds		
d.	Used as gift		
e.	Others (specify)		

4.3. If you have sold rice last season, to whom did you sell?

Buyers	Did you sell to these buyers? 0=No, 1=Yes	Quantity sold/unit	In what form did you sell?	In what type of market did you sell?	Price/ unit sold
Direct to others consumers					
Private traders					
Cooperatives					
Government institution					
Others (specify…)					

Codes for form: 1=paddy, 2=processed, 3= seed, 4= cooked.

Codes for type of market: 1=farm gate, 2= road side, 3=local market, 4= urban market 5=home

4.4. What was your farm income from sale of lowland rice last year? ..... ₦

4.5. What was your total farm income from sale of all crops last year? ..... ₦

5.0. Farmer's assessment of Lowland rice

5.1. Will you still be planting lowland rice in the future? ..... 1 = Yes, 0 = No.

5.2. If your response to 5.1 is no, give reasons.

S/no	Reasons	Tick as applicable
1.	Non- availability of fertilizer	
2.	Non- availability of herbicides	
3.	Non- availability of seeds	
4.	Shortage of cash for inputs	
5.	Late maturing variety	
6.	Non profitability	
7.	Birds problem	
8.	Less revenue than former cultivated crop	
9	Low prices	
10	Low demand	
11	Others (specify)	

5.3. Between the lowland and upland rice, which one do you prefer to cultivate?

Lowland rice ( ), upland rice ( )

5.4. What are the reasons for your preference? (Tick)

S/no	Reasons	Lowland rice	Upland rice
1.	High grain yield		
2.	Tillering ability		
3.	Can easily substitute many crops		
4.	Resistance to pest and diseases		
5.	Early maturing- food security/cash		
6.	High market value		
7.	Less labour		
8.	Others (specify)		

5.5. How would you assess the performance of lowland rice and upland rice based on the following attributes?

S/No	Attributes of lowland and upland rice	Performance (*use code*)**
1.	High grain yield	
2.	Tillering ability	
3.	Resistance to logging	
4.	Resistance to pest and diseases	
5.	Early maturing- food security/cash	
6.	High market value	
7.	Taste and food quality	
8.	Grain size	
9.	Adaptability to poor soil	
10.	Ease of harvesting and threshing	
11.	Yields with little fertilizer	
12.	Others (specify)	

*** 0 = No idea, 1 = Lowland rice is better, 2 = no difference, 3 = Upland rice is better*

5.6. Which of the following deterred you from cultivating lowland rice? (*Multiple answers are allowed)*

Not convinced it is superior to my preferred crop variety (ies) { }

No assistance or advice from extension agents { }

No knowledge on lowland rice cultivation { }

Lack of production inputs { }

High cost of labour { }

Serious attacks from birds { }

5.7. When did you sell most of your paddy rice last cropping season? (*Tick option below*).

Immediately after harvest when prices were relatively low. { }

Immediately after harvest when prices were relatively high { }

A couple of months after harvest when prices were relatively high { }

5.8. In terms of money realized from the sale of Lowland rice, do you think you have been able to cover your expenses? ……. 1 = Yes, 0 = No

5.9. Has the cultivation of lowland rice contributed to improve your livelihood significantly? Yes ( ), No ( )

5.10. If your response to 5.9 is yes, which of these areas have been impacted?

S/no	Items	Yes = 1	No = 0
1.	Increased in the quality and quantity of food consumed by your household		
2.	Purchase of non- food items		
3.	More saving potential		
4.	Expansion of rice production business		
5.	Purchase of livestock (cow, goat, sheep, donkeys, etc)		
6.	Education of children		
7.	Payment of hospital bills		
8.	Acquisition of capital assets		
9.	Others (specify)		

5.11. Please provide information on your access to roads and cost of transportation last season.

S/no	Items	2012
1.	Distance to nearest source of inputs (km)	
2.	Cost of carrying a bag of paddy from the farm(₦)	
3.	Distance to the nearest market (km)	
4.	Cost of carrying a bag of paddy to the market(₦)	
5.	Others transport costs (specify …….	

