PROFITABILITY AND TECHNICAL EFFICIENCY OF SWAMP RICE PRODUCTION IN NIGER STATE, NIGERIA

BY

Angulu USMAN
M.Sc/AGRIC/03664/08-09

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY
FACULTY OF AGRICULTURE
AHMADU BELLO UNIVERSITY, ZARIA,
NIGERIA

JULY, 2012

PROFITABILITY AND TECHNICAL EFFICIENCY OF SWAMP RICE PRODUCTION IN NIGER STATE, NIGERIA

BY

Angulu USMAN
M.Sc/AGRIC/03664/08-09

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

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY
FACULTY OF AGRICULTURE
AHMADU BELLO UNIVERSITY, ZARIA,
NIGERIA

JULY, 2012

DECLARATION

I hereby declare that this dissertation titled "**Profitability and Technical Efficiency of Swamp Rice Production in Niger State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All borrowed ideas have been duly acknowledged in the text and a list of references provided.

_____ _____

Usman Angulu **Date**

Student

CERTIFICATION

This thesis titled '**Profitability and Technical Efficiency of Swamp Rice Production in Niger State, Nigeria',** by Angulu **Usman** meets the regulation governing the award of the Degree of Master of Science in Agricultural Economics of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

_____ _____

Prof. J.F. Alamu **Date**
(Chairman, Supervisory Committee)

_____ _____

Prof. S.A Rahman **Date**
(Member, Supervisory Committee)

_____ _____

Dr. Zakari Abdulsalam **Date**
(Head of Department of Agricultural
Economics and Rural Sociology)

_____ _____

Prof. A.A. Joshua **Date**
(Dean, School of Postgraduate Studies)
Ahmadu Bello University, Zaria.

DEDICATION

To Almighty God and my late guardians Etsu Usman Chepa and Salamatu Etsu Usman.

ACKNOWLEDGMENT

I wish to express my gratitude and praises to Almighty God for sparing my life and making this programme possible. My appreciation goes to my parent for their moral support and continuous encouragement over my academic career.

I sincerely wish to thank my supervisors; Prof. J. F. Alamu and Late Dr. T. M. Kudi for the privilege to tap their wealth of experience. I also wish to thank Prof. S. A. Rahman who took over the supervision of this work after the passing away of Dr. T. M. Kudi. He had twice supervised my work both at first degree and master programmes. I remain grateful to him and may God bless him and his family.

I wish to thank the H. O. D. and all my lecturers in the Department for being part of the instrument in the process of this programme. I wish to express my special indebtedness to my late guardian; Etsu Usman Chepa and Salamatu Usman (Ya Tusoko) for their sound moral upbringing

I appreciate the effort of the following friends and brother for their financial and moral support, Arch. Tauheed Isah, Alh Angulu Bello, Dr. Mohammed Yelwa, Alh. Mundi Abini, Alh Abdullahi Umar, Mr Yusuf Adamu, Dr. Mohammed Isah, Salihu Ibrahim and Muson Mohammed.

I wish to express my appreciation to all my colleagues and friends during my M.Sc. programme and to everyone who has contributed toward this enviable academic programme. I say thank you and God bless.

TABLE OF CONTENTS

Content	Page
Title Page	i
Declaration	ii
Certification	iii
Dedication	iv
Acknowledgement	v
Table of Content	vi
List of Figures	ix
List of Tables	x
Abstract	xi

CHAPTER 1

INTRODUCTION	1
1.1 Background to the Study	1
1.2 Problem Statement	3
1.3 Objective of the Study	5
1.4 Justification of the Study	6
1.5 Research Hypothesis	6

CHAPTER 2

LITERATURE REVIEW	7
2.1 Rice Production Trends and Effort to Meet Production Needs in Nigeria	7
2.2 Influence of Socio-economic Factors on Swamp Rice Production	11
2.3 Inputs and Output Relationship in Swamp Rice Production	13

2.4 Profitability in Swamp Rice Production - - - - 16

2.5 The Concept of Efficiency Measurement in Agricultural Production - - - - - - - - 18

2.6 The Econometric Approach of Efficiency Measurement - - 18

2.7 The Stochastic Frontier Production Function - - - - 20

2.8 Empirical Application of Stochastic Frontier Production Function- 22

CHAPTER 3

METHODOLOGY - - - - - - - - 25

3.1 Study Area - - - - - - - - 25

3.2 Sampling Techniques and Sample Size - - - - - 27

3.3 Method of Data Collection - - - - - - 28

3.4 Analytical Techniques - - - - - - - 29

3.4.1 Descriptive Statistics - - - - - - - 29

3.4.2 Gross Margin Analysis - - - - - - - 29

3.4.3 The Stochastic Frontier Production Function - - - - 30

CHAPTER 4

RESULTS AND DISCUSSION - - - - - - 32

4.1 Socio-economic Characteristics of Swamp Rice Farmers - 32

4.1.1 Age of the Farmers - - - - - - - 32

4.1.2 Family Size - - - - - - - - 33

4.1.3 Farming Experience - - - - - - - 34

4.1.4 Level of Education - - - - - - - 35

4.1.5 Access to Credit - - - - - - - - 36

4.1.6 Non-Farm Income - - - - - - - 37

4.1.7 Extension Contact - - - - - - - 38

4.1.8 Membership of Cooperative - - - - - - 39

4.2 Input and Output Level in Swamp Rice Production - - - 40

4.3 Input –Output Relationship in Swamp Rice Production - - - 42

4.4 Technical Efficiency and Elasticity in Swamp Rice Production - - 45

4.4.1 Elasticity of production and return to scale in Swamp Rice Production- 47

4.5 Factors Determining Technical Efficiency in Swamp Rice Production- - - - - - - - - - 48

4.6 Gross Margin Analysis - - - - - - - 50

CHAPTER 5

SUMMARY CONCLUSION AND RECOMMENDATIONS - - 52

5.1 Summary - - - - - - - - - 52

5.2 Conclusion - - - - - - - - 53

5.3 Recommendations- - - - - - - - - 53

References - - - - - - - - - 55

Appendix - - - - - - - - - 59

LIST OF FIGURES

Figure	Title	page
1	Map of Niger State showing the study areas - - -	26
2	Map of Niger State showing sampling areas - - -	27

LISTS OF TABLES

Table	Title	Page
1:	Rice production trends in Nigeria (1961-2005)	11
2:	Distribution of sample size by L.G.A	28
3:	Age distribution of farmers	33
4:	Family size distribution of farmers	34
5:	Distribution of farmers based on farming experience	35
6:	Distribution of farmers based on educational status	36
7:	Distribution of farmers based on accessibility to credit	37
8:	Distribution of farmers based on accessibility to non farm income	38
9:	Distribution of farmers based on extension contact	38
10:	Membership of cooperative distribution of farmers	39
11:	Variability in socio-economic characteristics of swamp rice farmers in Niger State	40
12:	Inputs and output levels in swamp rice production per hectare	42
13:	Maximum likelihood estimate of stochastic frontier production function	45
14:	Distribution of farmers based on technical efficiency in swamp rice Production	46
15:	Elasticity of production and return to scale in swamp rice production	47
16:	Socio-economic factors influencing inefficiency in the estimated stochastic frontier production for swamp rice in Niger State	50
17:	Average cost and returns of swamp rice production per hectare	51

ABSTRACT

This study was conducted to examine the profitability and technical efficiency of swamp rice production in Niger state, Nigeria. Specifically, the study described the socio-economic characteristics of swamp rice farmers, determined inputs and output levels, estimates the relationship between input and output, determines technical efficiency, determine the profitability as well as to identified the determinants of technical efficiency in swamp rice production. A multi-stage sampling technique was used to select 159 swamp rice farmers for the study. Data were collected on socio-economic characteristics inputs and output quantities as well as their prices. The descriptive statistics was used to describe socio-economic characteristics and inputs and output level of swamp rice farmers. The estimation of technical efficiency and its determinants was achieved using stochastic frontier production function. Equally, gross margin analysis was used to determine the profitability of swamp rice production. The result of the study revealed that all the estimated coefficients of the production function were positive and statistically significant at 1 and 5 percent levels of probabilities. The study showed that the technical efficiency of individual swamp rice farmers ranged from 34 to 98 percent with a mean technical efficiency of 86 percent. The elasticities of production were less than 1 indicating that the resources used in swamp rice production were inelastic. The study also showed that gross margin was ₦56, 740.60 per hectare while the gross margin per naira invested was ₦0.97. The study showed that age, family size, extension contact, and membership of cooperatives were the significant determinants of technical efficiency among swamp rice farmers. It was recommended that policy should be directed toward providing labour saving technologies and that farmers should be enlightened by extension agents on the use of recommended farm practices so as to improve technical efficiency.

CHAPTER 1

INTRODUCTION

1.1 Background to the Study

Agricultural sector played a significant role in Nigerian's economic development before the oil boom of the early 1970s by providing food, employment, foreign exchange earnings and alleviating poverty. It was one of the most important sectors of the Nigerian economy. However, in recent years, there has been a marked decline in the performance of Nigerian agricultural sector. The contribution of agriculture to Gross Domestic Product (GDP) which stood at an average of 56 percent in 1960-1964, declined to 47 percent in 1965-1969, further declined to 35 percent in 2002-2004 and there is recent increase to about 40 percent in 2009 (Amaza and Maurice, 2005, FAO, 2010).

According to FAO (2010), the Nigerian rice sub-sector witnessed a remarkable increase in output from 2.5 million metric tonnes in 1990 to about 4.2 million metric tonnes in 2008. This increase in output of rice over the years was as a result of increase in hectarage cultivated. However, there has been falling yield of rice in Nigeria from 2069.54kg per hectare in 1990 to 1754.40kg per hectare in 2008 (FAO, 2010). This falling yield of rice led to supply deficit situation in the country.

In response to the prevailing rice supply deficit situation in the country, successive Nigerian governments have intervened in the rice sub-sector by increasing tariff on rice importation so that local production could be encouraged. This was expected to widen the home market for the nation local rice (Bamidele *et al.,* 2010). The Federal Government of Nigeria has also established research institutions and programmes which

were geared toward increasing rice production and other crops. These are; Federal Rice Research Station (FRRS) in 1970, National Cereal Research Institute (NCRI) in1974, National Seed Service (NSS) in 1975, and Operation Feed the Nation (OFN) in1976. Other programmes were the River Basin Development Authority (RBDA) in 1977,Agricultural Development Project(ADP) in 1975, Structural Adjustment Programme (SAP) in 1986 and the presidential initiatives on increased rice production, processing and export in 2002 (Bamidele *et al*., 2010). These agricultural programmes have common objectives of increasing production and productivity in the rice sub-sector thereby achieving food self sufficiency. It is important to state that most of these programmes were terminated without achieving the set objectives. The result of this failure is the persistent demand-supply gap for rice

Rice is a staple food for about 2.6 billion people in the world (CTA, 2005).The global output shows that the Asian continent account for about 92 percent, while America and the Caribbean account for 5 percent and 3 percent for Africa (CTA, 2005). Rice as a cereal grain is the most important staple food for large part of the world human population. It is also the second highest worldwide production after maize (FAO, 2010). Since a large portion of maize crops are grown for purposes other than human consumption, rice is the most important grain with regard to human nutrition and calorie intake. Rice provides more than one fifth of the calorie consumed worldwide by human beings (Smith, 1998).

