ECONOMIC ANALYSIS OF IRRIGATED RICE PRODUCTION IN KURA LOCAL GOVERNMENT AREA OF KANO STATE, NIGERIA

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN AGRICULTURAL ECONOMICS

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JUNE, 2016

DECLARATION

I hereby declare that this dissertation titled **"Economic Analysis of Irrigated Rice Production in Kura Local Government Area of Kano State, Nigeria"** has been written by me and it is a record of my research work. No part of this dissertation has been presented in any previous application for another degree or diploma in this or any other institution. All borrowed information have been duly acknowledged in the text and a list of references provided.

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CERTIFICATION

This dissertation titled **"Economic Analysis of Irrigated Rice Production in Kura Local Government Area of Kano State, Nigeria"** by **Olufemi James AYODELE** meets the regulations governing the award of the Degree of Master of Science in Agricultural Economics of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my family in view of the moral support I received all through the period of my academic pursuit.

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I am very grateful to the Almighty God for giving me the life, opportunity, strength, wisdom and financial endowment to complete this study. To Him is the glory. I sincerely appreciate the thoughtful contributions of my Supervisors. I am very grateful to those who stood by me with strong words of encouragement during the periods of this work. May the Almighty God reward you all abundantly.

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ABSTRACT

The main focus of the study is on economic analysis of irrigated rice production in Kura local government area of Kano State, Nigeria. The Research was carried out in 10 selected villages in Kura local government area. The 10 villages were selected from the 26 villages in the local government and 10% of the farmers in each of the selected 10 villages were used as respondents. The study made use of primary data, collected through structured questionnaire. Descriptive statistics, multiple regression model, gross margin analysis were used as analytical tools. Farmers' average age was found to be 43 years which represents an opportunity for more active years in the study area. The study revealed that farmers have 5 household size on the average. Farmers experience in cultivation of rice was an average of 25 years in the study area. Furthermore, land acquisition for the cultivation of rice is largely through inheritance with average farm size of 1.18 hectares. Most farmers do not have contact with extension agents and also about 42% of farmers have had access to credit between the ranges of ₦1000 to ₦10,000. About 73% of the farmers do not belong to any cooperative membership. Farmers' age, farming experience, farm size and credit if increased will lead to increase in output of rice. This average seed rate was about 11.18% - 28.94% lower than recommended rate of 80-100 kilogramme/hectare. Also, the inorganic fertilizer used was an average of 381.4kg/hectare which is lower than the recommended 730kg/hectare. The output level was however at an average of 6,516.95kg/hectare which is higher than the expected 3-6tonnes. Farm size, seed, fertilizer and agro chemicals were positive factors of production. Labour was negative which implies that an increase in the use of labour would decrease farm output. The sum of the elasticities of production of the five variable inputs was 1.055, indicating increasing returns to scale. The total variable inputs (seed, labour, fertilizer and agro-chemical) was estimated to be N142, 844.70/hectare. The gross farm return was N391, 017/ hectare. The gross margin per hectare was therefore, N248, 172.30. Late discharge of water, high cost of fertilizer and poor price at harvest time ranked highest in that order in the list of constraints faced by farmers in the study area. It was concluded that the production of irrigated rice was found to be profitable and has the potential of contributing to improved livelihoods of the farmers in the study area. It was therefore recommended that the Government should liaise with the appropriate authorities for decisions on water release schedule in consultation with farmers.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Rice has been an important food for most people in sub-Saharan Africa particularly West Africa where the consumption of cereals mainly sorghum and millet has decreased while that of rice has increased as a result of shift in consumers' preference, urbanization and increase in population. Rice is notably palatable and can digest easily (Cadoni and Angelucci, 2013). It is grown approximately on 3.7 million hectares of land in Nigeria, covering 10.6% of the 35 million hectares of land under cultivation, out of a total arable land area of 70 million hectares (Cadoni and Angelucci, 2013). Where 77% of the farmed area of rice is rain-fed, of which 47% is lowland and 30 percent upland (Cadoni and Angelucci, 2013). The range of grown varieties is diverse and includes both local (such as Dias, Santana, Ashawa, Yarsawaba, and Yarkuwa) and enhanced varieties of traditional African rice (such as NERICA) (Bayou 2009).

In Nigeria, demand for rice had been increasing at a much faster rate than in any other African countries since mid-1970 (FAO, 2001). Nigeria consumes 50 percent of the total 10 million metric tons of rice for which only 3 million metric tons is produced in Africa (Oryza marked report – Nigeria, 2004). Furthermore, during the 1960s, Nigeria had the lowest per capita annual consumption of rice in the West Africa sub region with an annual average of 3kg. Since then, Nigeria per capital consumption levels have grown significantly at 7.3 percent per annum (PCU, 2002). Consequently, per capital consumption during the 1980s average 18kg and reached 22kg in 1995 to 2000. In an apparent move to respond to the increase in per capita consumption of rice, local production increased at an average of 9.3 percent per annum.

These increases have been traced to vast increase in rice area totaling an annual average of 7.9 percent and to a lesser extent through increase in rice yield of 1.4 percent per annum. In spite of this, the production increase was not sufficient to match the consumption increase. In a bid to address the demand-supply gap, government, at various times, has come up with different policies and programmes. It is observed that those policies have not been consistent (Ogundele and Okoruwa, 2004). The erratic policies reflected the dilemma of securing cheap rice for consumers and a fair price for the producers.

Nigeria is the largest producer of rice in West Africa and the second largest behind Egypt in Africa. Rice is cultivated in upland and swamp ecosystems in Nigeria. Upland rice accounts for about 30-35% of total rice while swamp rice accounts for about 25% of rice production in the country with yields as high as 2 to 8 tonnes/hectare (Idiong, 2006). Its production in the country rose from 2.4 million metric tonnes in 1994, to 3.9 million metric tonnes in 2005 (CBN 2006). In spite of the increase in production of about 1.8 percent, the demand for rice surpasses supply (Adeoye 2003; Ojehomon *et al*., 2004). Consequently, the country has been importing to bridge the supply-demand gap. Considering its vast agricultural land and suitable ecology, Nigeria is endowed to produce enough rice to satisfy domestic demand and has the potential to export to other countries (Babafada, 2003). However, domestic rice production has not increased sufficiently to meet the increased demand despite the various policy measures put in place to facilitate production. FAO (2004) estimates indicated that Nigerian rice import increased from 2,630 metric tonnes in 1970 to 1.876 million metric tonnes in 2002. Total import also stood at 1.9 million tonnes in 2003 (GAIN 2004). Today rice is cultivated in virtually all the agro-ecological zones in Nigeria. Despite this, area cultivated to rice appears small. Estimate of locally produced rice for year 2002 was 2.9

million tonnes (FAOSTAT 2003). Also, only about 6.7% of the 25 million hectares of land cultivated to various food crops was cultivated to rice between 2000 and 2002 (Osiname 2002).

1.2 Problem Statement

Despite recorded increase in rice production over the years, the demand for the commodity in Nigeria outstripped it supply. For example, Paddy rice production had increased between 2001 and 2006 from 2.75 million to 4.0 million tonnes, followed by a decline in 2007 to 3.5 million tonnes and a positive peak in 2008 was witnessed in which the output was estimated at 4.3 million tonnes. From 2008 to 2010 production statistics showed a decreasing trend in production from 4.3 to 3.5 million tonnes (FAOSTAT, 2012). On the other hand, the consumption pattern keep increasing from 3.05 million in 2001 to 5.95 million tonnes in 2012 (IRRI, 2013). This shows a wide gap between production and consumption of the commodity.

This phenomenon led various governments to come up with policies and programmes that would ensure efficient bridging of the gap. However, the policies were erratic and so unable to achieve the designed goals and objectives of increasing rice production in particular, and achieving agricultural growth and equity in general. Existing low level of productivity in food grain production reflect low level of technical, allocative and economic efficiencies. Therefore, increasing agricultural growth is an indication of appreciable growth in agricultural production process that is linked to farm profit (Ogundari, 2006).

The demand for rice in Nigeria as at 2011 was estimated at 19.2 million tonnes against the production level of 4.5 million tonnes (CBN, 2012). This has created a demand production gap of about 14.7 million tonnes to be met. Diagne *et al.* (2011) in their

work on historic opportunities for rice growers in Nigeria stated that less than 10% of the 3.4 million hectares of irrigated land that could be used for irrigated rice production in Nigeria are currently cultivated. Rice yields in irrigated areas are between 3 and 3.5 tonnes/per hectare, which are much lower than the potential yields estimated at between 7 and 9 tonnes/per hectare (Diagne *et al.*, 2011).This study seeks to provide answers to the following research questions:

(i) What are the socio-economic characteristics of irrigated rice producers?

(ii) What are the levels of inputs and output in irrigated rice production?

(iii) What is the technical relationship between inputs and output in irrigated rice production?

(iv) Are resources efficiently utilized in irrigated rice production?

(v) Is irrigated rice production profitable?

(vi) What are the constraints associated with irrigated rice production in the study area?

1.3 Objectives of the Study

The broad objective of the study was to evaluate the economics of irrigated rice production in Kura Local Government Area of Kano State. The specific objectives were to:

(i) describe the socio economic characteristics of irrigated rice producers in the study area;

(ii) determine the input and output levels in irrigated rice production;

(iii) determine the technical relationship between inputs and output in irrigated rice production;

(iv) determine whether or not resources are efficiently utilized in irrigated rice production;

(v) determine costs and returns in irrigated rice production; and

(vi) identify the constraints associated with irrigated rice production in the study area.

1.4 Hypothesis

The following hypothesis was tested:

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

1.5 Justification of the Study

Rice is one of the few crops recommended for rapid production expansion in Nigeria. Various studies have revealed that rice can be produced in all States of Nigeria (Hardcastle, 1959; Davis, 1962; Blackenburg, 1971; Filani, 1980). Although the bulk of rice in Nigeria is produced in swamp and upland areas, potentials exist for increased output through irrigation (Davis, 1962; Colin, 1965; Adeniyi, 1986).

The provision of adequate food for the rapidly growing population also requires that irrigated rice production be expanded. This will depend, to some extent, on determining the production function for irrigated rice production, the efficiency of resource use in irrigated rice production and the constraints associated with irrigated rice production. Policy makers will also find the results of the research useful in policy formulation. Furthermore, the study will help to add to the wealth of knowledge in the area of income generation on farming.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 World Production and International Trade in Rice

Rice cultivation is the principal activity and source of income for millions of households around the globe. Several countries of Asia and Africa are highly dependent on rice as source of foreign exchange earnings and government revenue also Rice is the second largest produced cereal in the world after wheat. (Kadiri, 2014). Rice is a crop that cuts across regional, religious, cultural, national and international boundaries. Rice production is geographically concentrated in Western and Eastern Asia. Asia is the biggest rice producer in the world accounting for 90% of the world's production and consumption of rice. China and India, which account for more than one-third of global population supply over half of the world's rice. Brazil is the most important non-Asian producer, followed by North and Central America, United States of America ranks third in North America continent after Brazil and North and Central America. Nigeria ranks second in Africa after Egypt (Kadiri, 2014).