6.0. Trend and constraints to lowland rice production

6.1. Please provide information on the trend of the following crops in the last five years

S/no	Crops	Trend (*enter code*)	Main reason for the observed trend
1.	Upland Rice		
2.	Maize		
3.	Sorghum		
4.	Soybeans		
5.	Cowpea		
6.	Groundnut		
7.	Cassava		
8.	Yam		
9.	Others specify		

Trend: 1 = Increasing, D = Decreasing, S = Same

6.2. What are the constraints associated with lowland rice production and how did you cope last season? (Use table)

Constraints	Rank	Coping strategies

Ask farmer to list all the constraints first and tell him/her to rank starting with most severe problem.

APPENDIX III

QUESTIONNAIRE FOR UPLAND RICE FARMERS'

COMPARATIVE ECONOMICS ANALYSIS OF UPLAND AND LOWLAND RAINFED RICE PRODUCTION IN KADUNA STATE

Dear respondent,

This questionnaire will be used to generate data for a PhD research in the Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University Zaria. All information will be treated with utmost confidentiality and will be strictly used for the purpose of the research. Thanks for your cooperation.

Village…… L.G.A……. Questionnaire No.....

Name of respondent…….

Respondents' Phone number ……...

1.0. Socioeconomic characteristics

1.1. Age of respondent…… Years

1.2. Sex of respondent…… 1 = Male; 0 = Female

1.3. Marital status …… 1 = Married; 2 = Divorced; 3 = Widowed; 4 = Single

1.4. Household headship…… 1 = Yes ; 0 = No

1.5. If respondent is a man, Number of wife/wives……

1.6. Number of schooling years (including primary school)……years

1.7. Provide information on the number of people living in your household.

	Male			Female		
	< 15 years	> 15 years	< 60 years	< 15 years	> 15 years	< 60 years
Number						

1.8. What is the main occupation of the respondent? (Use code) …….

Code of occupations: 1 = Farming; 2 = Trade/business; 3 = Civil Servant; 4 = Agent in private sector; 5 = fishing; 6 animal raising; 7 = retired; 8 = others (specify)……

1.9. If the main activity is not farming (1), what proportion of household income was obtained from other activities last season? …… (%)

1.10. How many years has the respondent been farming? ……. Years

1.11. How many years has the respondent been cultivating Upland rice? .....Years

1.12. Please fill in the table below on land allocation to farming.

Plot No	Sources of land acquisition	Plot size/ha	Crop(s) planted
1			
2			
3			
4			

Code of sources of land acquisition: 1= Family, 2= Hired, 3= Lease 4=purchased

1.13. How much does it cost to hire one hectare of land per season in your village? (₦)…….

1.14. Are you a member of any association ……1 = Yes; 0 = No

1.15.If yes provide information on the following.

Association	Membership 1 = Yes, 0 = No	For how long? (years)	Benefit of joining the association. (*enter code*)
Producers cooperative			
Marketing cooperative			
Farmers association			
Community development			
Contribution (esusu, adashi etc.)			

Codes of benefit: 0= not beneficial, 1= somehow beneficial, 2= beneficial, 3= very beneficial

1.16. How many times did extension agents visit you in the last cropping season? .....

1.17. Have you participated in any training/demonstration related to improve upland rice technology in the last two years? 1 = Yes, 0 = No

1.18. If 1.17 is yes, please provide information on the following.

Type of training/demonstration	**Involvement 1= Yes, 0= No**	**Benefit of Training /demonstration *(enter code*)**	**Did you adopt the technology? 0 = No, 1 =Yes**
Improved crop varieties			
Agronomic practices			
Weed control technologies			
Fertilizer use/application			
Soil fertility management			
Storage			
Pest control			
Others (specify)			

Codes for benefit of training/demonstration: 0=not beneficial, 1=somehow beneficial, 2=beneficial, 3=very beneficial

1.19. What are the 4 major crops the household cultivated in order of preference in the last season?

	Main crop 1	Main crop 2	Main crop 3	Main crop 4
Crop				
Farm size/ unit				
Purpose of cultivation (enter code)				

Codes for purpose of cultivation: 1= mainly for food, 2= mainly for cash, 3= for both food and cash

1.20 Which was your main source of capital for farming last season? (1= *personal saving, 2= borrowed 3= Gift, 4= others specify……).*