Swamp rice is produced in water logged and seasonal flooded low land area. The traditional method for cultivating swamp rice is by flooding the field and planting young seedlings. Swamp rice cultivation is well suited to countries and regions with low

labour cost and high rainfall, as it is labour intensive to cultivate and require ample water (NRC, 1996).

The Nigerian food sub-sector parades a range of crops, but of all these, rice gained prominence (Akande, 2001). Nigeria plays a vital role in rice production in the West African sub-region with increasing production over the years. The production of rice rose from 2.5 million tonnes in 1990 to about 4.2 million tonnes in 2008, representing about 37 percent rise in domestic production (FAO, 2010). However, despite the numerous government policies and programmes on rice and rise in domestic production, the demand/consumption exceeds the local production resulting in rice importation.

It is on record that, Nigeria has become one of the largest importers of rice, second to Indonesia. Its importation bill of rice has increased from one million United States Dollar in 1970s to as high as 800million United States Dollar in 2005 (WARDA, 2007). The short fall in supply of rice in Nigeria has been attributed to continuous rise in per capita consumption brought about by increased population and rapid urbanization (Akande, 2001., Fabusoro and Agbonlahor, 2002).

1.2 Problem Statement

Rice is a staple food in many African countries and constitutes the major part of diet in many homes. Over the years, the crop has witnessed a steady increase in demand and this gave rise to its importance in the strategic food security planning of many countries. The Nigeria rice sub-sector has witnessed some remarkable improvement in output thereby attaining a position of prominence (Akande, 2001). Since the mid 1970s, the rice consumption in Nigeria has risen tremendously at about 10 percent per annum due

to changing in consumer preferences. However, production has never been able to meet demand, leading to considerable imports which today stand at about one million metric tonnes yearly. The imports are procured in the world market with Nigeria spending about 356 billion naira in 2010 on rice import alone (IITA, 2011).

In an attempt to address the nation rice demand-supply gap, the Nigerian government has intervened in the rice sub-sector over the past few decades. However, the public policy has neither been consistent nor appropriate and domestic production has continued to lag behind demand (Akande, 2001). For instance, from 1986 to mid 1990s import was illegal, in 1995 import was allowed at 100 percent tariff and in 1996 the tariff was reduced to 50 percent but it was later increased to 85 percent in 2001 (Akpokodje *et al*., 2001). Even during the rice ban period, Nigeria was still importing several hundred thousand of tonnes of rice annually through illegal trade. Notwithstanding the various policy measures, the domestic rice production has not increased sufficiently to meet the increased demand (Akpokodje *et al.,* 2001).

The inability of Nigeria rice sub-sector to meet the domestic demand could be attributed to low productivity, inefficiency in the use of resources, disincentives from macro-economic environment and production being in the hands of small scale farmers who use traditional technologies (Federal Ministry of Agriculture, 1995). Nigeria has experienced falling yield of rice from 2069.54kg per hectare in 1990 to 1754.40kg in 2008 FAO (2010). For the swamp rice production to bridge the demand-supply gap, efficiency in production must be increased. Although various studies (e.g. Amaza and Maurice, 2005; Idiong *et al*., 2007) that have been carried out on rice production in Nigeria, (dwelling mostly on either technical efficiency, or determinant of technical

efficiency, or profitability of swamp rice production). Few studies have been carried out in Niger State to determine technical efficiency and profitability of swamp rice production. To bridge this gap in knowledge, this study seeks to answer the following research questions:

(i) what are the socio-economic characteristics of swamp rice farmers?

(ii) what are the levels of inputs and output in swamp rice production?

(iii) what is the relationship between inputs and output in swamp rice production?

(iv) what are the levels of technical efficiency of swamp rice farmers?

(v) what are the determinants of technical efficiency in swamp rice production?

(vi) is swamp rice production profitable?

1.3 Objectives of the Study

The broad objective of this study is to examine the economics of swamp rice production in Niger State, Nigeria.

The specific objectives are to:

(i) describe the socio-economic characteristics of swamp rice farmers in Niger State, Nigeria.

(ii) determine the inputs and output levels in swamp rice production

(iii) estimate the relationship between inputs and output in swamp rice production.

(iv) estimate technical efficiency in the swamp rice production.

(v) identify the determinants of technical efficiency in swamp rice production.

(vi) determine the profitability in swamp rice production.

1.4 Justification of the Study

Rice is cultivated in virtually all the agro-ecological zone in Nigeria, despite this; the area under cultivation to rice is still small. Consequently, Nigeria is not among lead world rice producers (NGADP, 2003) In 2009, out of about 30.7million hectares of land cultivated to various crops, only about 7.82 percent was cultivated to rice (FAO, 2010). Niger State is one of the leading rice producers in Nigeria and the study area has a favourable climatic condition for rice production

There is need to investigate efficiency status of rice farming for purpose of expanding its production. The efficiency study is very important for provision of information on how to improve swamp rice output and enhance productivity of resources on farms. In the economy, where resources are scarce and opportunities are lacking, the efficiency study can show whether it is possible to raise the productivity without increasing the resource base of the farmers in the study area. The findings of this study would provide additional empirical evidence on technical efficiency in rice production in the study area. The information from this study would also contribute to knowledge relevant to policy formulation that would create enabling environment for sustainable rice production in Nigeria.

1.5 Research Hypotheses

The hypotheses tested include:

(i) There is no significant relationship between the input and output in swamp rice production.

(ii) socio-economic variables have no significant effect on the technical efficiency of swamp rice farmers.

CHAPTER 2

LITERATURE REVIEW

2.1 Rice production trends and effort to meet production needs in Nigeria

Rice production started in Nigeria in 1500 BC with the low-yielding indigenous red grain species *Oryza glaberrima* that was widely grown in the Niger Delta Area (Hardcastle, 1959). The high-yielding white grain (*Oryza sativa)* was introduced about 1890 and by 1960 accounted for more than 60% of the rice grown in the country. Today, rice is cultivated in virtually all the agro-ecological zones in Nigeria, but on a relatively small scale. In 2000, out of about 25 million hectares of land cultivated to various food crops, only about 6.7% was under rice (PCU, 2001).

The trend in production shows that paddy rice first experienced a boom in the 1965–1970 periods, when average output stood at 321,000 tons (Table 1). During this period, average area cultivated to rice stood at 234,000 hectares while average national yield was 1.36 tons/ha. Another significant improvement in rice production in Nigeria was recorded in 1986–1990. During this period the output increased to over 2 million tons while average area cultivated and yield rose to 1,069,200 hectares and 2,096 tons/ha, respectively. This significant improvement in production was made possible with the introduction of structural adjustment programme (SAP) in 1986. During this period (SAP), there was total ban on importation of rice in Nigeria. This was expected to encourage local production and widen the home market for the nation rice. Throughout the 1980s, rice output and yield increased. But in the 1991–1995 periods, while rice output increased, yield of rice declined. This implies that the increased output was as a result of increased land cultivation.

There was also great disparity among the states of the federation in rice production in terms of both output and yield. In 2000, Kaduna State was the largest producer of rice, accounting for about 22% of the country's rice output. This was followed by Niger State (16%), Benue State (10%) and Taraba State (7%) (PCU, 2001). Great variations also exist in terms of yield. The average national rice yield during the dry season (3.05 tons/ha) was higher than that of the wet season (1.85 ton/ha).

However, an active and systematic rice research started in the country in 1953 with the establishment of the federal rice station at Badeggi in Niger State, now the headquarter of the national cereals research institute (NCRI). The focus for rice research at the station was the development of varieties with improved grain quality, uniform shape and sizes appropriate for minimal breakage during milling. These aims were achieved mainly through introduction and adaptation (Imolehin, 1991). Between 1954 and 1970, 13 improved rice varieties, comprising two upland, eight shallow swamps and three deep-flooded rice were released to Nigerian farmers. From 1971 onwards, research activities on rice focused on developing high-yielding and disease resistant varieties, the efficient use of nutrients, and good soil management. These aims were achieved through introduction, adaptation and hybridization (Imolehin, 1991).

The Efforts made by the research institute resulted in the release of 16 rice varieties, with the desired traits for pest and disease resistance, nutrition and yield to Nigerian rice farmers between 1971 and 1984. The 16 varieties comprised one upland, 12 lowland and three deep-water ecology rice. As from 1985 to 1989, an additional 14 high-yielding blast-resistant varieties including six upland and three lowland varieties were released. From 1990 to date 11 more rice varieties, comprising eight uplands and three

shallow swamp varieties have been released (FAO, 1999). Thus, from 1954 to 2002 a total of 54 rice varieties have been released to serve the different ecological zone and other specific needs in Nigeria. A remarkable effort to develop suitable rice varieties for Nigerian farmers was made in 1997 with the release of FARO 51, a variety that is resistant to the African rice gall midge. This variety was grown in the endemic area of Abakaliki. The variety exceeded the yields of the existing farmers' varieties by 26% (FAO,1999).

However, recently WARDA has developed an improved variety mainly for upland farmers. The variety is known as NERICA (New rice for African countries) and it is observed that the yield could be as high as 3.0 tons per hectare or more with strict compliance with recommendations. This variety has just been released, however, and some time is required for adoption before the technology can be evaluated. Increased rice production is expected to be achieved effectively when Nigerian farmers in all the ecological zones of the country utilize improved rice varieties, along with appropriate cultural and management practices (Okoruwa and Ogundele,2006)

A second part of the research effort is germplasm collection and conservation. The idea is to ensure the preservation of diverse genetic information that can be tapped in variety of ways and used to evolve varieties with desirable characters. The rice breeding programme started to collect rice germplasm from Nigeria and the rest of the world. This is an activity made possible by the active collaboration with international and national institutes working on rice, including the international rice research institute (IRRI), the International Network for Genetic Evaluation of Rice for Africa (INGER-Africa), the West Africa Rice Development Association (WARDA), the International

Institute of Tropical Agriculture (IITA), and the Institute for Agricultural Research and Training (IART) in Ibadan. Some of the rice germplasm collected is conserved at the institute in freezers, but the bulk is stored in IITA's more efficient cold rooms (Imolehin, 1991).

Since the establishment of the National Centre for Genetic Research and Biotechnology (NAGRAB) at Ibadan, rice germplasm materials have always been conserved there, and it is from there that genetic information is being sourced for routine breeding work. The breeding or adaptation of various types to suit the diverse ecological zones of the country has been possible because of nationally coordinated rice evaluation trials in which newly bred varieties are evaluated for at least three years for desired characteristics. The Promising varieties are evaluated further for yield performance in multi location on-farm adaptive research trials across the country before being released to Nigerian farmers (Imolehin, 1991). Released varieties also have properties that satisfy different consumer preferences in terms of grain type, swelling capacity, amylose content, protein and cooking time.