There has been a major decline in world rice production since late 2007 due to many reasons including climatic conditions in many top rice producing countries as well as policy decisions regarding rice export by government of countries with considerable rice production. Despite a low world rice production in 2009, the current global rice stocks are much higher than in 2007. In the last two years, rice stocks have increased by more than 16 million tons from 75 million tons in 2006 to 91.5 million tons in 2009 (Rice Trade, 2011).

According to Shellemiah (2006), Africa spends over two million dollars importing rice from Asia, with an increased consumption rate of almost six per cent, and that rice is no longer a luxury crop since poor people as well as wealthy eat Rice.

The estimated annual paddy rice production of Africa is about 24million tones (15.6Mt equivalent of milled rice). Additionally, 10 Mt of milled rice is imported into the continent annually (Manful, 2010). Despite continuously increasing production, world market rice prices remain high and do not show signs of abating(Manful, 2010). Only about 5-6% of the rice produced reaches international markets. In 2010, the three largest rice exporters, in decreasing order of quantity exported, were: Thailand, Vietnam and India. Together, they accounted for nearly 70% of world rice exports. Global rice stocks fell from 147.3 MT in 2000 to 74.1 MT in 2008. Current rice exporters may however turn into importers at some stage. For instance, China, a traditional exporter of rice, has since 2010 turned into a net importer. Major importers include Nigeria, Indonesia, Bangladesh, Saudi Arabia, Iran, Iraq, Malaysia, the Philippines, Brazil and some African countries (Ivory Coast and Senegal). Although China and India are the two largest producers of rice in the world, both countries consume the majority of the rice produced domestically (with China becoming an importer), leaving little to be traded internationally (Manful, 2010).

2.2 Rice Production in Nigeria

Rice is an increasingly important crop in Nigeria. It is relatively easy to produce and it is grown for sale and for home consumption. In some areas there is a long tradition of rice growing, but for many, it is considered a luxury food for special occasion only. With the increased availability of rice, it has become part of the everyday diet of many in Nigeria. There are many varieties of rice grown in Nigeria; some of these are traditional varieties while others have been introduced into the country. Rice is grown virtually in all the agro-ecological zones in Nigeria (Akande, 2003). This is because, Nigeria have ideal climatic conditions which is akin to that of South East Asia where the crop is produced for export.

A combination of various factors seems to have triggered the structural increase in rice consumption in Nigeria. Urbanization is the most important cause of the shift in consumer's preference towards rice in Nigeria.

Rice is easy to prepare compared to the other traditional cereals, thereby reducing the chore of food preparation and fitting more easily in the urban lifestyles of rich and poor alike. Similarly, as men work at greater distances from their homes in the urban setting, more meals are consumed from the market where the ease of rice preparation has given it a distinct advantage. Also, as women enter the labor force, the opportunity cost of their time increases and convenient foods such as rice, which can be prepared quickly rise in importance. These trends have meant that, rice is no longer a luxury food but has become a major source of calorie for the urban poor and rich. According to Onyishi, *et al*. (2010), the main production ecologies of rice are rain-fed lowland, rain-fed upland, irrigated lowland, deep water floating, and mangrove swamp. They noted that, land area for rice production under rain-fed upland is 25%, rain-fed lowland 50%, irrigated lowland 16%, deep water and mangrove 9%, and their share of production is 17%, 35%, 27%, and 3% for rain-fed upland, rain-fed lowland, irrigated lowland, and deep water mangrove respectively. The deep water mangrove is not fully developed in Nigeria because; there is lack of appropriate technology (Singh *et al*., 1997).

In recent time, Nigerians have increased their level of foreign rice consumption irrespective of their relative prices simply because they are polished, stone free and easy to cook. Yet nutritionally, the local varieties produced in Nigeria are far better than those imported. Rice production is very essential in Nigeria as a whole and in Niger Delta in particular because, it guarantees food production; creates employment opportunities; reduce poverty; and create capacity building at both individual and

institutional levelsOnyishi, *et al*. (2010). All these are needed for Sustainable Rural Development of a region.

Table 2.1 shows the area cultivated and output of both rain-fed and irrigated rice production in Nigeria between 2000 and 2012. There was an increase in the planted area for both rain-fed and irrigated rice production within the period, but the area cultivated under rain-fed rice was higher than that for irrigated rice. The total output was also higher under rain-fed than under irrigated production, possibly as a result of the larger area of land cultivated under rain-fed rice production.

Table 2.1: Rain-fed and Irrigated Rice Production in Nigeria, 2000-2012

	Rain-fed		**Irrigated**	
Year	**Area of land cultivated (Hectares)**	**Output (Tonnes)**	**Area of land cultivated (Hectares)**	**Output(Tonnes)**
2000	1800000	3400000	560000	1900000
2001	1931400	3648200	600880	2038700
2002	2072392	3914519	644744	2187525
2003	2223677	4200278	691810	2347214
2004	2386005	4506899	742312	2518561
2005	2560184	4835902	796501	2702416
2006	2747077	5188923	854646	2899692
2007	2947614	5567715	917035	3111370
2008	3162789	5974158	983979	3338500
2009	3393673	6410271	1055809	3582210
2010	3641411	6878221	1132883	3843712
2011	3907234	7380331	1215583	4124303
2012	4192462	7919096	1304321	4425377

Source: CBN (2012)

2.3 Rice-Growing Systems in Tropical Africa

Irrigated rice-growing areas are divided into three subcategories based on temperature. Two are found in West and Central Africa: favorable temperature and low-temperature, tropical irrigated zones. The latter is restricted to the mid-altitude areas of Cameroon. The former is represented by the dry-season irrigated rice that is found in all agro

ecological zones from the rainforest to the Sahel (Sohl, 2005). While nearly all the rice grown in Mauritania (Sahel) is irrigated, only 12–14% (0.5 million ha) of the total rice area in West and Central Africa is irrigated. This includes substantial areas in Cameroon (80%), Niger (55%), Mali (30%) and Burkina Faso (20%). Irrigated rice in these countries (except Cameroon) is mainly in the Sudan Savanna and Sahel, which account for nearly 60% of the irrigated rice area in West and Central Africa. In Côte d'Ivoire, about 24,500 ha (7% of total area) is irrigated. Yield potential (10 t/ha) is higher in these drier zones than in others, because of high solar radiation and low disease stress. WARDA, 2007).

Rice yields in rain-fed lowlands (flood plains and valley bottoms) depend on the degree of water control and vary from 1 to 3 t ha^{-1}. These systems have a high potential for intensification, which is pushed by local land pressures and pulled by urban market demand. With improved water control, use of external inputs may become attractive and rice yields may be increased rapidly in these systems that are inherently much more stable than the upland areas (Balasubramanian *et al*., 2007). Biophysical factors affecting rice yield in rain-fed lowland systems include weeds, drought, flooding, soil nutrient supply, iron toxicity, blast, rice yellow mottle virus (RYMV) and African rice gall midge (AFRGM). High yield potential is the priority objective in breeding for rain-fed lowlands, combined with weed competitiveness, short duration, resistances to blast, RYMV and AFRGM, and tolerance to iron toxicity (Sohl, 2005). The major socio-economic constraints include resource availability, production risk, knowledge on best-bet crop management practices, and human health problems.

2.4 Uses of Rice

The uses of rice include:

(i) The rice grain is cooked by boiling or steaming, and eaten mostly with pulses, vegetables, fish or meat.

(ii) Flour from rice is used for breakfast foods, baby foods, bread and cake mixes and cosmetics.

(iii) Starch from made from broken rice is used as laundry starch and in foods, cosmetics and textile manufacture.

(iv) Beers wines and spirits are made from rice.

(v) The husk or hull is used as fuel, bedding, absorbent, packing material and as carrier for vitamins and drugs; it is also made into building board. The charred hull is used for filtration of impurities in water, a medium for hydroponics and manufacture of charcoal briquettes.

(vi) Rice bran or meal obtained in pearling and polishing is a valuable livestock and poultry feed. Oil is extracted from the bran. Crude rice bran oil is processed into solidified oil, stearic and oleic acids, glycerine and soap. Processed bran oil is used for cooking, antirust and anti-corrosive agents, textile and leather finishers and in medicine.

(vii) Rice straw is used for animal feed and bedding for the manufacture of straw boards and pulp for paper, for the production of compost and mushroom growing medium, for mulching vegetable crops, for making ropes, sacks, mats and hats, for roof thatching, and to make plastering material (mixed with clay mud) for the construction of houses, and for incorporation into the soil or burning on the field as a way to maintain/improve soil fertility.

(viii) Several traditional medicinal applications of rice have been reported from tropical Africa: leaf dressings are applied to ulcers and grain decoctions are drunk to treat diarrhoea, as a diuretic and as an emollient. Rice powder is applied against itch in

Senegal. In Democratic Republic of Congo, a decoction of the roots, leaves and husks is taken against madness and beriberi.

2.5 Irrigated Rice Production Schemes in Nigeria

Average irrigated rice yields of 3.5 tons/ha are generally higher than yields obtained in other rice production systems, but much lower than the potential yield of more than 6 tons/ha for irrigated rice. The relatively poor performance of irrigated rice schemes in the country can be attributed to a number of biophysical, socioeconomic and institutional constraints (Fagade, 2001). These factors have together contributed to low irrigated rice productivity, and the performance of irrigated rice schemes in northern Nigeria continues to be below those of similar schemes in the Sahel region of West Africa. Also, an important issue revolves around the viability of large and medium-scale irrigation schemes in terms of investment, maintenance and operational costs. Current low productivity will continue to undermine the competitiveness of irrigation agriculture vis-à-vis other production systems that have relatively low operating and maintenance costs. Identifying and addressing constraints and opportunities for improving the performance of these schemes will result in significant increases in productivity and farm incomes, improve the competitiveness of the domestic rice sector and reduce rice importation needs (Fagade, 2001).

Irrigated rice production systems encompass lowlands with good water control, enabling two crops to be grown per year. The yield obtained in these systems is generally higher than in other systems (Oladapo, 2003). Irrigated rice production systems include both large-scale irrigation schemes in the North and small-scale inland valleys in the South. Rice is the main irrigated crop in Nigeria, particularly in the dry season (Fagade, 1997).

In 1979, the following major rice production schemes were identified:

(i) South-Chad Irrigation Scheme with a capacity of 8,000 hectares.