1.21. If your response in 1.20 is borrowed provide information on the following.

Purpose of borrowing	Amount	Interest (%)	Sources of borrowing (*enter the code(s)*	Have you paid back? (0=No, 1=yes)
For personal purposes (food, medical)				
To buy fertilizers				
To buy seeds				
To buy Herbicides				
To hire labour				

Code of sources: 1= bank/micro-finance, 2 = cooperative, 3 = friends/relation, 4 = government/credit scheme, 5 = ADP, 6 = Moneylenders, 7=input/output dealers, 8= others (specify……..),

1.22. If you used the credit for farming activities, how much of the money did you spend on cultivating upland rice? …….. ₦

1.23. How do you get to your farm (Tick the appropriate?)

(i) On foot (ii) on bicycle (iii) on motorcycle (iv) animal (v) Vehicle (vi) others (specify)…

1.24. How do you evacuate your farm product from the farm? (i) Head load (ii) on bicycle

(iii) On motorcycle (iv) animal (v) vehicle (vi) others (specify)……

2.0. Resource allocation.

2.1 Please give the information relating to the following inputs used for the cultivation of upland rice last year

Types of inputs	**Quantity used per unit**	**Price per unit**	**Availability (*use code*)**
NPK fertilizer (50kg bag)			
Urea fertilizer (50kg bag)			
Manure (50kg bag)			
Herbicides (litre)			
Pesticides (litre)			
Seed (local variety) (kg)			
Seed (improved variety) (kg)			

1Code for availability: 0= Not available, 1=Very scarce, 2=fairly available, 3=Available

2.2. What are the problems associated with accessing farm inputs for cultivating upland rice last season?

Farm inputs	Problems	Coping strategies
NPK fertilizer		
Urea fertilizer		
Manure		
Herbicides		
Pesticides		
Seed (local variety)		
Seed (improved variety)		

2.3. Do you have a sprayer? Yes ( ), No ( )

2.4. How much does it cost to rent a sprayer per day in your village? …… ₦

2.5. Did you hire someone to spray for you? Yes ( ), No ( ). If yes how many load? …….

2.6. How much were you charged per load? …….. ₦

2.7. How many times did you spray your upland rice farm last season? ……

2.8. Fill the following information relating to the family labour used for upland rice production last season.

	ADULT MALE		ADULT FEMALE		CHILDREN	
	No of persons	No of days	No of persons	No of days	No of persons	No of days
Land preparation						
Planting						
Weeding						
Spraying						
Harvesting						
Threshing						
Others (Specify ……						

2.9. Fill the following information relating to the hired labour used for Upland rice production last season.

	ADULT MALE		ADULT FEMALE		CHILDREN	
	No of persons	No of days	No of persons	No of days	No of persons	No of days
Land preparation						
Planting						
Weeding						
Spraying						
Harvesting						
Threshing						
Others (Specify ……						

2.30. What does it cost to hire one adult male per day in your village last season? ……₦

2.31. What does it cost to hire one adult female per day in your village last season? ……₦

2.32. What does it cost to hire one child per day in your village last season? ……₦

3.0. Productive assets

3.1. Provide information on the implements used during the last season.

S/no	Implement	Number owned	Number rented	Cost ₦		Life span	Years of usage	Year of purchase
				owned	rented			
1.	Hoe							
2.	Cutlass							
3.	Spade/ shovel							
4.	Wheel barrow							
5.	Knapsack							
6.	Tractor							
7.	Others (specify							

4.0. Output and marketing

4.1. What quantity of upland rice did you harvest from all your rice plots last season?

Plot number	Quantity harvested (paddy)	Unit (mudu, tiya, bag)
1		
2		
3		
4		

4.2. Please provide information on the distribution of upland rice harvested last season.

S/No	Distribution of upland rice	2012	
		Quantity	Unit
a.	Household consumption		
b.	Sold		
c.	Kept as seeds		
d.	Used as gift		
e.	Others (specify)		

4.3. If you have sold rice last season, to whom did you sell?

Buyers	Did you sell to these buyers? 0=No, 1=Yes	Quantity sold/unit	In what form did you sell?	In what type of market did you sell?	Price /unit sold
Direct to other consumers					
Private traders					
Cooperatives					
Government institution					
Others (specify…)					

Codes for form: 1=paddy, 2=processed, 3= seed, 4= cooked.