Table 1 : Rice production trends in Nigeria (1961-2005)

Period	Average area cultivated (hectare)	Average output(tons)	Average yield (tons/h)
1961-1965	179,200	207,200	1.147
1966-1970	234,000	321,000	1.360
1971-1975	288,800	470,200	1.670
1976-1980	332,000	596,200	1.710
1981-1985	630,000	1,300,200	2.063
1986-1990	1,06,200	2,216,064	2.090
1991-1995	1,678,000	2,979,600	1.784
1996-2000	1,742,582	3,011,028	1.733
2001-2005	2,270800	3,139440	1.096

Source : FAO, 2010

2.2 Influence of Socio-Economic Factors on Swamp Rice Production

The age of farming household heads was observed to have inverse relationship with the productivity of the farmers (Ajibefun and Abdulkadri, 2004). This is understandable since it is expected that as farming household head becomes older his or her productivity will decline. Consequently, Ajani (2000) observed that years of farming experience is another factor that enhances productivity among farming households in Nigeria and increases as the age of the farmer increases. It is within this context that years of farming experience and age have positive correlation with productivity. Older farmers have been observed to have higher productivity than younger farmers.

It was observed by Adeoti (2002) that the residency status of the farming household head positively influenced productivity in the dry savannah agro-ecological zone of Nigeria. This is likely because nonresident farmers were likely to have problem managing their farms effectively, while resident farming household heads that live close to their farms would not have this problems. The land ownership status of the household is important because those farmers that owned parcels of land on which they farm were more productive than non land owning farming households. Since those who owned land are ready to make long time and huge investment on such land through adoption of innovation to enhance productivity (Olawoye, 1998).

Education is one of the key assets needed to foster productivity in any profession. Findings from Ogundari *et al*. (2006) confirmed that education was needed to enhance productivity among farming households in Nigeria. It is because good education propels heads of farming household to adopt new innovation and technologies that are vital to enhancing farm productivity. On the effect of farm size on farm productivity, Lau and Yotopolous (1971) using profit function equation, found that small farms attained higher productivity levels than the larger farms in India. Idiong *et al.* (2007) reported that education enhances the acquisition and utilization of information on improved technology by farmers as well as their innovativeness. They also reported that access to credit enhances their timely acquisition of production inputs that would enhance productivity via efficiency.

Amaza and Maurice (2005) who worked on the identification of factors that influence technical efficiency on rice based production system in Nigeria. They reported that the coefficient of farming experience was estimated to be negative as expected and

statistically significant at 1% level. The implication for this result was that farmers with more years of farming experience tend to be more efficient in rice production. They also reported that the coefficient of education was negative and statistically significant at 1% level. It implies that farmers with more years of schooling tend to be more efficient in rice production, presumably due to their enhanced ability to acquire technical knowledge which makes them close to the frontier output.

According to Coelli and Battese (1996) who reported that negative production elasticity with respect to farming experience for farmers in two villages in India. Thus, suggesting that older farmers were relatively more efficient and vice versa. It is possible that such farmers gained more years of farming experience through learning by doing and there by become more efficient. Muhammad-Lawal *et al*. (2009) on their study of youth participation in agricultural programme reported that years of participation 0f youth in agriculture was negatively related to technical inefficiency. This means that youth have develop more skill with time during the years of the programme which tend to decrease their technical inefficiency. They also reported that household size was positively related to technical inefficiency, implies that as number of household members' increases, technical efficiency decreases.

2.3 Input-output Relationship in Swamp Rice production

Idiong *et al.* (2007) who examined technical efficiency in swamp and upland rice production system in cross river state Nigeria. They reported that the coefficient of labour and farm size were significant at one percent level in swamp and up laud system fertilizer was positive and significant at 1% in upland system, but not significant in swamp system . it was observed that majority of swamp rice farmers did not apply

fertilizer**.** It is believed in the area that a well puddle soil requires little or no fertilizer application. They also reported that coefficient of seed was positive and significant at 5% level in swamp, but not significant upland rice production. The coefficient of capital was not significant in both systems. Labour appear to be the most important variable with elasticity of 0.75 and 0.4 respectively. It implies that increasing labour use by 10% would lead to about 7.5% and 4.5% in output for both systems. They also reported that sum of elasticity (1.57and 1.27) indicates that swamp and upland rice farmers were operating in increasing return to scale (in efficient stage).

Muhmamad-lawal *et al*. (2009) who worked on technical efficiency of youth participating in agriculture programme in Ondo State, Nigeria. They reported that farm size labour and herbicide were positive and significant. it implies increase in these input would increase output level of the farmers. Amaza and maurice (2005) who work in the identification factors that influence technical efficiency in rice-based production system in Nigeria. They reported that estimated coefficient of farm size, fertilizer, labour and seed were positive and significant. Implies that increase in quantity of these inputs would lead to increase in the output levels.

Goni *et al*. (2007) who examined the resource – use efficiency in rice production in the Lake Chad Area of Borno State, Nigeria, they observed that the estimated coefficient of seed, farm size and labour were positive and statistical significant at 1% implies that increase in these input would lead to increase in output level. The sum of elasticity was 1.87 shows increasing return to scale.

Rahman and umar (2009) who examined measurement of technical efficiency and it determinants in crop production in lafiya local Government Nassarawa State, Nigeria. who reported that they estimated coefficient of farm size and fertilizer were statistically significant and positive. This coefficient denotes the variation or possible change in aggregate output of crops as the result of unit change in input.

David and Terwase (2011) who work on resource use in rice farming enterprise in Kwande Local Government Area of Benue State, Nigeria. Who reported that farm size and fertilizer were statistically significant at 1% and 5% level. However, other inputs such as herbicide, seed and labour were positive but not statistically significant. This implies that a unit increase in farm size and fertilizer would lead to an increase in output level. The sum of elasticity of production was 1.3, implies an increasing return to scale in inefficient stage of production.

According to Adebayo (2006) who worked on resource use efficiency and multiple production objectives of diary pastoralist in Adamawa State, Nigeria. Who reported that the use of hired labour reduced productivity when not properly utilized. The access to fertilizer, agro-chemical and improved seed material have been proven as an important driver of agricultural production and productivity among farmers. Using stochastic frontier model Okoruwa and Ogundele (2006) who examined technical efficiency differentials in rice production technologies in Nigeria observed that the use of fertilizer increased agricultural productivity of crop farming. They also reported that the coefficient was positive and significant for traditional technology and that increase in seed would increase output levels of farmers.

According to Odemenem and Inakwu (2011) who studied economic analysis of rice production in Cross River State, Nigeria. They reported that all the estimated coefficient of variable inputs used were statistically insignificant, except for herbicide and rice variety. These insignificant variables have no influence on rice output. However, the used of rice variety and herbicide have influence on rice output. A unit increase in rice variety and herbicide would lead to increase in yield by41.8kg and 684.2kg, respectively.

2.4 Profitability in Swamp Rice production

Jirgi *et al.* (2009) who worked on adoption of improved rice varieties among small scale of farmers in kacha Local Government Area of Niger State, Nigeria they reported that the major component of the variable cost was labour (55.42 %) and inputs (32. 75%). They also reported that highest percentage of input could be attributed to the fact that the majority of farmers bought the input from open market. The gross margins of the farm per hectare was ₦84750,while the net farm income was found to be ₦80,230 the average yield per hectare is 23 bag which is equivalent to 1,840kg.

Hyuha *et al.(*2007) who worked on the analysis of profit inefficiency in rice production in eastern and northern , Uganda. They reported that access to extension services and education were negative and statistically significant in all the district and for the pooled data .This implies that to extension service and education reduce profit loss in all the three district (Tororo, Lira and Pallisa district).They also reported that access to credit for pooled data in Tororo and Pallisa district reduce inefficiency in rice profit. However, access to credit in Lira district for pooled data was negative but not statistically significant. Odoemenem and Inakwu (2011) who worked on economic

analysis of rice production in Cross River State, Nigeria, reported that the gross margin per average rice farmer studied was N91338.26. This result implies that rice production is profitable enterprise in the study area.

Akimi, (1976) who examined the economic analysis of peasant rice farming in Kelantan, Malaysia. The profitability of rice farming is measured by cost and return analysis. They reported that most of farmers recorded a negative profit net profit from their rice farming. The average of net profit of $107.49 per acre and only three farmers or 5.5% of farmers had a net profit. This negative profit was due to comparatively high production cost and low productivity per acre.

There were considerable variations in profitability of rice farming, to examine this variation only labour earning instead of net profit were used as criterion. The result further showed that an average of $0.45 labour earning per day and the average labour earning for six months of intensive rice cultivation was $57.28. This gave only an average $9.55 per month as an average earning to family labour The result showed that thirty nine farmers positive earning. However, in term of ownership of land 85% of owner tenant farmers had positive earning while only 57% and 67% of owner land and tenant farmers had positive earning. Only sixteen farmers recorded a negative family labour earning. The result of the study also revealed that farmers association members were not better in terms of profit. This was because less knowledgeable farmers tend to follow the progressive farmers in terms of cultivation techniques and use of improved varieties in off season.

2.5 The Concept of Efficiency Measurement in Agricultural Production

The farm households are both involved in consumption and production activities. This dual economic character of the household has implication for economic analysis that can be made on it. The hypothesis that farm households are efficient is attributed to the farm household motivation for profit maximization. The efficiency and profit maximization are two sides of the same coin in that at level of individual production unit, you cannot have one without the other. The strict definition of economic efficiency requires a competitive market, since neither the individual production unit nor the sector can attain efficiency if some economic agents can influence the prices and returns of other economic agents (Ellis, 1993).

The concept of efficiency measurement begins with Farrel (1957) who define a simple measure of firm efficiency which could account for multiple inputs. He proposed that efficiency measurement of a firm consists of two components; technical efficiency (TE) and allocative efficiency (AE) which reflects the ability of a firm to use the inputs in optimal proportion, given their respective prices.

The econometric approach is stochastic and so attempts to distinguish the effects of noise from the effects of inefficiency. The programming approach is non-stochastic and lump noise and inefficiency together and calls the combination inefficiency.

2.6 The Econometric Approach to Efficiency Measurement

The discussion in this section is confine to the estimation of technical efficiency under the assumption that the producer produces only a single output. The data underlying the study would consist of observation on the quantities of inputs employed and output

produced by each farmer. Furthermore, it is assumed that a cross sectional data on the quantity of k-inputs used to produce a single output is available for each N-producer. Therefore, production frontier model is stated as:

$Y_i = f(X_{ij}\beta).TE_{ij}$---------- (1)

Where, Y_i is output of producer i, i=1----------N

X_i is the vector of k-inputs used by producer i, $f(X_{ij\beta})$ is the production frontier, β is vector of parameters to be estimated and TE_i is the output oriented technical efficiency of producer i.

In the econometric models of efficiency measurement, production frontier is characterized by smooth, continuous, continuously differentiable, quasi-concave product transformation function. The frontier is the limit to the range of possible production, hence we have;

$TE_i = \frac{Y_i}{f(X_{ij}\beta)}$ ---------- (2)

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

An econometric model is classified as either deterministic frontier model or stochastic frontier model according to the assumption about the classified noise and the way the inefficiency is defined (Coelli and Battese, 1996). In equation (1), production frontier $f(X_{ij}\beta)$ is deterministic while in equation (2) the entire shortfall of observed output Y_i from maximum feasible output $f(X_{ij}\beta)$ is attributed to technical inefficiency. The deterministic frontier would take factors outside the control of unit, such as bad

weather, uncertainties in the market situation and so on as inefficiency. Any error or imperfection in the specification of model could likewise translate into increased inefficiency measures.