(ii) Sokoto-Rima River Basin Irrigation Scheme, with a capacity of 4000 hectares.

(iii) Badeggi Irrigation Scheme with a capacity of 580 hectares

(iv) Edozhigi Irrigation Scheme with a capacity of 900 hectares.

(v) Shonga Irrigation Scheme with a capacity of 300 hectares.

(vi) Longuma irrigation scheme with a capacity of 200 hectares.

Some of these large-scale irrigation schemes have collapsed due to lack of maintenance while some are functioning below full capacity. These problems have led to an increased emphasis on small-scale irrigation schemes, which are more manageable and capable of being sustained (WARDA, 1981).

2.6 Agricultural Productivity

Agricultural productivity may be defined as the index of the ratio of the value of total farm output to the value of the total inputs used in farm production (Olayide and Heady, 1982). Since one of the chief objectives of any society is the attainment of an optimally high level of living with a given amount of effort, any increase in the productivity of resources employed in farm production will contribute to the well-being of the economy as a whole (Olayide and Heady, 1982). Aggregate measures of productivity in production economics analyses will add to the sum of our knowledge by (a) serving as barometers of economic progress, (b) serving as guides to adjustment of resources, (c) providing a framework for formulating and evaluating policy and (d) indicating problem areas that need further research (Olayide and Heady, 1982).

The final objective of our interest in productivity should be to find ways of increasing output per unit of input, and of attaining desirable inter-firm, intra-firm, and inter-sector transfers of production resources, thereby providing the means for raising our economic level of living (Olayide and Heady, 1982).

2.6.1 Input-output resource productivity

The input-output process of farm production is important in at least four major problem areas. These are the distribution of income, the allocation of resources, the relation between stocks and flows, and the measurement of efficiency or productivity (Olayide and Heady, 1982). In the productivity concept, a meaningful assessment will depend upon a clear and precise definition of input and output in such a way that their movements over time are not equal. We should also seek to determine which inputs and outputs are consistent with the particular productivity concept in question. Thus, we are faced with separate and distinct conditions when we direct our efforts to, say, the measurement of labour or capital, or land, or water or management productivity (Olayide and Heady, 1982). In other words, resource productivity is definable in terms of individual resource inputs or in terms of a combination of them. Thus, we shall define labour productivity as the ratio of total output to labour inputs. Similarly, "land," "capital," "water," and "management" productivities can be defined as the ratio of total output to inputs of land, capital, water and management, respectively. Using this definition as bench-mark, change in productivity over time will depend upon changes in both the "included" and "excluded" components and maximum resource productivity will imply obtaining the maximum possible output from the minimum possible set of input. In this context, optimal productivity of resources implies an efficient utilization of resources in the production process. This means that productivity and efficiency are synonymous in this context (Olayide and Heady, 1982).

An increase in farm output will result from one of three forces. First, it will result from an increased quantity of inputs, with no change in output per unit of input. Second, it will result from an increased productivity of inputs with no change or a decrease in quantity of inputs. Thirdly, it will result from a combination of changes in inputs and productivity. This situation makes the concept of efficiency a central issue in production economics (Olayide and Heady, 1982).

2.6.2 Efficiency in agricultural production

Several attempts have been made to define economic efficiency and to measure it in an empirical sense. Most of these definitions have foundered in one way or another. However, Farrel (1957) has defined economic efficiency in an admirable accepted form, but his definition defies precise measurement. His definition of efficiency is couched in three-related terms. First, he defines "technical" efficiency as the measure of a firm's success in producing maximum output from a given set of inputs. It indicates all those undisputed gains that can be obtained by simply gingering up the management. Second, he defines "price" efficiency as the measure of a firm's success in choosing an optimal set of inputs. This is an indication of the gains that can be obtained by varying the input ratios on certain assumptions about the future price structure. Thirdly, he defines "overall" efficiency as the simple product of the technical and the price efficiencies (Olayide and Heady, 1982).

2.6.3 Measurement of production efficiency

In the estimation of efficiency in agricultural production, observation of the operator's behavior can be modeled depending on the research questions and data availability. Efficiency can therefore, be measured by comparing the actually attained or realized value of the objective function against what is attainable at the frontier subject to available inputs. Broadly, two quantitative approaches abound for the measurement of

production efficiency; parametric and non-parametric approach. The two techniques use different methods of data enveloping.

Efficiency measure as the average productivity of say labour, capital, land, water and so forth can only be a meaningful index of technical efficiency if any one of the resources is limiting in the production process. Index of efficiency, measure as the weighted average of all inputs compared with output is replete with index number problems and hence is not a dependably meaningful measure of technical efficiency. The use of cost comparisons in the production process as an index of technical efficiency has limited applicability where all farms or plants do not face the same factor prices.

In situations where all farms of plants face the same factors prices, cost comparisons constitute a much better criterion than productivity, and are therefore equivalent to the best "efficiency index" (Olayide and Heady, 1982).

If we cannot obtain a universally acceptable yardstick for measuring technical efficiency, which is of interest in resource productivity, we can at least specify certain necessary conditions for the attainment of technical efficiency. Heady (1952) specifies eight conditions for the attainment of economic efficiency. These are:

(i) The marginal rate at which factor is transformed into product must be the same for any pair of farms using the same factors and producing the same product.

(ii) The marginal rate of substitution between any pair of factors must be the same for any two farms using both factors to produce the same product.

(iii) The marginal rate of substitution between two factors must be the same for every product in which they are used.

(iv) The marginal rate of substitution between any two products must be the same for nay two farms producing both products.

(v) The marginal rate at which two crops substitute as products on one farm must be equal to the marginal rate at which they substitute as factors on another or the same farm.

(vi) Marginal rate of substitution must be equal between (a) the income and direct utility (leisure) of a resource, in production, and (b) the income and direct utility of a resource in consumption for any single resource owner and between resource owners.

(vii) Marginal rate of substitution of products in time or resources in time must be equal for all farms which produce or use both.

(viii) Price ratios must equal substitution and transformation rates in all cases such that (a) the factor-product price ratios equal the marginal rate at which factor is transformed into product, (b) the product-product price ratio is equal to the marginal rate of substitution of any two commodities, (c) the factor-factor price ratio is equal to the marginal rate of substitution between any pair of factors, (d) the discounted price ratio is equal to the substitution ratio for one product produced at two points in time, and (e) the compounded price ratio is equal to the substation ratio for two resources extending into time.

Attainment of maximum efficiency is only possible if the eight conditions outlined above are simultaneously satisfied. A simultaneous attainment of these physical conditions will allow a maximum product from a given stock of resources, or

conversely, a minimum input of resources for a given output of product (Olayide and Heady, 1982).

The eight conditions outlined above are necessary but not sufficient conditions for efficiency in resource use to be attained. This is due to the fact that the eight conditions do not guarantee that the maximum product is forthcoming from a given stock of resources, or, otherwise, that a given output is being produced with a minimum of factor services (Olayide and Heady, 1982). Maximum efficiency will be guaranteed if single products are produced under conditions of decreasing returns (or increasing costs) and if commodities produced in combination are never produced within ranges of complementary and supplementary relationships. In order words, the factor-product and the production possibility curves must be concave to the origin in the relevant area of equilibrium for each producing unit.

Unless the eight necessary conditions and the sufficient conditions are all attained simultaneously, resources are not efficiently used, and this implies that they can always be arranged to allow (with given and limited resources) a greater total output of the products desired by the consuming society (Olayide and Heady, 1982).

If the goals of efficiency are specifically the reorganization of resources and the maximization of farm income, then it is necessary to isolate the main causes of inefficiency in farm production process. Inefficiency may be due to endogenous and/or exogenous factors. These factors fall into three main categories. First, there are factors explaining why the resources of an individual farm are not organized to maximize the value of the product. Second, there are those which explain why the return on resources differs between agricultural areas. Third, there are those which seek to explain why the value of the product of agricultural resources is low relative to that of certain other

occupations, and/or less than the maximum for the resources employed in the industry (Olayide and Heady, 1982).

These three categories when analyzed in detail lead to an isolation of the specific causes of inefficiencies. These causes are (Olayide and Heady, 1982):

(i) Lack of knowledge of alternative technique and resource organizations.

(ii) Uncertainty and capital limitations coupled with net product of labour in relation to capital.

(iii) The hypothesis that resource returns in primary or extractive industries, such as agriculture, are continually pressing below those of secondary industries, such as manufacturing.

(iv) Institutions serving as adjustment base may precipitate inefficiency.

(v) The low-income structure of family farms and the complexities of rural life and farm-household complex.

(vi) The labour supply function in agriculture in relation to non-agriculture, and the level of investment in the human agent, coupled with tribal restraints as well as problems of migration.

(vii) The degree of competitiveness or otherwise of markets for goods, services and products.

(viii) The structure of costs and returns to society, due to regional differences in resource productivity, as well as the allusive structure of an efficient agriculture.

It is, however, necessary to outline some positive steps in reducing inefficiency in resource utilization in the production process. These steps will, among others, include the following:

(i) The minimization of risk and uncertainty in farming enterprise.

(ii) Useful education directed at increasing productivity and adoption of new techniques on small-income farms.

(iii) Provision of employment outlook services, coupled with job training and transfer assistance.

(iv) Provision of credit for acquisition of capital and expansion of farm size.

(v) Introduction of steps that will try to successfully eliminate differences in costs and returns for the individual and the community.

(vi) Integration of agriculture and industry in agribusiness framework and introduction of corporate and part-time farming (Olayide and Heady, 1982)

2.7 Profitability Analysis

This involves estimation of costs and returns of production. Gomez (1975) developed a farm level model to evaluate alternative cropping mixtures and patterns. These involves as follows: (i) profitability: this is measured as the differences between value of yield and cost of production, and (ii) Net return: this involves the difference between value of yield and cost of inputs, including hired labour. In choosing economic indicators on the basis of production factors affected by potentials innovation Werner (1993) suggested the use of the following: (i) the gross margin and returns to variable cost, where only capital is affected. (ii) Yield/labour ratio, where only labour is affected, and (iii) Gross margin, return to variable costs and monetary return to labour, where capital and labour are affected.

The major problems associated with cost-return analysis as basis for profitability assessment are: (i) It does not indicate the relative importance of each of the resources in production and (ii) It is location bound and specific in applicability due to use of money as the common unit of measurement and the prevailing price for estimates. Gomez (1975), said that in spite of the limitations, cost-return analysis is a useful tool of enterprise comparison and indicating a profitability pattern of aggregate input use.