Codes for type of market: 1=farm gate, 2= road side, 3=local market, 4= urban market 5=home

4.4. What was your farm income from sale of upland rice last year? .....₦

4.5. What was your total farm income from sale of all crops last year? .....₦

5.0. Farmer's assessment of Upland rice

5.1. Will you still be planting Upland rice in the future? .....1 = Yes, 0 = No.

5.2. If your response to 5.1 is no, give reasons.

S/no	Reasons	Tick as applicable
1.	Non- availability of fertilizer	
2.	Non- availability of herbicides	
3.	Non- availability of seeds	
4.	Shortage of cash for inputs	
5.	Late maturing variety	
6.	Non profitability	
7.	Birds problem	
8.	Less revenue than former cultivated crop	
9	Low prices	
10	Low demand	
11	Others (specify)	

5.3. Between the upland and lowland rice, which one do you prefer to cultivate?

Upland rice ( ), Lowland rice ( )

5.4. What are the reasons for your preference? (Tick)

S/no	Reasons	Upland rice	Lowland rice
1.	High grain yield		
2.	Tillering ability		
3.	Can easily substitute many crops		
4.	Resistance to pest and diseases		
5.	Early maturing- food security/cash		
6.	High market value		
7.	Less labour		
8.	Others (specify)		

5.5. How would you assess the performance of upland rice and lowland rice based on the following attributes?

S/No	Attributes of upland and lowland rice	Performance (*use code*)**
1.	High grain yield	
2.	Tillering ability	
3.	Resistance to logging	
4.	Resistance to pest and diseases	
5.	Early maturing- food security/cash	
6.	High market value	
7.	Taste and food quality	
8.	Grain size	
9.	Adaptability to poor soil	
10.	Ease of harvesting and threshing	
11.	Yields with little fertilizer	
12.	Others (specify)	

*** 0 = No idea, 1 = Upland rice is better, 2 = no difference, 3 = lowland rice is better*

5.6. Which of the following deterred you from cultivating lowland rice? (*Multiple answers are allowed)*

Not convinced it is superior to my preferred crop variety (ies) { }

No assistance or advice from extension agents { }

No knowledge on lowland rice cultivation { }

Lack of production inputs { }

High cost of labour { }

Serious attacks from birds { }

5.7. When did you sell most of your paddy rice last cropping season? (*Tick option below*).

Immediately after harvest when prices were relatively low. { }

Immediately after harvest when prices were relatively high { }

A couple of months after harvest when prices were relatively high { }

5.8. In terms of money realized from the sale of upland rice, do you think you have been able to cover your expenses? ……. 1 = Yes, 0 = No

5.9. Has the cultivation of upland rice contributed to improve your livelihood significantly? Yes ( ), No ( )

5.10. If your response to 5.9 is yes, which of these areas have been impacted?

S/no	Items	Yes = 1	No = 0
1.	Increased in the quality and quantity of food consumed by your household		
2.	Purchase of non- food items		
3.	More saving potential		
4.	Expansion of rice production business		
5.	Purchase of livestock (cow, goat, sheep, donkeys, etc)		
6.	Education of children		
7.	Payment of hospital bills		
8.	Acquisition of capital assets		
9.	Others (specify)		

5.11. Please provide information on your access to roads and cost of transportation last season.

S/no	Items	2012
1.	Distance to nearest source of inputs (km)	
2.	Cost of carrying a bag of paddy from the farm(₦)	
3.	Distance to the nearest market (km)	
4.	Cost of carrying a bag of paddy to the market(₦)	
5.	Others transport costs (specify …….	

6.0. Trend and constraints to upland rice production

6.1. Please provide information on the trend of the following crops in the last five years

S/no	Crops	Trend (*enter code*)	Main reason for the observed trend
1.	Upland Rice		
2.	Maize		
3.	Sorghum		
4.	Soybeans		
5.	Cowpea		
6.	Groundnut		
7.	Cassava		
8.	Yam		
9.	Others specify		

Trend: 1 = Increasing, D = Decreasing, S = Same

6.2. What are the constraints associated with upland rice production and how did you cope last season? (Use table)

Constraints	Rank	Coping strategies

Ask farmer to list all the constraints first and tell him/her to rank starting with most severe problem.