The stochastic production frontier incorporates producer-specific random shock into the analysis. This is accomplished as:

$Y_i = f(X_{ij}\beta), \exp\{V_i\}.TE$ ---------- (3)

Where $[f(X_{ij}\beta)) . \exp\{V_i\}]$is the stochastic production frontier. And with this specification equation (2) becomes:

$TE_i = \frac{Y_i}{f(X_{ij}\beta).\exp\{V_i\}.}$ ---------- (4)

Defining technical efficiency as the ratio of observed output to maximum feasible output in an environment characterized by exp $\{V_i\}$. In this case Y_i achieve its maximum value of $f(X_{ij}\beta), \exp\{V_i\}\}$ if and only if TE = 1. Otherwise TE < 1 provides measure of the shortfall of observed output from maximum feasible output in an environment characterized by stochastic elements that vary across producers. Either the deterministic frontier model or stochastic frontier model can be used to estimate technical efficiency.

2.7 The Stochastic Frontier production Function.

According to Aigner *et al*. (1977), Battese and Coelli (1977) and Meeusen and Vanden Broeck (1977) said that the production frontier may be entirely under the control of the farmer. The model allows for technical inefficiency and that random shock outside the control of the farmer can affect output. The main feature of stochastic frontier model is that the disturbance term is composed of two parts; the symmetric component V_i

capture the random error outside the control of the farmer while the one-sided (non negative) component U_i with $U_i \geq 0$ capture the random human error or technical inefficiency relative to the stochastic frontier. This randomness is under the control of a farmer. Its distribution is assumed to be half normal or exponential. The V_i is assumed to be independently and identically distributed random variable of U_i. The U_i is also assumed to be independently and identically distributed as exponential (Meeusen and Van den Broeck, 1977). An appropriate formulation of stochastic frontier model in terms of a general production function from ith production unit is:

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

Y_i = output of ith farm

X_{ij} = actual j^{th} input used by i^{th} farm

β = regression coefficient to be estimated.

$V_{i\text{i}}$ = random variability outside the control of the farmer.

U_i = Error term under the control of a farmer.

The direct estimates of the parameters can be obtained by either the maximum likelihood method (MLM) or the corrected ordinary least square method (COLS). In the context of stochastic frontier production function, the technical inefficiency of the firm is defined as the ratio of the observed output to the corresponding frontier output conditional on the level of inputs used by the farm. Thus, the technical efficiency of the farm is defined as;

$TE_i = \exp(-u_i)$

$TE_i = Y/Y^* = e_i^{-u}$ ---------- (6)

Where,

TE = technical efficiency of farmer (i)

Y_i= Observed output from ith farm

Y^*= frontier output

TE ranges between 0 and 1 and maximum efficiency has a value of 1 and less than 1 represent less than maximum efficiency.

2.8 Empirical Applications of Stochastic Frontier Production Function

The stochastic frontier production function has been applied in a considerable numbers of empirical studies in the field of Agriculture. Some of these studies are presented below.

Bagi (1982) used stochastic frontier Cobb-Douglas production function model to determine whether there was significant difference in the technical efficiencies of small and large crop farms as well as and mixed-enterprise farms in West Tennesse. His finding indicated that variability of farm effect was highly significant and the mean technical efficiency of mixed enterprises (76%) was smaller than that of crop farms (85%).

Rola and Quintana-Adejandrino (1993) used a Cobb-Douglas stochastic frontier production function to estimate the technical efficiencies in selected regions of the phillippines. The estimated mean technical efficiencies were found to be 72%, 65% and 57% for irrigated, rain fed and upland environment. It indicated high variability in the technical efficiency estimates between the different rice environments. He further reported that education, access to capital and land tenure status were some factors that affected the level of technical efficiencies of farmers in the different environment.

Seyoum *et al.* (1998) investigated the technical efficiency of two samples of maize producers in Eastern Ethiopia, one involving farmers within Sasakawa Global 2000

project and the other involving farmers outside the project. Using Cobb-Douglas stochastic frontier production function, the results indicated that Sasakawa Global project farmers were more technically efficient than those outside the project relative to their respective technologies (94% and 79%, respectively).

Amos, *et al.* (2004) used a Cobb-Douglas Stochastic frontier production function to study productivity and technical efficiency of farmers of sole maize and mixed cropping system in Niger State of Nigeria. They found that the mean technical efficiency of both sole and mixed cropping system farmers was (62%), but the mean technical efficiency of sole maize farmers (53%) was lower compared to that of the mixed (yam/maize) cropping system (72%). They further reported that over 50 percent of the mixed crop farmers had technical efficiency greater than 75% as compared to sole maize farmers who all had less 60% technical efficiency.

Amaza and Maurice (2005) used a Cobb-Douglas stochastic frontier production function to study factors influencing technical efficiency in rice production. It revealed that technical efficiencies differed substantially among farmers rangeing between 26% and 97%, with a mean of 80%. Since the mean technical efficiency was 80%, the productions of farmers fell short by 20 percent of the maximum possible output.

Okoruwa and ogundele (2006) used Cobb-Douglas stochastic frontier production function to study rice farmers in North Central Nigeria. The technical efficiencies of upland and lowland rice enterprise were 81.6% and 76.9% respectively. There was difference in the mean efficiencies of upland and lowland rice, indicating that upland rice was more efficient than lowland rice. Both output of upland and lowland rice could be increased with improvement in resource use.

Mohammad-Lawal *et al.* (2009) used frontier Cobb-Douglas production function model to estimate technical efficiency of youth participating in agricultural programme in Ondo State, South-Western Nigeria. The estimated individual technical efficiency ranges between 32.62% and 96.25%, with a mean technical efficiency of 85.23%.The study showed that 86% 0f the respondents were operating at 80% level of technical efficiency. The mean technical efficiency value indicate that if the efficiency of inputs usage is increased by 14.77%, the youth in agricultural programme would be operating at production frontier. The significant determinant of technical efficiency were years of participation in agricultural programme, household size, usage of extension service and education.

Idiong *et al*. (2007) also used Cobb-Douglas stochastic frontier model to estimate technical efficiency of swamp and upland production system in Cross River state, Nigeria. The estimated individual technical efficiency ranged 48% to 99% and 55% to 99% in swamp and upland rice production systems, respectively. The mean technical efficiency was 77% and 87% for swamp and upland rice respectively. The mean technical efficiency values of both swamp and upland rice production are an indication that if the efficiency of inputs used is increased by 23% and 13%, the farmers would increase output and income generation. The significant determinants of technical efficiency for both swamp and upland rice were education, membership of cooperatives and access to credit.

CHAPTER 3

METHODOLOGY

3.1 Study Area

The study was conducted in Niger State, Nigeria. The State is in the Northern part of Nigeria and is located between latitudes $8^0$22'N and $11^0$30'E and longitude 3^0 30'N and 7^0 20'E (NGADP, 2003). It covers a land area of 76,000 sq km which is about 9% of the country's land mass with a total arable land of 80%. This makes the State the largest in the country with an estimated population of 3,950249 (NPC, 2006). The estimated projection of population based on 3% growth rate per annum in 2010 is 4,343,038.

The State is bordered to the north by Zamfara, to the northwest by Kebbi, to the south by Kogi, to the south-west by Kwara, while Kaduna and FCT border the State to the north-east and south-east, respectively. Niger State is popular for its brass work, particularly in Bida. It is also known for pottery, weaving and several cottage industries which can be found throughout the State. However, there are three prominent ethnic groups namely, Nupe, Gbagi (Gwari) and Hausa. Other ethnic group include, Kambari, Kamuku, Gade, Pangu and Ingwai (NGADP, 2003).

The State has a tropical climate marked by distinct dry and wet seasons. The rainy season commences in April and ends in October. The dry season begins from November to end of March. It is characterized by hot weather and hamattan. It has a mean annual rainfall of 1000mm and mean temperature of 33.5^0C. The state is characterized by Guinea Savanna vegetation with trees like Shea butter and locust bean (NGAD, 2003). More than 80% of the State's population is engaged in agricultural production activities. The State is endowed with fertile agricultural land and has the capacity to produce most

Nigerian staple food crops. It has a vast land for grazing, fishing and forestry. The Gwari, Kadara and Kamberi are noted for yam and guinea corn production, while Nupe are the major rice producers and Hausa and Fulani are known for animal husbandry. The State is endowed with abundant mineral resources, such as gold, granite, marble, copper, iron, columbite and lime stone. It has tourism attraction such as Zuma rock, Gurara water falls and Baro empire hill.

Figure: 1 Map of Niger State showing local government areas of study.