2.7.1 Measurement of profitability in agriculture

Profitability is obviously related not only to cost of production but also to revenue. Profitability can be defined in several ways, such as the difference between revenue and cost (gross margin) or the ratio between cost and revenue. As Harrrison and Kennedy (1997) argue, firms with positive profits indicate that are able to create barriers preventing the entry of new firms (whose entrance would result in profits decreasing to zero for all firms in the industry), that is to say they are able to maintain their market shares and thus possess some type of competitive advantage. Market shares are sometimes mentioned as a way of assessing a firm's competitiveness, but the concept is often quantitatively measured by profitability variables.

2.8 Stochastic Frontier Production Function (SFPF)

Frontier production function models have been applied in a considerable number of empirical studies both in agriculture and non-agricultural sectors since the pioneering work of Farrell (1957).

The stochastic frontier production function is a method of economic modeling. The stochastic production frontier models was used by Ogundari (2006), Rahman and Umar (2009), Thomas (2007), Emokaro and Ekunwe (2009) and others which derived from

the error model of Aigner *et al*. (1977) and Meeusen and Van den Broeek (1977). The stochastic frontier production function is specified as:

$Y_i = f(x_i.\beta) + e_i$---------- **(1)**

$e_i = v_i - u_i$---------- **(2)**

Where:

Y_i = quantity of output of the i^{th} farm

x_i= vector of the inputs used by the i^{th} farm

β = a vector of the parameters to be estimated

e_i = composed error term

v_i= random error outside farmer's control

u_i = technical inefficiency effects

$f(x_i, \beta)$ = a suitable function of the vector

This according to Ogundari (2006), it has been used by many empirical studies, particularly those relating to agriculture in developing countries and also that the functional form meets the requirement of allowing an examination of economic efficiency.

$\ln Y = \beta o + \beta_1 \ln X_1 i + \beta_2 \ln X_2 i + \beta_3 \ln X_3 i + \beta_4 \ln X_4 i + \beta_5 \ln X_5 i + (Vi-Ui)$ ---------- **(3)**

Where,

ln = the natural logarithm

Y = output of rice (kg/ha)

βo = constant term

β_1- β_5 = regression coefficients

Y_i = Quantity of irrigated rice output (kg)

X_1 = Farm size (ha)

X_2 = Quantity of seed used (kg)

X_3 = Labor input used (both family and hired labor) (man days)

X_4 = Quantity of fertilizer (kg)

X_5 = quantity of agrochemicals (Liters)

Vi = random variability in the production that cannot be influenced by the farmer.

U_i = deviation from maximum potential output attributable to technically inefficiency.

The inefficiency of production, U_i will be modeled in terms of the factors that are assumed to affect the efficiency of production of farmers. Such factors are related to the socio-economic and management variables of the farmers. The determinant of technical inefficiency is defined by:

$U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 lnZ_2 + \delta_3 lnZ_3 + \delta_4 lnZ_4 + \delta_5 lnZ_5 + \delta_6 lnZ_{6+} \delta_7 lnZ_7$ **…….. (4)**

Where,

U_i = inefficiency effects

Z_1 = Age (years)

Z_2 = Household size (Number of persons)

Z_3 = Education (years of schooling)

Z_4 = Access to credit (amount borrowed in ₦)

Z_5 = Extension contact (Number of visit per year)

Z_6 = Membership of association (Years of participation)

Z_7 = Farming experience (years)

δ_0 = constant

δ_1-δ_6 = Parameters to be estimated.

These variables are assumed to influence technical efficiency of the irrigated rice farmers. The gamma ($\gamma = \sigma^2 \mu / (\sigma 2 \mu + \sigma \nu)$ which is the ratio of the variance of U $\sigma^2 \mu$ to the sigma squared (σ^2) which is a summation of variances u and v of U and V ($\sigma^2 = \sigma^2 \mu + \sigma^2 \nu$) were also determined.

On the other hand, u_i is a non-negative truncated half normal random variable associated with farm- specific factors which lead to the ith farm not attaining maximum efficiency of production. U_i is associated with technical inefficiency of the farm and ranges between zero and one. U_i follows an independent and identical half-normal distributed N ($0.\delta^2u$). N represents the number of the farms involved in the cross-sectional survey. According to Bakhsh (2007), stochastic frontier production function model is estimated using the maximum likelihood estimation procedure (MLE).

In this study, Batese and Coelli (1995) model was used to specify a stochastic cost function (allocative efficiency). This model is expressed as:

$lnC_i = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + V_i + U_i$---------- **(5)**

Where,

C_i = Total cost of rice production (₦)

β_o= intercept or constant

β_1-β_4= Parameters to be estimated

X_1 = Cost of seed (₦)

X_2 = Cost of fertilizer (₦)

X_3 = Cost of agrochemicals (₦)

X_4 = Cost of labor (₦)

V_i = Error term which are random variables

U_i = Error term which are non-random variables or technical inefficiency effect

X_1 is expected to be positively related to the cost of rice production.

Economic efficiency (EE) is defined as the capacity of a firm to produce a predetermined quantity of output at minimum cost. It is equal to the product of technical efficiency and allocative efficiency expressed as;

EE = TE * AE ---------- **(6)**

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

The study was conducted in Kura Local Government Area (LGA) of Kano State. Kano State is located between latitudes $10^0 3'$ and $12^o\ 37'$ North and longitudes $7^o 3'$ and $9^0\ 5'$ East of the Greenwich meridian (Ogungbile *et al*., 1999). Kano State is the commercial nerve centre of Northern Nigeria. It has a total land area of 20, 760 square kilometres with 1,754,200 hectares of fertile agricultural land, of which 86,500 is exclusively *Fadama* land. About 75,000 hectares is made up of grazing lands (Olofin *et al*., 2008). Administratively, the State is divided into 44 Local Government Areas. Kano State is the most populous state in Nigeria with a population of 9,383,682 (NPC, 2006).

Kura Local Government lies in the savanna region; the area has and extensively irrigated farming system. Kura inhabitants are 80 percent (80%) farmers. The dry season is usually from October to April, while the rainy season begins from April to September with an annual rainfall of 134.4mm Kano, State Government (2012).

Some of the crops grown in the area are rice, wheat, maize, millet, guinea-corn, beans, tomatoes, onions, sugar-care, cucumber, cabbage and water melon.

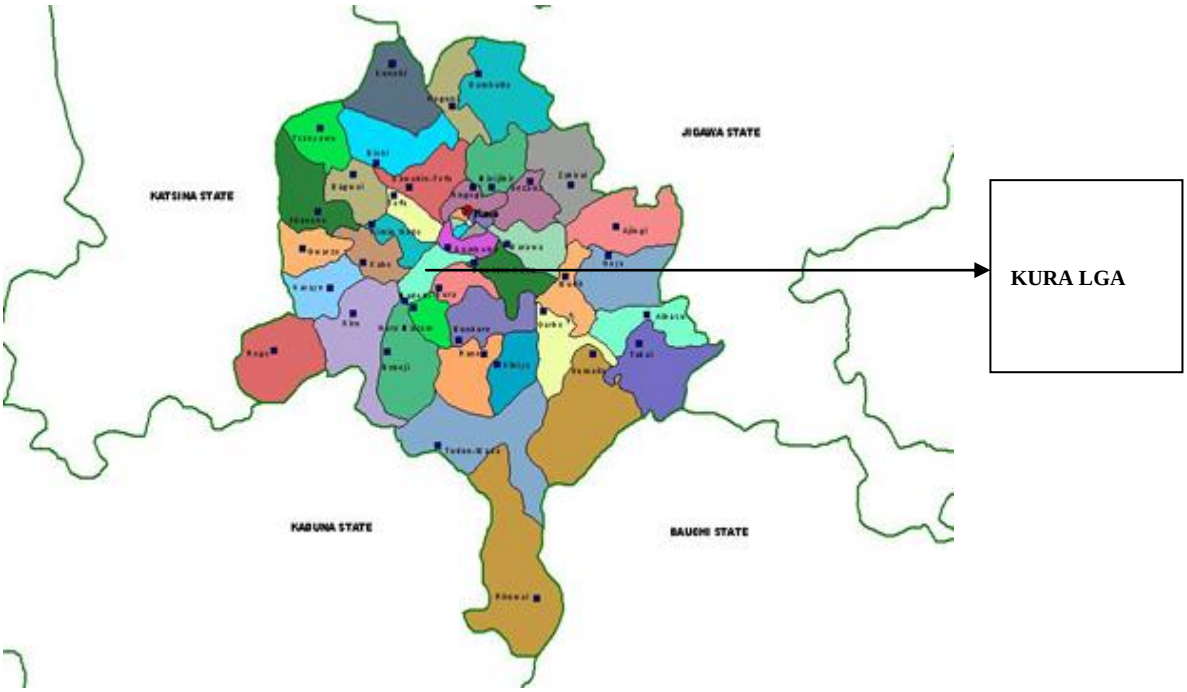


Figure 3.1: Map of Kano State showing the study area

3.2 Sampling Procedure

A two-stage sampling procedure was employed to select respondents for the study. The first stage was the random selection of 10 villages out of the 26 villages in Kura Local Government Area. These villages were Riga, Angolas, Korie, Kusawa, Rakaona, Yakashe, Karfi, Butalawa, Duka and Goro. In the second stage, simple random sampling was employ to select farmers from each of the villages and finally, 10% of the total sampling frame was used to select 200 rice growing farmers from the selected villages (Table 3.1).

Table 3.1. Distribution of respondents in the study area

LGA	Selected Villages	Population of irrigated rice farmers*	Number of Selected farmers
Kura	Riga	293	29
	Angolas	226	22
	Korie	206	20
	Kusawa	179	18
	Rakaona	183	18
	Yakashe	196	20
	Karfi	217	22
	Butalawa	181	18
	Duka	172	17
	Goro	168	16
	Total	**2021**	**200**

3.3 Method of Data Collection

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

(i) Socio-economic characteristics of the respondents such as age, gender, household size, farming experience, educational level, farm size, mode of land acquisition, number of extension visits, amount of credit obtained and membership of farmers' cooperatives

(iii) Quantities of inputs used and their costs

(iii) Quantity of output and the value

(iv) Constraints associated with irrigated rice production.