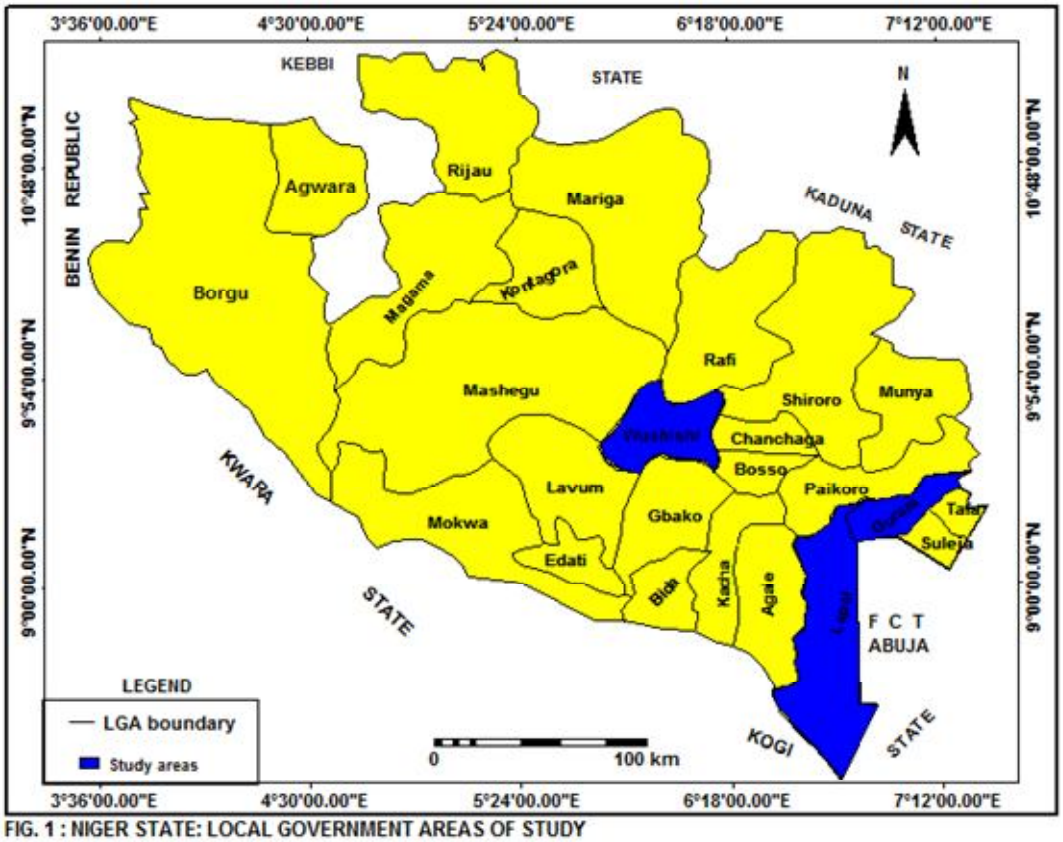


FIG. 1 : NIGER STATE: LOCAL GOVERNMENT AREAS OF STUDY

Source : Adapted and Modified from Administrative Map of Niger State

Figure: 2 Map of Niger State showing sampling areas

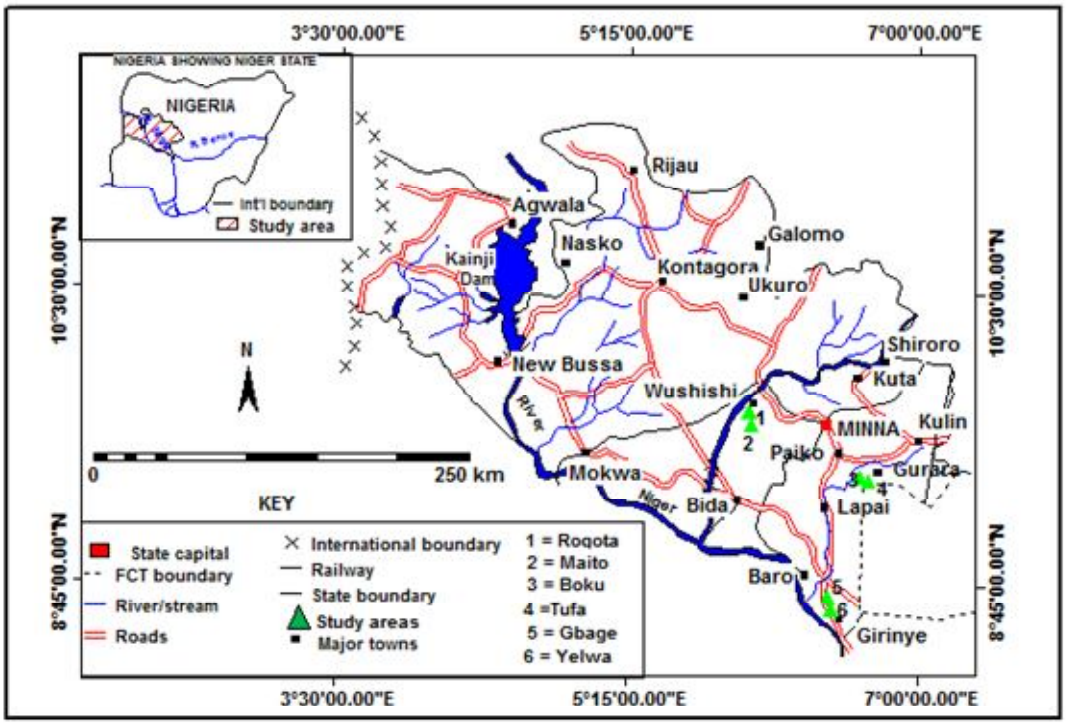


FIG.2 : NIGER STATE : LOCATION OF SAMPLING AREAS

Source : Modified from Administrative Map of Niger State

3.2 Sampling Techniques and Sample Size

Based on the reconnaissance survey carried out in the study area, a multi-stage sampling technique was used to select swamp rice farmers for the study. Firstly, the purposive sampling technique was used to select one Local Government area each from the three Agricultural zones (1, 2 and 3) of NGADP that is, Lapai, Gurara and Wushishi L.G.As. This was based on their level of involvement in swamp rice production. The number of villages that were only involved in swamp rice production in each L.G.As was selected. A total of 11, 8 and 12 were selected in Lapai, Gurara and Wushishi L.G.As. Secondly, two villages were randomly selected from each of the three selected Local Government Areas of the State. Thirdly, 10% of the swamp rice farmers were randomly selected from each of the six (6) villages. A total of one hundred and fifty nine swamp rice farmers were selected for the study. as shown in the Table 2.

Table 2: Distribution of sample size of LGA

Local government Area	Village	Sample frame	Sample size*
Gurara	Boku	152	15
	Tufa	291	29
Wushishi	Rogota	251	25
	Maito	352	35
Lapai	Yelwa	250	25
	Gbage	302	30
Total		**1598**	**159**

* Represent 10 percent of sample frame

3.3 Method of Data Collection

For the purpose of this study, only primary data were used. The primary data were collected by the extension agent in six villages during 2010 cropping season for the period of one month on a single visit. The primary data were collected using interview method with the aid of sets of structured questionnaire. The questionnaire was used to collect information on inputs and output as well as the socio-economic characteristics of the swamp rice farmers. The input data that were collected include: labour, capital, fertilizer, seed, agro-chemical and farm size. The socio-economic characteristics data that were collected include age, family size, farming experience, educational status, extension contacts, access to credit, non farm income and membership of cooperative.

3. 4 Analytical Techniques

The data were analyzed using descriptive statistics, gross margin analysis and the stochastic frontier production function.

3.4.1 Descriptive statistics

The descriptive statistics used include: percentages, mean, frequency distribution, standard deviation and coefficient of variation. These were used to achieve objectives (i) and (ii) of the study.

3.4.2 Gross margin analysis

The gross margin (GM) analysis was used to examine costs and returns in swamp rice production. The tool was employed to estimate the costs and returns. The total variable cost and total revenue were estimated. The difference between the total revenue and total variable cost is the gross margin (GM). The gross margin analysis was used with assumption that fixed costs in small scale farming are negligible (Olukosi and Erhabor, 1988). Gross margin is expressed as:

GM = TR – TVC

Where:

GM = Gross margin (₦/ha)

TR = Total Revenue (₦/ha)

TVC = Total variable Cost (₦/ha)

The gross margin was used to achieve objective (vi}

3.4.3 The stochastic frontier production function

The Cobb-Douglas functional form of the stochastic frontier production function was employed to estimate the technical efficiency of rice farmers in the study area.

The stochastic frontier production function has the advantage of allowing simultaneous estimation of individual technical efficiency of the farmers as well as identifying determinants of technical efficiency (Battese and Coelli, 1977). The Cobb-Douglas is commonly used because it is easy to estimate.

The Cobb-Douglas stochastic frontier production function was specified in its log form as:

$$\text{In } Y_1 = Ina_0 + a_1 InX_1 + a_2 InX_2 + a_3 InX_3 +$$

$$a_4 InX_4 + a_5 InX_5 + a_6 InX_6 + V_i - U_i \text{ ---------- (7)}$$

Where;

In = the natural logarithm

Y_1 = Output (kg)

X_1 = farm size (ha)

X_2 = Seed (kg)

X_3= Fertilizer (kg)

X_4= Herbicides (Litre)

X_5= other capital such as cost of ploughing (₦)

X_6 = Labour (Man-hour)

V_i = Error term not under the control of farmers

U_i = Error term under the control of farmers' (technical inefficiency)

a_o = Intercept (constant term)

$a_1 - a_6$ = regression coefficients to be estimated.

The determinants of technical efficiency were modeled in terms of factors that were assumed to affect the efficiency of production of farmers. Such factors are the socio-economic variables of the farmers. These variables were assumed to influence technical efficiency of the farmers. Therefore, any policy that will affect these variables will also affect the technical efficiency of the farmers.

The model to identify determinants of inefficiency, $U_{i,}$ is expressed as:

$$U_i = b_0 + b_1Z_1 + b_2Z_2 + b_3Z_3 + b_4Z_4 + b_5Z_5 + b_6Z_6 + b_7Z_7 + b_8Z_8 \text{----------} \quad (8)$$

Where,

Z_1 = age (years)

Z_2 = family size (number)

Z_3 = farming experience (years)

Z_4 = education (years)

Z_5 = Access to credit (₦)

Z_6 = non farm income (₦)

Z_7 = Extension contact (no of times each farmer had extension contact in a year)

Z_8 = Membership of cooperative (years)

b_0 = Constant

$b_1 - b_8$ = regression coefficient

U_i = inefficiency model.

The stochastic frontier model was used to achieve objectives (iii), (iv) and (v).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Socio- economic Characteristics of Swamp Rice Farmers

Some socio-economic characteristics may influence farmers' production decision as well as their overall technical efficiency in production. The essence of this sub-section is to discuss the findings of this research with reference to the socio-economic characteristics that affect farmers' technical efficiency. Such socio-economic characteristics include: age, family size, farming experience, extension contact, membership of cooperatives, access to credit and non-farm income.

4.1.1 Age of the farmers

More than half of the farmers (74%) were found to be within the age group of 31-50 years which is an active age group for meaningful agricultural production. The farmers within the age group of 51-60 and above 61 years constituted 5.03% and 3.15%, respectively. The least percentages of farmers (1.26%) were found within the age group of 11-20 years. The average age of swamp rice farmers was found to be approximately 39 years with minimum of 18 years and maximum of 82 years (Table 3). This finding agrees with Idiong *et al*. (2007) who in their study concluded that since the majorities (75%) of farmers were within the age of 24-45 years, there is likelihood of high productivity in swamp rice production.

Table 3: Age distribution of farmers

Age of farmers (years)	Frequency	Percentage
11-20	2	1.26
21-30	25	15.72
31-40	78	49.05
41-50	41	25.79
51-60	8	5.03
>61	5	3.15
Total	159	100

4.1.2 Family size

The study found that majority of the respondents (36.5%) had between 6-10 persons in their family. The farmers that had the family size of 1-5 and 11-15 constituted 30.8% and 24.5%, respectively. The family size of 16 and above constituted only 8.18%. The maximum family size observed was 22 persons with a minimum of 2 persons and average of 9 persons (Table 4). This implies that the farmers in the study area might have advantage of family labour availability if many household members participate in farms. However, the implication of large household size is that it will increase household consumption expenditure which would compete with production for limited financial resources within the household. According to Okoruwa and Ogundele (2006) large family size does not necessarily translate to higher use of family labour because some of the young able bodied family member may prefer other jobs than farming.

Table 4: Family size distribution of farmers

Family size	Frequency	Percentage
1-5	49	30.82
6-10	58	36.48
11-15	39	24.52
>16	13	8.18
Total	159	100

4.1.3 Farming experience

The study revealed that majority of swamp rice farmers (62.3%) had 11-30 years of experience in farming. About 30 percent of the farmers had 1-10 years experience while only 7.5% had more than 31 years of experience in farming. The maximum year of experience was 52 years with a minimum of 1 year and a mean of 17 years (Table 5). A study by Ajani (2000) on productivity in food farming in northern area of Oyo State showed that year of farming experience increased agricultural productivity among farming households in Nigeria.

Table 5: Distribution of farmers based on farming experience

Farming experience (years)	Frequency	Percentage
1-10	48	30.19
11-20	77	48.43
21-30	22	13.84
>31	12	7.54
Total	159	100

4.1.4 Level of Education

Table 6 shows that 34.6% of the farmers had no formal education. Those who had Quaranic /adult education were about 18.9%. About 16.9, 20.8 and 8.8% had primary, secondary and tertiary education, respectively. However, altogether about 46.5 percent of the farmers had formal education. Illiteracy is believed to have a negative implication on efficient use of productive resources and adoption of farm innovation. According to Mohammed-Lawal *et al.* (2009) level of education is expected to influence farmers' adoption of agricultural innovations and decision on various aspects of farming. They also maintain that education is highly important for sustainable agricultural growth and development since the study revealed that about 93.64% of the agricultural programme participant had some form of formal education. They noted that the participants were not likely to have much difficulty in understanding and adopting modern agricultural technologies and innovation

Table 6: Distribution of farmers based on educational status

Level of education	Frequency	Percentage
No formal education	55	34.59
Adult/Quaranic education	30	18.87
Primary education	27	16.98
Secondary education	33	20.75
Tertiary education	14	8.81
total	159	100

4.1.5 Access to credit

Table 7 shows the distribution of farmers according to their access to credit. Those who had access to credit ranges between ₦1000 - ₦200,000 which represent about 25.8% of the farmers with the minimum and maximum amount of ₦6,000 and ₦200,000 respectively. The majority (74%) of farmers had no access to credit. This implies that the farmers were using their personal saving to purchase farm inputs and adopt farm innovation.

Table 7: Distribution based on accessibility to credit

Access to credit (₦)	**Frequency**	**Percentage**
Zero credit	118	74.21
1000-50,000	28	17.61
51,000-100,000	9	5.66
101,000-150,000	2	1.26
151,000-200,000	2	1.26
Total	**159**	**100**

4.1.6 Non-farm income

Table 8 Shows that majority of farmers (70.4%) had no other sources of income Those who had income from non-farm activities ranges between ₦1000 - ₦800,000 constituted only (29.6%) with minimum and maximum amount of ₦5,000 and ₦800,000, respectively. This means that farmers in these communities relied absolutely on farm business and must have acquired a lot of farming experience over time. According to FAO (1999), employment in non-farm activities is essential for diversification of the sources of farm household's livelihood. It enables households to modernize their production by giving them an opportunity to apply the necessary inputs and reducing the food shortage during the period of unexpected crop failures.

Table 8: Distribution of farmers based on accessibility to non-farm income

Non-farm income (₦)	**Frequency**	**Percentage**
Zero non-farm income	112	70.44
1000-200,000	40	25.15
201,000-400,000	3	1.89
401,000-600,000	3	1.89
601,000-800,000	1	0.63
Total	**159**	**100**

4.1.7 Extension contact

Table 9 shows that reasonable number of farmers (45.2%) had extension contact ranged between 1-4 per year and with the minimum of 0 and maximum of 4 visits per year. The majority of farmers (54.72%) had no extension contact in a year. This implies that farmers had insufficient extension visits. According to Obwona (2000), extension service is very essential to the improvement of farm productivity and efficiency among farmers.

Table 9: Distribution of farmers based on extension contact

Extension contact	**Frequency**	**Percentage**
No contact	87	54.72
1-2	60	37.74
3-4	12	7.54
Total	**159**	**100**

4.1.8 Membership of cooperative

Those who were members of cooperative society constituted 27.7% of the farmers with the minimum and maximum years of membership of 0 and 15, respectively. The average years of membership of cooperative society was 3. This implies that farmers had less opportunity of interacting with other farmers to enhance diffusion of innovations among the farmers. According to Idiong *et al.* (2007), membership of cooperative affords the farmers opportunities of sharing information on modern rice practices.

Table 10: Membership of cooperative distribution of farmers

Years of membership in cooperative	**Frequency**	**Percentage**
Non-membership	115	72.33
1-5	8	5.03
6-10	33	20.75
11 and above	3	1.89
Total	**159**	**100**

The coefficient of variation (CV) of socio-economic characteristics as shown in Table 11 include: age (25%), family size (57%), farming experience (53%), level of education (91%) access to credit (235%), non farm income (323%), extension contact (112%) and membership of cooperation (146%). It implies that socio-economic variables with less than 50 per cent of coefficient of variation did not vary widely among the farmers; while those above 50 per cent reflects greater instability in values among sampled

farmers. The wider variability of such factors could induce high variation in output among the farmers and that could affect efficiency of production.

Table 11: Variability in the socio-economic characteristics of swamp rice farmers in Niger State

Variable	Minimum	Maximum	Average	Standard Deviation	Coefficient of variation (%)
Age	18	82	39	9.65	24.74
Family size	2	25	9	5.13	57.00
Farming experience	1	52	17	9.03	53.11
Level of Education (yrs)	0	16	6	5.45	90.83
Access to Credit (₦)	6000	200000	13893	32703.62	235.39
Non-farm Income (₦)	5000	800000	31465	101716.10	323.26
Extension Contact	0	6	1	1.12	112.00
Cooperative Membership (yrs)	0	15	3	4.39	146.33

4.2 Input and Output Level in Swamp Rice Production

The inputs that were used in swamp rice production include; land, seed, fertilizer, herbicide, capital (money used for plough) and labour. Table 4 shows the mean land area under swamp rice production as 2.35ha. The minimum and maximum land areas were 0.40ha and 13ha, respectively. The average seed quantity used by swamp rice farmers was 58.09kg/ha. The minimum and maximum seed used were 25kg/ha and 115.71kg/ha, respectively. Average fertilizer used by swamp rice farmers was 47.19kg/ha while the minimum and maximum were found to be 17.85kg/ha and 153.85kg/ha, respectively. Mean herbicide used by swamp rice farmers was 2.96

litres/ha while the minimum and maximum used were 1.29 litres/ha and 8.10 litres/ha. The capital (money used for ploughing) had a mean value of ₦9,790.14/ha used by individual swamp rice farmers. The minimum and maximum capital (money used for ploughing) was found to be ₦5,000/ha and ₦30,769/ha, respectively. The mean labour recorded was 46.43 mandays/ha while the minimum and maximum were observed to be 4 mandays/ha and 284.62 mandays/ha, respectively.

The output of swamp rice varied from one farmer to another depending on the inputs utilization and the management practices. The average output of swamp rice in the study area was 2054.72kg/ha. The minimum and maximum output produced by swamp rice farmers were 120kg/ha and 6923.08kg/ha respectively.

The low of coefficient of variation is a reflection of reliability (precision) of the result (Johnson and Welch, 1939). Johnson and Welch (1939) reported that for a normal distribution, the ratio of mean to standard deviation should be of order of three or more. They mentioned that 33 percent is often stated as the permissible upper fiducial limit of coefficient of variation (CV).

Table 4 shows that the coefficient of variation of all the variable inputs such as the land size, seed, fertilizer, herbicide, capital (money used for ploughing) and labour were 70.63, 187.64, 447.66, 250.68, 357.55 and 643.07, respectively. The high coefficient of variation of variable inputs implies high level of variation in the use of variable input among swamp rice farmers in the study area. However, the coefficient of variation for land size was lower compared to other variable inputs used for swamp rice production.

The wide variation in input used by the farmers could be attributed to the fact that they differ in purchasing power and size of production.

The coefficient of variation in swamp rice output was 376.00 percent which implies high inconsistency in output level among swamp rice farmers in the study area. This can prevent the country from attaining food security as greater proportion of farmers produces below average. The instability in output of swamp rice could be attributed to inconsistency and inadequacy of variable inputs among farmers in the study area.

Table 12: Input and output levels in swamp rice production per hectare

input	**Minimum**	**Maximum**	**Average**	**Standard Deviation**	**Coefficient of variation (%)**
Land	0.40	13.00	2.35	1.66	70.63
Seed (kg)	25	115.71	58.09	109.0	187.64
Fertilizer (kg)	17.85	153.85	47.19	211.25	447.66
Herbicide (L)	1.29	8.10	2.96	7.42	250.68
Capital (₦)	5,00	30769.23	9790.14	35004.4	357.55
Labour (manday)	4	284.62	46.43	298.58	643.07
Output (kg)	120	6923.08	2054.72	7725.69	376.00

4.3 Input – Output Relationship in Swamp Rice Production

Cobb–Douglas Stochastic Frontier Production Function was estimated to examine the nature of input-output relationship in swamp rice production and to determine Technical Efficiency. The results showed that the estimated coefficients for all inputs were positive except for herbicide which was negative but not significant.

In Table 13 the coefficient for farm size was positive and significant at 5% level. This implies that increase in farm size would result in increase in output level in swamp rice production in the study area. This result agrees with the finding of Muhammad–Lawal *et al*.(2009) who worked on the technical efficiency of youth participating in agriculture programme in Ondo State, Nigeria. They reported that farm size was positive and significant and that increase in the farm size would increase output level of farmers.

The coefficient of seed input was observed to be positive and significant at 5% level. This implies direct relationship between seed and rice output. Seed is an important component of farm input that if underutilized or over utilized could affect total output of farmers. This finding agrees with Okoruwa and Ogundele (2006) who examined technical efficiency differentials in rice production technologies in Nigeria. They reported that the coefficient of seed was positive and significant for traditional technology and that increase in seed would increase output levels of rice farmers. Fertilizer had a positive relationship with rice output and significant at 1%. This implies that increase in the use of fertilizer would lead to increase in output of swamp rice farmers. This finding agrees with the result of Amaza and Maurice (2005) who reported positive and significant coefficient of fertilizer in rice-based production system in Nigeria.

The coefficient of capital (money used for ploughing) was positive and significant at 1% level. This implies that increase in the use of capital would result in increased output. Capital appears to be one of the most important variables with elasticity of 0.3 which was higher than the other variables used in the swamp rice production. This finding disagrees with Oniah *et al*. (2008) who determined efficiency of resource use in

small scale swamp rice production in Obubra Local Government Area of Cross River State, Nigeria. They reported that coefficient of capital was positive and not significant which implies that capital had no influence on output levels of farmers. The coefficient of labour was found to be positive and significant at 1% level. This implies that increase in the use of labour would increase farm output in the study area. This agrees with several other studies such as Muhammad-Lawal *et al.* (2009) and Amaza and Maurice (2005) who reported that coefficient of labour was positive and significant and that increase in labour usage would result in increase in output levels in farm production. This also agrees with findings of Oniah *et al.* (2008) who reported that the coefficient of labour was positive and statistically significant and that increase in labour usage would increase output level of farmers.

Table 13: Maximum likelihood estimate of stochastic frontier production Function

Variable	Regression Coefficient	Stand Error	t-vale
Constant	1.471***	0.285	5.152
Farm size	0.217**	0.099	2.198
Seed	0.259**	0.088	2.940
Fertilizer	0.063***	0.019	3.325
Herbicide	-0.007	0.063	-0.113
Capital	0.304***	0.086	3.535
Labour	0.169***	0.056	3.026
Sigma Square	0.062***	0.017	3.683
gamma	0.836***	0.062	13.445

*** significant at 1%,
** significant at 5%

4.4 Technical Efficiency and Elasticity in Swamp Rice Production

Maximum likelihood estimate of the Cobb–Douglas Stochastic Frontier Production was carried out to determine the individual farmer's technical efficiencies as well as their mean technical efficiency in the study area. The sigma square (δ^2) and gamma (γ) estimated were 0.062 and 0.84, respectively, and they are significant at 1% level. The sigma square (δ^2) shows the goodness of fit of a model while the gamma (γ) shows the proportion of total deviation from frontier attributable to inefficiency of the farmers and the 0.84 observed in this study indicates presence of inefficiency in swamp rice production among the farmers. This study shows that about 84% of shortfall below the frontier output was due to technical inefficiency of the farmers.