3.4 Analytical Framework

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

3.4.1 Descriptive statistics

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

3.4.2 Regression analysis

This was used to achieve objective iii part of objective ii of the study. The regression equation is expressed as follows:

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

Where;

Y = Output of rice (kilogrammes)

X_1 =Age of the farmer (years)

X_3 = Household size (number of persons in the household)

X_4 = Farming experience (years)

X_4 = Education (years of formal schooling)

X_5= Farm size (hectares)

X_6 = Amount of credit received (Naira)

X_7 = Membership of cooperatives (years)

U = Error term

b_0 = Constant term

b_1 to b_7 = Coefficients of parameters estimated

3.4.3 The stochastic frontier production function analysis

This study specifies the stochastic frontier production function using the Cobb-Douglass frontier production function. This was used to achieve objective (iii) of the study. The Cobb-Douglass stochastic frontier model is specified as;

$$ln\ Y_i = \beta_o + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + V_i - U_i \text{---------- (7)}$$

Where;

ln = Natural Logarithm

Y_i = Quantity of irrigated output (kg)

X_1 = Farm size (ha)

X_2 = Quantity of seed used (kg)

X_3 = Labor input used (both family and hired labor) (man days)

X_4 = Quantity of fertilizer (kg)

X_5 = quantity of herbicides (Liters)

V_i = Error term which are random variables

U_i = Error term which are non-random variables or technical inefficiency effect

β_o = Intercept

β_1-β_5 = Regression coefficient

The technical inefficiency model is defined by;

$$U_i = \delta_o + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + e_i \text{---------- (8)}$$

Where,

U_i = Technical inefficiency effect of the i^{th} farm

Z_1 = Age (years)

Z_2 = Household size (Number of persons)

Z_3 = Education (years of schooling)

Z_4 = Access to credit (amount borrowed in ₦)

Z_5 = Extension contact (Number of visit per year)

Z_6 = Membership of association (Years of participation)

Z_7 = Farming experience (years)

δ_1-δ_7 = Parameters to be estimated

e_i= Error term

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

$$lnC_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + V_i + U_i \text{---------- (9)}$$

Where,

C_i = Total cost of irrigated rice production (₦)

β_o= intercept or constant

β_1-β_4= Parameters to be estimated

X_1 = cost of renting land

X_2 = Cost of seed (₦)

X_3 = Cost of fertilizer (₦)

X_4 = Cost of agrochemicals (₦)

X_5 = Cost of labor (₦)

V_i = Error term which are random variables

U_i = Error term which are non-random variables or technical inefficiency effect

X_2 is expected to be positively related to the cost of irrigated rice production.

Economic efficiency (EE) is defined as the capacity of a firm to produce a predetermined quantity of output at minimum cost. It is equal to the product of technical efficiency and allocative efficiency expressed as;

EE = TE * AE ---------- **(10)**

3.4.4 Estimation of resource use efficiency

This was used to achieve objective (iv) and the stochastic frontier production function was used to estimate the resource use efficiency in rice production.

Decision rule

If $r = 1$, it implies that resources are efficiently utilized.

If $r > 1$, it implies that resources are under-utilized.

If $r < 1$, it implies that resources are over-utilized.

3.4.5 Gross margin analysis

This was used to achieve objective (v). Gross margin is the difference between the gross farm income (GI) and the total variable cost (TVC), that is, GM = GFI – TVC

Where:

GM = Gross Margin (Naira/hectare).

GFI = Gross Farm Income (/Naira/hectare)

TVC = Total Variable Cost (Naira//hectare)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of the Respondents in the Study Area

This section describes the socio-economic characteristics of the farmers such as age, farming experience, household size, educational level, farm size, mode of land acquisition, number of extension visits, amount of credit obtained and cooperative participation

4.1.1 Age distribution

The results presented in Table 4.1 show the distribution of the respondents by their age. About 28% of the farmers were within 31-40 years of age, 23% were between 41-50 years, 22% between 51-60 years, 17% between 21-30 years and 10% were between 61-70 years of age. The mean age of the farmers was 43 years. This implies that the farmers were made up of relatively young people. Young farmers tend to be stronger, more capable of making good production decisions and have more potential for greater productivity than old farmers, hence are likely to be more efficient in the use of production inputs than older farmers (Adeola, 2010). Age has a significant influence on the decision-making process of farmers with respect to risk aversion and adoption of improved agricultural technologies (Adubi, 1992). Younger farmers adopt agricultural innovations more readily than younger ones (Obeta and Nwagbo, 1991).

Table 4.1: Distribution of the respondents based on their age

Age (Years)	Frequency	Percentage
21-30	34	17.0
31-40	56	28.0
41-50	46	23.0
51-60	44	22.0
61-70	20	10.0
Total	200	100.0
Average	43	

4.1.2 Farming experience

The distribution of respondents by their farming experience (Table 4.2) showed that 33.5% had between 11-20 years of farming experience, 22.5% had 21-30 years of farming experience, and 11% had 1-10 years of farming experience. Average farming experience was 25 years. Farming experience plays a significant role in agricultural production. It is expected that the higher the farmers' experience in farming, the better will be the production capacity of the farmers. Farming experience determines farmers' ability to make effective farm management decisions with respect to input combination or resource allocation. Farming experience is an important factor determining both the productivity and the production level in farming activities (Ajani, 2000).

Table 4.2: Distribution of the respondents based on their farming experience

Farming Experience	Frequency	Percentage
1-10	22	11.0
11-20	67	33.5
21-30	45	22.5
31-40	57	28.5
41-50	9	4.5
Total	**200**	**100.0**
Average	**25**	

4.1.3 Household size

The distribution of the respondents based on their household size is shown in Table 4. 3. From the table, 48.5% had 1-4 members, 40.5% had 5-8 members, 10% had 9-12 members and 1% had 13-16 members. The average household size was 5 members implying a reasonably high number of family labour for the accomplishment of farm activities. It implies that the significance of household size in agriculture hinges on the fact that the availability of labour for farm production, the total area cultivated to different crop enterprises, the amount of farm produce retained for domestic consumption, and the marketable surplus are all determined by the size of the farm household (Amaza *et al.,* 2009). However, Okoruwa and Ogundele (2006) reported that higher family size does not necessarily translate to higher use of family labour because some of these young able-bodied men prefer other jobs than farming. The advantage of small household size is that it may reduce household consumption expenditure and make more resources available for production. Large household size, on the other hand, is associated with increased household consumption expenditure which reduces the money that could be used for production purposes (Ahmed, 2011)

Table 4.3: Distribution of the respondents based on their household size

Household Size	**Frequency**	**Percentage**
1-4	97	48.5
5-8	81	40.5
9-12	20	10.0
13-16	2	1.0
Total	**200**	**100.0**
Average	**5**	

4.1.4 Educational level of the respondents

The distribution of respondents by their educational level in Table 4.4 indicates that 27 %had no formal education, 23.5% had primary education, 37.5% had secondary education and 12% had tertiary education.It implies that majority (73%) of the respondents had one form of educational qualification. Good education propels heads of households to adopt innovations and technologies that are vital for enhancing productivity. The level of education affects the type of decision farmers take in agricultural production and determines the level of opportunities available to improve livelihood strategies and managerial capacity in agricultural production (Sabo, 2011).The finding of this study agrees with the findings of Ogundari (2006) who reported that education enhances productivity among farming households.

Table 4.4: Distribution of the respondents based on their level of education

Education	Frequency	Percentage
No formal education	54	27.0
Primary	47	23.5
Secondary	75	37.5
Tertiary	24	12.0
Total	**200**	**100.0**

4.1.5 Distribution of respondents based on farm size

The distribution of the respondents based on their farm size is shown in Table 4.5. The results revealed that 64% had farm size of between 0.1-1.0 hectares, 25.5% had between 1.1 and 2.0 hectares and 9.5% had between 2.1-5.0 hectares. Only 1% had farm size greater than 3 hectares. Average farm size is 1.18 hectares. This implies that irrigated rice farmers are predominantly small-scale farmers. According to Olayide (1980), small-scale farms range from under 0.10 hectare holdings to 5.99 hectare holdings.

Small farm size is an impediment to agricultural mechanization because it is difficult to use farm machines on small holdings. Ekong (2003) argued that most Nigerian farms are small-size family farms in which family members contribute the required labour.

Table 4.5: Distribution of the respondents based on their farm size

Farm Size	Frequency	Percentage
0.1-1.0	128	64.0
1.1-2.0	51	25.5
2.1-3.0	19	9.5
4.1-5.0	2	1.0
Total	**200**	**100.0**
Average	**1.18**	

4.1.6 Mode of land acquisition

The results of distribution of respondents according to mode of land acquisition in Table 4.6 showed that about 49.07% of the respondents in the study area obtained their farmlands through inheritance, 20.67 % rented their farmland, 21.60% obtained their land through purchase, and 8.02% borrowed their farm land. This indicates that the predominant mode of land acquisition in the study area was through inheritance. Ogungbile *et al*. (1999) in their study in Kano also found inheritance to be the major mode of land acquisition, though there were increases in the rates of acquisition through purchase and rent.

Table 4.6: Distribution of the respondents based on mode of land acquisition

Mode of land acquisition	Frequency	Percentage
Borrowed	26	8.02
Purchased	70	21.60
Gifted	2	0.61
Rented	67	20.67
Inherited	159	49.07
Total	**324**	**100.00**

4.1.7 Extension contact

The distribution of the respondents according to extension contact in Table 4.7 shows that majority (86.5%) of the farmers in the study area had no contact with extension agents, 10 % had one contact, and 3.5% had two contacts in a year. Thus, only 13.5% of the respondents had access to extension agents. The limited extension contact may, therefore, means that the farmers had reduced access to information on modern agricultural technologies.

Table 4.7: Distribution of the respondents based on the number of extension visits

Number of extension visit	Frequency	Percentage
No contact	173	86.5
Once	20	10.0
Twice	7	3.5
Total	**200**	**100.0**

4.1.8 Amount of credit obtained

Table 4.8 shows the distribution of the respondents by the amount of credit received. The results revealed that 23.45% had no access to credit, 42 % received between

₦1000- ₦10,000, 21% received between ₦10,000- ₦20,000 and 5% each received between ₦20,000- ₦30,000 and ₦30,001-40,000. Only 3.5% received above ₦40,000. Accessibility to credit increases farmers' liquidity which, in turn, enhances their ability to purchase inputs and pay for hired labour. According to Oyewole (2012), accessibility of farmers to credit facilities would increase their access to agricultural inputs which would increase food production.

Table 4.8: Distribution of the respondents based on the amount of credit obtained

Amount of credit obtained (₦)	Frequency	Percentage
No credit	47	23.45
1,000-10,000	84	42.00
10,001-20,000	42	21.00
20,001-30,000	10	5.00
30,001-40,000	10	5.00
More than 40,000	7	3.50
Total	**200**	**100.00**
Mean = 13,817		

4.1.9 Years of membership of cooperatives

Table 4.9 shows the distribution of the respondents by their years of membership of cooperatives. The results showed that 72.5% did not belong to any cooperatives, 3.5% had between 1-3 years of cooperative membership, about13% had between 4-6 years of cooperative membership, 9.5% between 7-9 years of membership and 1.5% between 10-12 years of membership. Average years of cooperative membership were 2 years. Membership of cooperative organization provides means of interaction among farmers which can enhance innovation diffusion easily among them. According to Idiong *et al.* (2007), membership of cooperatives affords the farmers the opportunities of sharing

information on modern rice practices. Membership of cooperatives can also enhance the accessibility of farmers to information on improved technologies and to credit facilities for the purchase of inputs and payment of hired labour as well as serve as a medium for exchange of ideas that can improve their farm activities (Oyewole, 2012; Njoku, 1990).