In Table 14, the study observed that about 8% of swamp rice farmers operated below 70% level of technical efficiency. About 92% attained efficiency level greater than

70%. The mean technical efficiency was 86% with minimum of 34% and maximum of 98% among the sampled farmers. This implies that farmers could increase output if the efficiency of inputs usage is increased by 14%. Thus, opportunity still exists for increasing farmer productivity and income through increased efficiency with the use of existing resources.

The result is in line with the finding of Muhammad-lawal *et al.* (2009) in their study on the technical efficiency of youth participation in agricultural programme in Ondo State, Nigeria. They reported minimum estimated technical efficiency of 32.62%, maximum technical efficiency of 96.25% and mean technical efficiency of 85.23%. They concluded that if efficiency of input usage is increased by 14.77%, the youth would be operating on the production frontier. The technical efficiency of the swamp rice farmers had coefficient of variation of 11.87%, which implies stability in the technical efficiency among the farmers. This stability would help in addressing problems of risk in swamp rice production in the study area.

Table 14: Distribution of Farmers Based on Technical Efficiency in Swamp Rice Production

Level of efficiency	**Frequency**	**Percentages**
30-49	1	0.63
50-69	12	7.55
70-89	74	46.54
>89	72	45.28
Total	159	100
Minimum		34
Maximum		98
Mean		86
Standard deviation		10.21
Coefficient of variation (%)		11.87

4.4.1 Elasticity of Production and Return to Scale in Swamp Rice Production

In Table 15, the estimated input elasticity of production shows that all variables except herbicides were utilized within stage two of production, which is the rational stage. This is because the magnitude of elasticity of production was less than one for each input. The return to scale was 0.975, indicating that resources used in swamp rice production were inelastic. Return to scale (RTS) is used to determine the stage of the overall production process in the production surface. When 0<RTS<1 (i.e RTS is between 0 and 1), it implies production is in stage II, the stage of positive decreasing return to scale. This is the stage where every producer thrives to be and maximize profit as well as minimize cost.

Table 15: Elasticity of Production and Return to Scale in Swamp Rice Production

Variables	**Elasticity of production**
Farm size (ha)	0.217
Seed (kg)	0.259
Fertilizer (kg)	0.062
Herbicide (litres)	-0.007
Capital (₦)	0.304
Labour (man day)	0.169
Return to scale (RTS)	0.975

4.5 Factors Determining Technical Efficiency in Swamp Rice Production

Inefficiency model as shown in Table 16, analyzed influence of factors such as age, family size, farming experience, level of education, access to credit, non-farm income, extension contact and membership of cooperative on technical efficiency of swamp rice farmers.

The coefficient of age was negative and significant at 5% level. This means that as age of farmer increases, the technical inefficiency decreases thereby enhancing technical efficiency of the farmers. This result agrees with the study of Ajibefun and Abdulkadir (2004) on the impact of farm size operation on resource use efficiency in small scale farming in south-western Nigeria. They reported that age of farmers increased farm productivity.

The coefficient of family size was positive and significant at 5%. This implies that as family size increases, the technical inefficiency increases thereby reducing technical efficiency of farmers. This finding agrees with Mohammed Lawal *et al*. (2009) who reported that as family size increases the technical efficiency decreases. They observed that this may be as a result of the fact that most of the household members who are still at a very young age may not be able to contribute to labour supply since they are likely to be in school during the period of agricultural production activities. Farming experience, education, access to credit and non-farm income were not significant factors. This finding is in line with Okoruwa and Ogundele (2006) who examined technical efficiency differentials in rice production technologies in Nigeria. They reported that none of the socio-economic variables had significant effect on the technical efficiency of technology of farming. They also reported that this might be as a

result of technical inefficiency of the farmer and as well as other natural and environmental factors which could not be captured in the model. These factors include land quality, weather, labour quality, and disease and pest infestation and so on.

The coefficient of extension contact was negative and significant at 5% level. This means that an increase in extension contact will lead to increased in technical efficiency. This finding is in line with the study of Ajani (2000) who observed that extension contact enhance farm productivity and efficiency in his study of resources productivity in food crop farming in Northern area of Oyo State Nigeria. The coefficient of membership of cooperative was negative and significant at 1% level. This means that increase in years of membership in cooperative tend to increase technical efficiency level of farmers. This result is in line with the finding of Idiong *et al.* (2007) who found that membership of cooperative afford the farmers the opportunity of sharing information on modern rice practices. They noted that membership of cooperatives was negative and implies improvement in technical efficiency of the farmers.

Table 16: Socio-economic factors influencing inefficiency in the estimated stochastic frontier production for swamp rice in Niger State

Variable	Regression coefficient	Standard error	t-vale
Constant	0.408**	0.214	1.909
Age	-0.021***	0.010	-2.055
Family size	0.028**	0.012	2.511
Farming experience	0.013	0.011	1.323
Level of education	0.003	0.009	0.397
Access to credit	-0.001	0.001	-0.967
Non-far income	0.001^{-6}	0.00^{-3}	-0.300
Extension contact	-0.312***	0.142	-2.203
Membership of cooperative	-0.051***	0.014	-3.738

*** significance at 1%
** significance at 5%

4.6 Gross Margin Analysis

Swamp rice production in the study area was mainly small scale farmers. The variable inputs include seed, labour, fertilizer, herbicides and capital. Cost and returns associated with swamp rice production were examined for the purpose of this study. Only variable costs of production were considered in the cost and return analysis. The average farm gate price was used to derive the gross farm revenue. However, to derive the gross margin, the average total revenue and average variable cost per hectare were used.

Table 17, shows the gross margin analysis of swamp rice production. The study revealed that labour alone accounted for more than 50% of the total variable cost. This

shows that swamp rice production in the study area was highly labour intensive. As shown in Table 17, the gross margin per hectare was ₦56740.60. The gross margin per naira invested (gross margin divided by total variable cost) in the swamp rice production was ₦0.97.

The coefficient of variation of revenue and total variable cost was found to be 53.16% and 73.30% as shown in Table 17, which implies high level of variability in revenue and total variable cost among swamp rice farmers in the study area.

Table 17: Average cost and Returns of Swamp Rice Production per hectare

Variables	**Quantity**	**Unity price (₦)**	**Value/ha (₦)**
Seed (kg)	58.09	72	4182.48
Fertilizer (kg)	47.19	90	4247.10
Herbicide (L)	2.96	1000	2960.00
Labour (man day)	46.43	800	37144.00
Capital (₦)	-	-	9790.14
Total variable cost (₦)	-	-	58323.72
Yield (kg)	2054.72	56	115064.32
Gross Margin			56,740.60
Gross margin per naira invested			0.97

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

A multi-stage sampling technique was used to select 159 respondents for this study. The data were collected from the respondents using structured questionnaire. The data were analyzed using descriptive statistics, gross margin analysis and stochastic frontier model.

The study revealed that less than 30% of farmers belong to cooperative societies. Majority (74%) were found to be under active age group of 31-50 years. The study also revealed that more than 50% had no access to credit. Gross margin analysis showed that swamp rice production earned ₦56740.60 gross margins per hectare. The gross margin per naira invested was also found to be ₦0.97. However, labour alone accounted for more than 50% of the total variable cost of production.

The Cobb-Douglas stochastic frontier production function was used to estimate individual technical efficiency of the farmers. The result showed that the individual technical efficiency ranged between 34 and 98 percent with mean technical efficiency of 86%. The maximum likelihood estimate of Cob-Douglass stochastic frontier production function for swamp rice in the study area showed that the estimated coefficients of the production function were all positive except for herbicide (β_4) which was negative. All the positive parameters were statistically significant at 1 or 5 percent. The elasticity of individual parameters was less than one and the return to scale was between zero and one (0.98) indicating a positive decreasing return to scale within stage II of the production process. Analysis of inefficiency model showed that age, family size,

extension contact and membership of cooperatives were the significant determinants of technical efficiency among the swamp rice farmers in the study area.

5.2 Conclusion

The result of the study revealed that labour was the most limited and costly resource for swamp rice production in the study area. It accounted for more than 50% of the total variable cost of production. The major socio-economic determinants for swamp rice production were extension contact, age, membership of cooperatives and family size. The result of the study revealed that the swamp rice farmers in the study area did not produce at the frontier level. This was evident by the presence of technical inefficiency among the farmers.

5.3 Recommendations

1. Effort should be made by extension agents to encourage swamp rice farmers to form themselves into cooperative groups. This could give them access to formal credit and enable them to benefit from the economy of bulk purchase of input to reduce cost of production.

2. The mean technical efficiency of 86% is an indication that there is chance for swamp rice farmers to improve production so as to reach the frontier level by involving themselves into cooperative and improve access to extension contact.

3. Swamp rice farmers in the study area should be enlightened by the extension agents on the use of recommended farm practices so as to improve farmers' technical efficiency.

4. The fact that labour has been identified as the most costly input in swamp rice production in the study area. Therefore, policy should be directed toward providing labour saving technologies.

REFERENCES

Adewuyi, A. I. and Okunmadewa, F. Y. (2001) economic efficiency of crop farmers in Kwara State, Nigeria. *Journal of Nigerian Agricultural Development Studies*. 2(1):45-57

Adebayo, E. F. (2006) Resource use efficiency and multiple production objectives of diary pastoralist in Adamawa State, Nigeria. Unpublished Ph.D Thesis University of Ibadan, Nigeria. PP.189.

Adeoti, J. O. (2002) *Technology and Environment in Sub-Saharan Africa: EmergingTtrends in Nigerian Manufacturing Industry*. Alddershort, United Kingdom: Ashgate Publishing Limited. pp.275

Aigner, D. I., Lovelli, C. A. K. and Schmidt, P. (1977) Formation and estimation of stochastic frontier production function model. *Journal of Econometrics* 6:21-37.

Ajani, O. I. Y (2000) Resource productivity in food farming in northern area of Oyo State, Nigeria. Unpublished PhD thesis, Department of Agricultural. Economics, University of Ibadan.pp.167

Ajibefun, I. A. and Abdulkadri , A. O. (2004) Impact of farm size operation on resource use efficiency in small scale farming: Evidence from south western Nigeria. *Journal of Food, Agriculture and Environment* 2(1): 359-364.

Akande, T. (2001) An over view of Nigeria's rice economy. Nigeria Institute of Social and Economic Research (NISER), Ibadan, Nigeria.pp11

Akimi, F (1976) An economic analysis of peasant rice farming in Kelantan, Malaysia. Journal of South East Asian Studies. 14(2): 159-176.

Akpokodje, G., Lancoun, F. and Erestein, O. (2001) Nigeria Rice Economy: State of the Art. A Project Report, Nigeria Rice Economy in a Competitive: Constraints, Opportunities and Strategies Choices ,Bouake; .WARDA.pp 55 .