Table 4.9: Distribution of the respondents based on years of membership of cooperatives

Years of membership	Frequency	Percentage
Nil	145	72.5
1-3	7	3.5
4-6	26	13.0
7-9	19	9.5
10-12	3	1.5
Total	**200**	**100.0**
Average	**1.65**	

4.2 Socio-economic Characteristics of Irrigated Rice Producers that Influence Output of Irrigated Rice in Kura LGA

The results of the socio-economic characteristics of irrigated rice producers that influence output of irrigated rice in Kura LGA are shown in Table 4.10. The coefficient of multiple determination (R^2) was 0.81, indicating that 81% of the total variation in output of irrigated rice production was influenced by the socio-economic variables included in the regression model. The socio-economic variables of farmers that were significantly related with irrigated rice output were age, farming experience, farm size and amount of credit received. The coefficient obtained for age was positive (0.0185) and significant at 5% level of probability, implying that increases in age would lead to an increase in output of irrigated rice.

Older farmers have more farm knowledge and may be well exposed to better farm practices than younger ones that could lead to increases in irrigated rice output. The estimated parameter for farming experience was positive (0.0175) and significant at 5% level of probability. This implies that increases in farming experience would lead to increases in output. More experienced farmers tend to possess greater ability to predict farm outcomes and identify farm problems and thus provide better solutions that result in higher rice output. The coefficient of farm size was positive (0.7179) and significant at 1% level of probability. This implies that increases in farm size would lead to increases in farm output. Farm land is a very important input in agriculture and therefore, its size matters a lot in production. This is buttressed by Ajibefun (2006) who posited that land size is one of the indicators of the level of economic resources available to farmers and also, farmers' total land holding may serve as a good proxy for wealth and status and income levels (Bonabana-Wabi, 2002). Amount of credit received had a positive coefficient (0.0429) and was significant at 5 per cent level of probability. This implies that increases in the amount of credit received would lead to increases in output of irrigated rice. Credit is an important part of agricultural production, the absence of which poses severe constraints to agricultural development in low-income countries, like Nigeria. This result is at variance with that of Onyenweaku and Nwaru (2005) who found a positive relationship between credit and technical inefficiency.

Table 4.10: Socio-economic characteristics of irrigated rice producers that influence output of irrigated rice in Kura LGA

Variable	Coefficients	Standard Error	t-value
Constant	8.0331	0.1899	42.30***
Age	0.0185	0.0064	2.89**
Farming experience	0.0175	0.0064	2.68**
Household size	0.0227	0.0141	1.62
Education	0.0081	0.0068	1.18
Farm size	0.7179	0.0318	22.55***
Credit	0.0429	0.0193	2.23**
Membership of cooperatives	0.0126	0.0089	1.42

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

4.2.1 Test of hypothesis I

From the result in Table 4.10, the coefficient of multiple determination (R^2) was 0.81, indicating that 81% of the total variation in output of irrigated rice production was influenced by the socio-economic variables. Thus, the null hypothesis that farmers' socio-economic characteristics are not significantly related with their output is rejected and the alternative accepted.

4.3 Input and Output Levels in Irrigated Rice Production in Kura LGA

4.3.1 Input level

The results in Table 4.11 showed the inputs used in irrigated rice production in the study area. The inputs used were land, seed, labour, fertilizer and agro-chemicals. The average land area under irrigated rice production in the study area was 1.18 hectares. Rice seeds were obtained from open markets and previous harvest. The average market price of ₦200/unit (i.e. ₦80/Kg) for seed was used. The average quantity of seed used by the irrigated rice farmers was 71.06 kilogramme/hectare. This average seed rate was about 11.18% - 28.94% lower than recommended rate of 80-100 kilogramme/hectare (WARDA, 2012). It implies that the quantity of seed was

underutilized. The cost of inorganic fertilizer in the study area ranged from ₦3500 to ₦5500 per 50 kg bag. The average price of ₦ 4500/bag (i.e. ₦90/kg) was used in this study. The average quantity of inorganic fertilizer used by irrigated rice farmers was 381.41kilogramme/hectare, which was about 47.75% lower than the recommended rate of 730 kilogramme/hectare reported by Myint *et al*. (2010). It implies that inorganic fertilizer were well utilized, it could be that the amount used was limited by the high price of the commodity. The labour cost includes the cost of land preparation, fertilizer application, planting and harvesting. The wage rate varied depending on the operation that was performed. The average wage rate was ₦400 per man-day. The average labour used was 241.23 man-days/hectare, which was about 50.26% higher than the recommended rate of 120 man-days/hectare reported by Idem and Showemimo (2004). It implies that labour was well utilized, although rice is a high labour demanding crop. The average market price of ₦850 of agro-chemicals was used. The average quantity of agro-chemicals used by the irrigated rice farmers was 7.46 litres/hectare which was about 46.38% higher than the recommended rate of 4 litres/hectare reported by Ekeleme *et al*. (2008). It implies that quantity of agro-chemicals were well utilized,

The computed coefficients of variation for all the inputs used (Table 4.11) showed that farm size varied the most (78.80%), followed by seed (38.26%). The input that varied the least was inorganic fertilizer (16.92%).

Table 4.11: Input level in irrigated rice production per hectare in Kura LGA

Variables	Minimum	Maximum	Average	St. Dev.	Coefficient of Variation
Yield (Kg/ha)	847	13250	6516.95	1306.73	20.05
Farm size (ha)	0.2	5	1.18	0.93	78.81
Seed (kg)	150	25	71.06	27.19	38.26
Inorganic Fertilizer (kg)	63	2118	381.4	64.55	16.92
Labour(man-day)	80	397	241.23	51.44	21.32
Agro-chemicals (litre)	0	14	7.46	1.50	20.10

4.3.2 Yield

The average price of ₦6000/100bag (i.e. ₦ 60/kg) was computed and used to determine return. The average output of irrigated rice in the study area was 6516.95 kilogramme/hectare (Table 4.11) which is about 6.5ton/hectare. This output is higher than the potential yield of 3-6ton/hectare reported by Brink and Belay (2006). Also the estimated average output in the study area was 61.50% higher than the average output of 4035.03 kilogramme/hectare recorded by Abu (2011) in his study on fertilizer usage and technical efficiency of rice farms under tropical conditions in Nigeria and also (217%) higher than the 2054.72kilogramme/hectare recorded by Angulu (2012) in his study on profitability and technical efficiency of swamp rice production in Niger State. This result is, however not surprising since some of the inputs used (agro-chemicals, inorganic fertilizer and labour) were well-utilized

4.4.1 Estimation of Technical and Resource Use Efficiency of Irrigated Rice Production

The model specified was estimated using maximum likelihood (ML) method using FRONTIER 4.1 software developed by Coelli (1995). The ML estimates and inefficiency determinants of the specified frontier are presented in Table 4.12. The

Cobb-Douglas production function was selected as lead equation or line of best fit. However, the estimated coefficients of seed, labour, fertilizer and agrochemicals were positive and significant at different levels of probability. Hence, they play a major role in irrigated rice production in the study area. The average technical efficiency for the farmers was 0.76 implying that, on the average the respondents were able to obtain 76% of output from a given mixture of production inputs. Thus, in a short run, there is minimal scope (24%) of increasing the efficiency, by adopting the best practice in irrigated production. The study revealed that the generalized log likelihood function was -123.215. The log likelihood function implies that inefficiency exist in the data set.

The estimated coefficient for seed was 0.440 which is positive and statistically significant at 1% level 0f probability. The estimated 0.440 coefficient of seed implies that increasing seed by 1% will increase rice output by less than 1% which means, all things being equal the output is inelastic to changes in the quantity of seed used. The significance of seed quantity is however, due to the fact that seed determines to a large extent the output obtained. This finding agrees with that of Sani*et al*. (2007) in their study on economics of rice production in Bauchi Local Government Area, Bauchi State, where they found the coefficient of seed to be positive (1.021) and significantly related to rice output.

The coefficient of labour was negative (-0.096) and significant at 5% level of probability. This implies that a unit increase in the quantity of labour will decrease the output of the farmers by -0.096 and this could be attributed to over utilization of these resources. This result is similar to that of Omotesho *et al*. (2010) who, in their study on the economics of small-scale rice production in Patigi and Edu Local Government Areas of Kwara State, found the coefficient of labour to be negative (-0.038)

Table 4.12: Maximum Likelihood Estimates of Stochastic Frontier Production Function of irrigated rice production

Variables	Parameters	Coefficients	Std. error	T-Value
Production Function				
Constant	β_0	5.114	0.563	9.08***
Seed	β_1	0.440	0.040	11.00***
Labour	β_2	-0.096	0.071	-1.99**
Fertilizer	β_3	0.455	0.093	4.88***
Insecticides	β_4	0.128	0.068	1.86*
Inefficiency model				
Constant	Z_0	-0.5965	2.4264	-0.246
Age	Z_1	0.0181	0.0440	0.407
Household size	Z_2	-0.2046	0.3195	-0.640
Education	Z_3	-0.0303	0.0624	-0.487
Amount credit borrowed	Z_4	-0.0448	0.0950	-0.471
Extension contact	Z_5	-0.0402	0.0211	-1.908*
Cooperative association	Z_6	-0.00003	0.00006	-0.484
Farming experience	Z_7	0.0102	0.1652	0.0615
Diagnostic Statistic				
Sigma-squared	(σ^2)	0.7694	0.6679	1.152
Gamma	(γ)	0.8318	0.0836	9.725***
Log likelihood function	*L/f*	-123.215		
LR test	12.1372			
Total number of observation	200			
Mean efficiency	**0.76**			

****P<0.01, **P<0.05 and *P<0.10 level of probability*

The production elasticity of output with respect to quantity of fertilizer was 0.0455 which is positive and statistically significant at 1% level of probability. This implies that a 1% increase in quantity of fertilizer will increase irrigated rice output by about 0.05%. Fertilizer is a major land augmenting input because it improves the quality of land by raising yields per hectare. This finding agrees with that of Sani *et al*. (2010) in

their work in rice production under small-scale irrigation in Bunkure Local Government Area of Kano State, where they found the coefficient of fertilizer to be positive (0.059) and significant at 1% level of probability.

The coefficient for agrochemicals was positive (0.128) and statistically significant at 10 percent level of probability. This implies that an increase in the use of agrochemicals will increase output of irrigated rice. This result agrees with that of Sani*et al*. (2007) in their work on economics of rice production in Bauchi Local Government Area, Bauchi State where they found that the coefficient of agrochemicals to be positive (0.387) and significant at 10% level of probability.

The estimated result of the inefficiency model is contained in Table 4.13. The results show that all the technical inefficiency variable except extension contact were not statistically different from zero, and generally, a negative sign on a parameter means that the variable reduces technical inefficiency, while a positive sign increases technical inefficiency.

The estimated coefficient of extension contact (-0.0402) has a negative sign related to inefficiency and significantly different from zero at 10% level of significance. This implies that increase in extension contact will reduce technical inefficiency. This is a significant determinant of technical efficiency.

4.4.2 Estimated Stochastic Frontier Cost Functions (Allocative Efficiency)

The Maximum Likelihood (ML) estimates of the stochastic frontier translog cost parameters for irrigated rice are presented in table 4.13. For the cost function, the sigma (σ^2= 0.16) and the gamma (γ=0.58) are quite high and highly significant at 1% and 5% level of probability respectively. The high and significant value of the sigma square (σ^2)

indicate the goodness of fit and correctness of the specified assumption of the composite error terms distribution. The gamma ($\gamma = 0.58$) shows that 0.6% of the variability in the output of irrigated rice farmers that are unexplained by the function is due to allocative inefficiency.

The estimated coefficients of the parameters of the cost function are positive except that of cost of renting farm size which is negative and agrochemicals which is positive and both not significantly different from zero as shown in the results of stochastic frontier cost function for rice farmers in Table 4.13.

Table 4.13: Maximum Likelihood Estimates of Stochastic Frontier Cost Function for irrigated rice production

Variables	Parameters	Coefficients	Std. error	T-Value
Production Function				
Constant	β_0	7.8142	0.6144	12.7184***
Farm size	β_1	-0.2698	0.5665	-0.4763
Seed	β_2	0.3571	0.0840	4.2512***
Fertilizer	β_3	0.3727	0.0468	7.9637***
Agrochemicals	β_4	0.0268	0.0710	0.3775
Labour	β_5	0.0546	0.0169	3.2308***
Output	B_6	0.2672	0.0407	6.5651***
Diagnostic Statistic				
Sigma-squared	(σ^2)	0.1648	0.0151	10.9139***
Gamma	(γ)	0.5834	0.2823	2.0665**
Log likelihood function	*L/f*	-56.1762		
LR test		22.1343		
Total number of observation	200			
Mean efficiency	**0.69**			

****P<0.01, **P<0.05 and *P<0.10 level of probability*

The coefficients of cost of seed, fertilizer, labour and output were positive and significant at 1% level of probability. This implies that they are important in the production of rice.

The estimated coefficient of the variable output was positively signed and statistically significant at 1% level indicating that if there is an increase in rice output the total cost of production will increase.

This shows that the cost of production is influenced by the quantity of output realized. The result of this research agrees with the findings of Mohammed. (2011) where he reported direct effect of output on cost of production in their study on economics of rain-fed and irrigated rice production under upper Benue River Basin Development Authority Scheme, Dadinkowa, Gombe State, Nigeria

The coefficient of the cost of seed was 0.3571 which is positive and significant at 1% level of probability. This implies that seed are important in rice crop production. The implication of this is that 1% increase in the cost of seed will give rise to 0.36% increase in the cost of rice production. Similar results were reported by Idiong *et al*., (2006) in a study of comparative analysis of technical efficiency in swamp and upland rice production systems in Cross River State, Nigeria.

The coefficient of cost of fertilizer was 0.3727 which is positive and significant at 1% level of probability. This implies that an increase in the quantity of fertilizer used will increase the cost of rice production by about 0.37%.

The cost of labour was 0.0546 which is positive and significant at 1% significance level. This implies that 1% increment in cost of labour will increase the cost of rice production by 0.05%. Mohammed *et al*., (2009) confirms it in their study on comparative study of rain-fed and irrigation methods of rice Production in Dadinkowa Gombe State, Nigeria.

4.4.3 Distribution of Technical, Allocative and Economic Efficiencies Estimates.

4.4.4 Frequency distribution of technical efficiency estimates

The general distribution of the technical efficiency estimates of rice farmers' efficiencies presented in Table 4.14 shows that about80% were operating at technical efficiency level between 0.61 and 1.00 while about 21% of the farmers operated at <0.61 technical efficiency levels.

The farmer with the best and least practice had technical efficiencies of 0.91 and 0.32 respectively. This implies that on the average, output fell by 9% from the maximum possible level attainable due to inefficiency. The study also suggest that for the average farmer in the study area to achieve technical efficiency to be most efficient, he could realize about26% (1-0.76/0.91*100) cost savings while on the other hand, the least technically efficient farmers will have about 75% (1-0.32/0.91*100) cost savings to become the most efficient farmer. This finding is in line with the findings of Taru *et al*., (2010) who observed that average groundnut farmer in Adamawa State would enjoy cost saving of about 32.9 (1-0.65/0.97) percent if he or she attains the level of the most efficient farmer among the respondents in the study area.

4.4.5 Distribution of irrigated rice farmers according to allocative efficiency estimates.

The allocative efficiency estimates presented in Table 4.14, indicate that it ranged from 0.01 to 1.00; most of the farmers (59%) operate at allocative efficiency of >0.61 while 41% operate at <0.61, the mean allocative efficiency was 0.69. The result also indicates that average irrigated rice farmer in Kura LGA would enjoy cost saving of about 36% (1-0.69/0.86*100) if he or she is to attains the level of the most efficient farmer among the respondents. The most allocatively inefficient farmer will have an efficiency gain of

about 73% (1-0.37/0.86*100) in irrigated rice production if he or she is to attain the efficiency level of most allocatively efficient farmer in the study area.

4.4.6 Distribution of irrigated rice farmers according to economic efficiency estimates.

The frequency distribution of the economic efficiency estimates for the farmers in the study area as obtained from the stochastic frontier model is presented in Table 4.14. It was observed that about 18% of the farmers operate at >0.61 efficiency level while about 82% operate between 0.61 and 1.00 efficiency level. The mean economic efficiency of the farmers in the study area was 0.51. The farmer with the best and least practice had economic efficiencies of 0.77 and 0.29 respectively.

The study also suggest that for the average farmer in the study area to achieve economic efficiency of his most efficient counterpart, he could realize about 63%(1-0.51/0.77*100) cost savings while on the other hand, the least technically efficient farmers will have about 92% (1-0.29/0.77*100) cost savings to become the most efficient farmer. However, the average economic efficiency of the irrigated rice farmers was 51%. This indicates that irrigated rice farms were economically inefficient. Okpe *et al.* (2012) confirms similar results.

Table 4.14: Frequency Distribution of Technical, Allocative and Economic Estimates from the Stochastic Frontier Model

Efficiency Level	Technical Frequency	%	Allocative Frequency	%	Economic Frequency	%
0.01- 0.20	0	0	17	8.5	21	10.5
0.21-0.40	12	6.0	24	12.0	33	16.5
0.41-0.60	29	14.5	42	21.0	111	55.5
0.61-0.80	105	52.5	98	49.0	30	15.0
0.81-1.00	54	27.0	19	9.5	5	2.5
Total	200	100	200	100	200	100
Minimum	0.32		0.37		0.29	
Maximum	0.91		0.86		0.77	
Mean	0.76		0.69		0.51	

4.5 Estimates of resource use efficiency

The individual coefficients of farm size, seed, fertilizer, agrochemical and labour with respect to the output of rice derived from the Cobb-Douglas stochastic frontier production function represent the elasticities of the variables. The sum of these coefficients indicates the nature of return to scale (Koutsoyannis, 1977). The elasticities of the variables with respect to rice output are: seed (0.44); labour (-0.096), fertilizer (0.455) and insecticide (0.128). The result also revealed that all of the four variables had coefficient that is less than one. This implies an inefficient utilization of the four input in the production rice.

The sum of the elasticities of production of the four variable inputs is 1.00, indicating that the rice farmers in the study areas are operating at an increasing return to scale.This implies that if all the productive resources are increased in the same proportion, the output of rice will increase more than proportionate. These results agree with those of Sani *et al.* (2010) who, in their work on resource-use efficiency in rice production under small-scale irrigation in Bunkure Local Government Area of Kano State, found the elasticities of production for farm size, seed and fertilizer to be 0.505 and 0.059,

respectively. Also, Sani *et al. (*2007) in their work on economics of rice production in Bauchi State found the elasticities of production of seed, labour, fertilizer and agro-chemicals to be 1.021, -0.074, 0.014 and 0.387, respectively.

Table 4.15: Elasticity of Production and Returns to Scale in irrigated rice Production in Kura LGA of Kano State

Variable	Production elasticities
Seed (kg)	0.44
Labour (man-day)	-0.096
Fertilizer(kg)	0.455
Insecticide (litre)	0.128
Returns to Scale	1.00

4.6 Costs and returns of irrigated rice production in Kura Local Government Area of Kano State

The results in Table 4.16 show the costs and returns of irrigated rice production in the study area. The total cost of variable inputs (seed, labour, fertilizer and agro-chemicals) per hectare was estimated to be N142844.70. The cost of labour accounted for the largest percentage of the cost of production (67.55%) while the cost of seed accounted for the least (3.82 %).

The gross farm return was ₦ 391017 per hectare. The gross margin per hectare was, therefore, ₦248, 172.30. The average rate of return obtained was 2.74, implying that for every ₦1 invested, there was a return of 74 kobo. This result shows that irrigated rice production is profitable in Kura LGA of Kano State. Thus, the null hypothesis that irrigated rice production is not profitable is rejected and the alternative accepted. This finding is similar to that of Sani *et al*. (2007) who, in their work on economics of rice production in Bauchi State, found the average rate of return to be 77 kobo.

Table 4.16: Costs and returns of irrigated rice production in Kura LGA of Kano State

Cost and Return Items	Average quantity Kg/hectare	Unit price (₦)	Value (₦/ha)	Percentage
(A) Variable Costs				
Seed (kg)	71.06	80	5684.80	3.82
Labour (man-day)	241.23	400	96492.00	64.87
Fertilizer(kg)	381.41	90	34326.90	23.07
Agro-chemical(litre)	7.46	850	6341.00	4.26
Total Variable Cost			142844.70	
(B) Output (Kg/ha)	6516.95	60	391017.00	
(C) Gross Margin /ha			248172.30	
(D) Average Rate of Return			1.73	

4.7 Constraints Associated with Irrigated Rice Production in the Study Area

The results in Table 4.17 show the constraints associated with irrigated rice production in the study area. The constraints identified by the respondents were ranked in order of severity. Late discharge of irrigation water was the most important constraint (23.41%). Late discharge of irrigation water may be because the decision about water release schedule is purely the responsibility of the irrigation authority. High cost of fertilizer ranked second among the constraints faced by the farmers (22.48%). High cost of fertilizer may be due to inefficient fertilizer distribution systems and the artificial hording of fertilizer by middlemen.