Amaza, P. S. and Maurice, D. C. (2005) Identification of factors that influence technical efficiency in rice based production system in Nigeria: A paper presented at workshop on policies and strategies for promoting rice production and food security in Sub-Sahara Africa, Cotonou (Benin).1-9

Amaza, P. S. and Olayemi, J. K. (2000) The influence of education and extension contact on food crop production in Gombe State, Nigeria. *Journal of Agriculture and Rural Development* 1(1): 80-90.

Amos, T. T., Chickwendu, D. D. and Nmadu, J. N. (2004) Productivity, technical efficiency and cropping pattern in the savanna zone of Nigeria. *Journal of Food and Agricultural Environment*. 2: 173-176.

Bagi, F. S. (1982) Economic efficiency of share cropping: reply and some further results: *Malaysia Economic Review*, 27: 86-95

Bamidele, F. S.; Abayomi, O. O. and Adebiyi E.O. (2010) Economic analysis of rice consumption pattern in Nigeria, *Journal of Agricultural Technology* 12:1-11

Battese, G. E. and Coelli, G. S. (1977) Estimation of a production frontier model with application to the pastoral zone of eastern Australia, *Australia Journal of Agricultural Economics* 21(3):169-179

Bravo-Ureta, B. E. and Rieger, L. (1991) Dairy farm efficiency measurement using stochastic frontier and neoclassical duality, *American Journal of Agricultural Economics* 73: 421-428.

Coelli, T. J. (1995) Recent development in frontier estimation and efficiency measurement. *Australia Journal of Agricultural Economics* 39: 219-245

Coelli, T. J. and Battese, G. (1996) Identification of factors which influence the technical efficiency of India farmers. *American Journal of Agricultural Economics* 40:103-128.

CTA (2005) Rice: A success story for some *CTA BI-monthly Magazine.* A publication of Technical Centre for Agriculture and Rural Cooperation 115: 4-5.

David, T. A and Terwase, S (2011) Efficiency of resource use in rice farming enterprise in Kwande Local Government Area of Benue State, Nigeria. Inetrnational Journal of Humanities and Social Science. 1 (3) : 215-220.

Ellis, F. (1993) *Peasant Economics: Farm Household and Agrarian Development* 2nd Edition. Cambridge University Press, Cambridge. pp.309

Fabusoro, E. and Agbonlahor, M. (2002) Optimal production and resources allocation for small rice-based Farmers in Ogun State, Nigeria, *Asset* Series A, 2(2):37-42

Federal Ministry of Agriculture (FMA) (1995) Planning, research and statistical data. Annual Report, Abuja, Nigeria.

Farrel, M. J. (1957) The Measurement of production efficiency. *Journal of Royal Statistical Society Series*. 120:253-290

Food and Agriculture Organization (FAO) (1999) North and South Gender Food Security Assessment in parts of the Tekez River Watershed. United Nation *D*evelopment Programme, Emergencies Unit for Ethiopia mission: 26th May-7th June, 1999, Addis Ababa, Ethiopia.

Food and Agriculture Organization (FAO) (2010) FAOSTAT Online Datase, Available at *http//faostatfao.org. and* http://en.wikipedia.org/wiki/rice Food and Agriculture organization of united Nations. Rome. Accessed in June 9th, 2010.

Goni, M, Mohammed, S, Baba, B.A (2007) Analysis of resource use efficiency in the Lake Chad Area of Borno State, Nigeria. Journal of Sustainable Development in Agriculture and Environment 3: 31-37.

Hardcastle, J.E. 1959. "The development of rice production and research in the Federation of Nigeria". *Tropical Agriculture*, 36: 79–95.

Hyuha, T. S, Nkonya, E, Kraybill and Bashaasha, B (2007) Analysis of profit inefficiency in rice production in eastern and northern, Uganda. African Crop Science Journal. 15 (4):243-253.

Idiong, C. I., Onyenweaku, E.C., Domian, I. A. and Susan, B. O. (2007) A stochastic frontier analysis of technical efficiency in swamp and upland rice production system in Cross River State Nigeria *Medwell Agricultural Journal* 2(2): 299 – 305.

International Institute of Tropical Agriculture (IITA)(2011) On minister of agriculture addressed at the international institute of tropical on cassava value chain development in Ibadan, Nigeria.15th August,2011.

Imolehin, E.D.(1991). Rice improvement and production in Nigeria". Paper presented at WARDA Upland Breeding Task-Force Workshop, Bouake, Côte d'Ivoire, 26,August 1991.

Jirgi, A. J.; Abdulrahman, M. and Ibrahim, F. D. (2009) Adoption of improved rice varieties among small scale farmers in Kacha Local Government Area of Niger State, Nigeria. *Journal of Agricultural Extension* 13(1):95-98

Johnson, N. L and Welch, B. L. (1939). On the calculation of cumulants of the K-distribution *Biometrika.* 31:362-389

Lau, L. J. and Yotopolous, P. A. (1971) A test for relative efficiency and application to Indian agriculture, *America Economic Review* 61: 92-109.

Meeusen, W. and Van den Broeck, J. (1977) Efficiency estimation for Cobb-Douglas production function with composed error, *International Economic Review*, 18:435-444.

Muhammad-Lawal, A. Omotesho, O. A. and Falola, A. (2009) Technical efficiency of youth participation in agriculture programme in Ondo State, Nigeria. Nigeria *Journal of Agriculture Food and Environment* 5(1): 20-26

National Population Commission (NPC) (2006) Provisional census report for Nigeria, Draft Report, 2006.

National Research Council (NRC) (1996). *Africa Rice. Lost Crop of Africa.* National Academic Press. Abuja.1:17-38

NGADP (2003) Niger State Agricultural Development Project: 2003 Annual Report. Pp79

Obwona, M. (2000) Determinant of technical efficiency among small and medium scale farmers in Uganda: A case of tobacco growers. Final Report at the AERC Biannual Research Workshop, Nairobi, Kenya.

Odoemenem, I.U and Inakwu, J.A (2011). Economic analysis of rice production In Cross River State, Nigeria. Journal of Development and Agricultural Economic. 3(9):469-474.

Ogundari, K.; Ojo, S. O. and Ajibefun, I. A. (2006). Economics of scale and cost efficiency in small scale production: Empirical evidences from Nigeria. *Journal of Social Sciences*. 13(2):131-136.

Okoruwa, V. O. and Ogundele, O. O. (2006). Technical efficiency differentials in rice production technologist in Nigeria. African Economic Research Consortium, Research paper No.154.

Olawoye, J. O. (1998) Factors affecting the role of rural women in agricultural production: A survey of rural women in Oyo State, Ibadan, Nigeria .No 3

Olukosi, J. O. and Erhabor, P. O. (1988) *Introduction to Farm Management Economics 2nd edition , AGITAB Publishers Zaria, Nigeria pp.77*

Oniah, M.O., Kuye, O.O. and Idiong, I.C. (2008) Efficiency of resource use in small scale swamp rice production in Obubra Local Government Area of Cross River State, Nigeria. *Middle East Journal of Scientific Research*. 3(3): 145 – 148

Project Coordinating Unit (PCU)(2001). "Crop area yield survey (CAY)". Federal Ministry of Agriculture and Rural Development, Abuja.

Rahman, S. A ane, Umar, H.S(2009) Measurement of technical efficiency and its determinants in crop production in Lafia Local Government Area of Nasarawa State, Nigeria. Journal of Tropical Agriculture, Food, Environment and Extension. 8 (2) : 90-96

Rola, A. and Quintana-Adejandrino, J. T. (1993) Technical efficiency of Philippines rice farmers in irrigated, rainfed lowland and upland environment: A frontier production function analysis. *Philippine Journal of Crop Science*.18:56-69

Seyoum, E. T., Battese, G. E. and Fleming, E. M. (1998) Technical efficiency and productivity of maize producers in eastern Ethiopia: A study of farmers within and outside the Sasakawa Global 2000 project" *Agricultural Economics Journal* 19:340-348.

Smith, B. D. (1998). *The Emergence of Agriculture*. Scientific American Library. Division of HPHLP, New York.pp.230

West African Rice Development Association(WARDA) (2007). *African Rice Trend*, 5th Edition, WARDA, Coutonou, Benin. pp.84.

APPENDIX

ECONOMIC ANALYSIS OF SWAMP RICE PRODUCTION IN NIGER STATE, NIGERIA

Dear respondents,

This questionnaire will be used by a student of agricultural economic department, ABU, Zaria please, fill and tick where necessary. All information will be treated with utmost confidentiality and will be used for purpose of research

A. Socio-economic characteristics

1. Name…….Village…….
   LGA…….
2. Sex: Male ( ) Female ( )
3. Marital Status: Single ( ) Married ( ) Widow ( )
4. Age (Years)……
5. Level of Education (Years)……
   i. (a) No formal education( ) (b) Adult education ( ) (c) Quranic education( ) (d) Primary education( ) (e) Secondary education ( ) (f) Tertiary education( )
   ii. How many years did you spent in school……..
6. Family size (in number) …….
7. Farming experience (years) …….
8. Access to credit (whether formal or informal) yes ( ) No ( )
   If yes specify the amount…….and sources of formal and informal credit……
   How much interest paid on credit…….
9. Access to non-farm income (other income apart from farm income) Yes ( ) No ( )
   If yes specify the amount……
10. Do you belong to any cooperative society? Yes ( ) No ( )
    If yes how long……..
11. Do you have contact with extension agents Yes ( ) No ( )
    If yes how many times in a year……

B. Input used

i Farm size

Field no	Field size (ha)	Cost (N)
1		
2		
3		
4		
5		

ii Seed quantity (kg)

Field no	Quantity of seed	Cost (N)
1		
2		
3		
4		
5		

Unit = kg modu, tiya, bucket, bags etc

iii Fertilizer

Field no	Type of fertilizer	Quantity	Cost (N)
1			
2			
3			
4			
5			

Unit = kg modu, tiya, bucket, bags etc

iv Herbicide (litre)

Field no	Type of herbicide	Quantity	Cost (N)
1			
2			
3			
4			
5			

v. Tractor

Field no	Cost of plough	Cost of harrow	Total Cost (N)
1			
2			
3			
4			
5			

Labour

(i) Manual ploughing

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(ii) Planting

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(iii) Fertilizer application

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(iv) Herbicide application

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(v) First weeding

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(vi) Second weeding

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(vii) Harvesting

(a)Rice cutting

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(b) Rice packing

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(c) Threshing

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(d) Rice winnowing

	Family Labour					Hired Labour				
Field No	No of men	Days spent	Hours /day	Cost/ day	TC	No of men	Days spent	Hours/day	Cost/ day	TC
1										
2										
3										
4										
5										

(C) Depreciation

S/N	Types of tools	Years of purchase	Purchase price	Years of utilization	Resale value
1					
2					
3					
4					
5					

(D) Marketing costs

SN	No bags	Price/bag	Total cost
Transportation			
Cost of warehouse			
Chemicals			
Packaging materials			
Others			

(E) Output

Field No	Quantity harvested	Price per quantity	Value in N
1			
2			
3			
4			
5			

Unit = Kg, bags, modu, tiya

(F) Constraints faced by rice farmers

1……..…….

2……

3……..…….

4……

5…….

6……...

7……

G Suggest the possible solution to the problems identify by the farmers

……

……..

……..

…….

……