The third major constraint was poor price at harvest time (22.33%). This could be due to glut in the market at harvest time that reduces price of rice. The fourth constraint identified by the respondents was that of pests and diseases (13.64%). Pests and diseases reduce the quantity and quality of rice output. It is estimated that, worldwide, up to 30 percent of total

agricultural production is lost to pests, diseases and weeds each year (Serageldin, 1991). High cost of labour ranked fifth (2.09%) and shortage of improved seeds ranked sixth (6.05%). The high cost of labour may be attributed to the fact that food production in the study area is labour-intensive and shortage of labour in relation to the demand as a result of competition for available labour raises the cost of labour. The shortage of improved seeds may be caused by the limited supply of the improved seeds by government and private seed agencies in the study area as a result of deficiencies in them.

Table 4.17: Constraints associated with irrigated rice production in Kura LGA of Kano State.

Constraints	**Frequency**	**Percentage**	**Rank**
Late discharge of irrigation water	151	23.41	1st
High cost of fertilizer	145	22.48	2nd
Poor price at harvest time	144	22.33	3rd
Problem of pests and diseases	88	13.64	4th
High cost of Labour	78	12.09	5th
Shortage of improved seeds	39	6.05	6th
Total	**645***	**100.00**	

*Multiple responses were allowed

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study examined the economics of irrigated rice production in Kura Local Government Area of Kano State. The specific objectives were to determine the socio-economic characteristics of the farmers in the study area, identify the socio-economic characteristics of irrigated rice producers that influence output of irrigated rice, determine input and output levels in irrigated rice production, determine the technical relationship between input and output, determine whether or not resources are efficiently utilized in irrigated rice production, evaluate the costs and returns in irrigated rice production, and identify the constraints associated with irrigated rice production in the study area.

Primary data were used for this study and these data were collected with the aid of structured questionnaire. Purposive and proportional sampling methods were used to select 200 respondents from ten villages in Kura LGA. These villages were Riga, Angolas, Korie, Kusawa, Rakaona, Yakashe, Karfi, Butalawa, Duka and Goro. Descriptive statistics, multiple regression analysis production function and gross margin analyses were employed to analyze the data.

The results of the socio-economic characteristics of the farmers revealed that for age distribution, 17% were between 21-30 years, 28% of the farmers were between 31-40 years and 10% were between 61-70 years of age. For farming experience, about 34% had between 11-20 years of farming experience, about 29% had 31-40 years of farming experience and about 5% had farming experience between 41-50 years. For marital

status, 26% were single while 74% were married. For household size, about 49% had 1-4 members, 40% had 5-8 members and 10% had 9 -12 members.

For formal education, 27% had no formal education, about 24% had primary education, about 38% had secondary school education and 12% had tertiary education. For farm size, 64% had farm size between 0.1-2.0 hectares, about 26% had between 1.1-2.0 hectares and about 10 % had between 2.1 and 3.0 hectares. For method of land acquisition, about 49% obtained their farmlands through inheritance, about 21% rented their farmland, about 22% purchased their farmland and about 8% borrowed their farmland. For extension contact, about 87% had no contact with extension agent while 10% had contact with extension once in a year. For credit, about 24% had no access to credit, 42% obtained between ₦1000- ₦10000 and 21% received between ₦10001-₦20000. For membership of cooperatives, about 73% did not belong to any cooperative association, about 13% had 4-6 years of membership and about 10% had between 7-9 years of cooperative membership.

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

The inputs and their average quantities used in irrigated rice production were land (1.18 hectares), seed (71.06 kilogrammes per hectare), labour (241.23 man-days per hectare), fertilizer (381.41kilogrammes per hectare) and agro-chemicals (7.46 litres per hectare). The average output of irrigated rice in the study area was estimated to be 6,516.95 kilogrammes per hectare.

The results of production function analysis for irrigated rice production showed that seed was positive (0.440) and significant at 1% level of probability, farm size (0.128)

and fertilizer (0.455) were positive and significant at 5% level of probability and agro-chemicals (0.128) were positive and significant at 10% level of probability implying that increases in seed, farm size, fertilizer and agro-chemicals would lead to increases in output of irrigated rice. Labour was negative (-0.096) and significant at 5 % level of probability, implying that an increase in the use of labour would decrease farm output in the study area.

The results of the efficiency of resource use in irrigated rice production in the study area showed that farm size, seed, fertilizer and agro-chemicals with resource use efficiency ratios of 16.65, 30.88, 5.18, and 7.90 were under-utilized in the production of irrigated rice, while labour with efficiency ratio of 0.39 was over-utilized.

The cost and returns showed that the total cost of production was ₦148, 844.70 per hectare and the gross returns was ₦391017.30 per hectare. The gross margin was, therefore, ₦248, 172.30 per hectare.

The constraints to irrigated rice production identified by the respondents, in order of their severity were late discharge of irrigation water (23.4%), high cost of fertilizer (22.4%), poor price at harvest (22.32%), pests and diseases (13.63%), high cost of labour (12.09%) and shortages of improved seeds (6.05%).

5.2 Conclusion

Rice is one of the most important cereal foods in the world and the staple food of millions of people. The production of irrigated rice in the study area was found to be profitable and this has the potential of contributing to improved livelihoods of the farmers. Farmers' socio-economic characteristics were found to significantly influence their output, hence change agents in the study area should be trained to understand the factors influencing the underutilization of most of the inputs meant that farmers' lacked

knowledge on the optimal rates of use of these inputs. The constraints associated with irrigated rice production in the study area must be addressed if the existing low-yielding rice production systems are to be transformed into higher yielding and sustainable production systems.

5.3 Recommendations

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

(i) Farm inputs such as farm size, seed, fertilizer and agro-chemicals positively and significantly influenced the production of irrigated rice in the study area. It was therefore, recommended that timely and adequate supply of inputs be made available to farmers at affordable price in order to enhance the production of this crop by the Government and non-Government organizations.

(ii) Since extension contact was significantly determinant of technical efficiency, irrigated rice farmers should through their cooperative societies make arrangements for an extension agents to be visiting at least twice a month, so as to be able to benefit from the farm advisory services that would increase output.

(iii) Late discharge of irrigation water was reported as a major constraint in irrigated rice production. Therefore, the Government should liaise with the appropriate authorities for decisions on water release schedule in consultation with farmers.

(iv) The study revealed that for every naira spent in irrigated rice production, a gain of 73 kobo was made; it is therefore recommended that farmers should be encouraged to go into irrigated rice production in the study area in order to generate more income. This can be done by direct intervention through empowerment programmes and training by

government agencies and donor organizations that will stimulate and sustain farmer's interest in small-scale irrigated rice production in the study area.

5.4 Contribution of the Study to Knowledge

(i) The study revealed that irrigated rice production in the study area is profitable with gross margin of ₦248,172.30 per hectare despite the problems identified.

(ii) It was revealed that irrigated rice farms were economically inefficient in the study area having an economic efficiency of 51% and achieved technical efficiency of 76%.

(iii) The study found that late discharge of irrigation water (23%), high cost of fertilizer (22%) and low price at harvest time (22%) were major constraints faced.

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APPENDIX I: FARMERS RESEARCH QUESTIONNAIRE

(A) BACKGROUND INFORMATION ON THE QUESTIONNAIRE

(i) Name.....

(ii) Village.....

Date of interview.....

(B) SOCIO-ECONOMIC CHARACTERISTICS

(1) Age of the respondents ..... (years)
(2) Gender (i) Male ( ) (ii) Female ( )
(3) Marital status (i) Married ( ) (ii) Single ( )
(4) Educational qualification
(i) No formal education ( )
(ii) Primary ( ) .....(years)
(iii) Secondary ( ).....(years)
(iv) Tertiary ( ) .....(years)
(v) Others specify .....
(5) Family size (indicate the number of people depending on you for a living)…….
(6) How long have you been involved in farming ..... (years)
(7) Did extension staff visit you last growing season Yes ( ) No ( )
(8) If yes, how many times did extension staff visit you last cropping season.....
(9) Do you belong to farmers' association or cooperative society (a)Yes ( ) (b)No ( )
(10) If yes how long have you been in the association or cooperative ..... (years)
(11) Do you have access to credit (a) Yes ( ) (b) No
(12) If yes indicate from which source and the amount given
(i) Agricultural bank (NACRDB) ₦.....
(ii) Commercial bank ₦.....
(iii) Cooperative ₦.....
(iv) Friend/Relatives ₦.....
(v) Others specify .....₦.....

(C) Inputs Used

(I). Farm Size (HA)
i) How many irrigated rice farm plots do you have? ----------
Total irrigated rice farm (Ha) ----------
(13) Kindly indicate the ownership type of the land you cultivate
(a) Borrowed ( ) (b) Purchased ( ) (c) Gifted ( ) (d) Rented ( ) (e) Inherited ( ) (e) Others specify .....
iii. What is the rentage for a hectare of land per season ? ₦.....

II. Labour Used

i. Hired Labour.

	ADULT MALE		ADULTFEMALE		CHILDREN		TOTAL
	Number	Days	Number	Days	Number	Days	Man-days
Land Preparation							
Planting							
Fertilizer Application							
Weeding							
Harvesting							
Packing							
Threshing and Bagging							
Transportation							

Adult is 18 years and above.

III. Family Labour.

	ADULT MALE		ADULT FEMALE		CHILDREN	
	Number	Days	Number	Days	Number	Days
Land Preparation						
Planting						
Fertilizer Application						
Weeding						
Harvesting						
Packing						
Threshing & Bagging						
Transportation						

iv. What is the cost of adult labour per day? ₦ ----------

III. Seed

(a) What quantity of rice seed was used (kg)? ----------

(b) What was the cost of rice seed per kg? ₦ ----------

(c) What was the source of your seed? ----------

i). ADP (ii) Seed Company (iii) Open Market (iv) Own.(v) Others (Specify)_____

V. Fertilizer

Type	Quantity (No of bags/50kg)	Total Quantity (kg)	Price per Bag (₦)	Total Cost (₦)
N.P.K				
CAN (Urea)				
SSP				
ANIMAL MANURE				

Vi. Agrochemicals.

	Quantity	Total Cost (N)
Herbicide		
Pesticide		

VIII. Farm Output & Income Level.

Quantity Harvested (bag of 100kg)	Total Quantity (Kgs)	Unit Price Per Bag (₦)	Total Revenue (₦)

Production Constraints:
List by ranking the problems you face in producing Rice.

No	
1	
2	
3	
4	
5	
6	
7	
8	