IMPACT OF FADAMA III ON PRODUCTIVITY, FOOD SECURITY AND POVERTY STATUS OF TUBER FARMERS IN CENTRAL STATES OF NIGERIA

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A THESISSUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRICULTURAL ECONOMICS

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DECLARATION

I hereby declare that this thesis was written by me and it is the record of my own research. No part of this work has been presented in any previous application for another Degree or Diplomain any institution. All citations and sources of information are duly acknowledged by means of references.

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Solomon Taiwo, **FOLORUNSO** Date

CERTIFICATION

This dissertation titled"**Impact ofFadama IIIon Productivity, Food Security and Poverty Alleviation of Tuber Farmers in Central States of Nigeria**" by Solomon Taiwo,**FOLORUNSO** meets the regulation governing the award of the Degree of Doctor of Philosophy in Agricultural Economics ofthe Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation

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DEDICATION

This thesis is dedicated to the Lord **JESUS CHRIST**.

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My greatest appreciation goes to God, who through His son Jesus Christ has made life meaningful to me here and in eternity.I sincerely thank my supervisors; Prof Z. Abdulsalam, Prof S.A Sanni and Prof. T.K. Atalafor the privilege to tap from their wealth of knowledge. May God bless and reward them in Jesus 'name. My special appreciation also goes to the HOD, Prof. Z. Abdulsalam for his effort in ensuring that the programme is completed successfully.

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ABSTRACT

This study examined the impact of Fadamaprogrammeon productivity, food and poverty status of root and tuber crop farmers in central States of Nigeria. A multi-stage sampling procedure was used to select 934 farmers with 427 respondents from programme participants and 507 respondents from the non-participants. Primary data were collected on socioeconomic variables, (age, and educational level, farm size, farming experience and non-farming activities of the respondents); input – output level and house hold expenditure of participants and non-participants using structured questionnaires and interview schedules. Data collected were analyzed using descriptive statistics, net farm income analysis, double difference estimator, stochastic production function analysis, logit regression model ,Foster, Greer and Thorbeeke food security index and Foster, Greer and Thorbeeke (FGT) poverty indices. The results shows that Age, family size, farmers' level of education, farm size and farmers' farming experience were the socio-economic factors identified in the study area. The net farm income (NFI) for Fadama III root and tuber crop participants and non-participants before programme intervention is₦268,195.04 /Ha and ₦287,768.09 /Ha respectively before the programme intervention,while the net farm income after the programme intervention is ₦639,584.75,584.75 and ₦511,515.40/Ha for participants and non-participants respectively. The change in income is 50% and 38% for participants and non-participants respectively while the change in net farm income (NFI) was 58% and 44% for participants and non-participants respectively. The double difference figure of 298779.86,F-chow statistic shows that Fadama III root and tuber crop scheme had an impact on the participants' productivity; propensity match score of 61.86215, and Z-statistics shows that Fadama III root and tuber crop scheme had impact on participants ' productivity, food security and poverty status in the study area. The problems encountered by the farmers in the study area are high cost of input, limited finances, bad roads, low produce prices, inadequate fixed inputs, poor marketing practices, high cost of labour, poor storage facilities, non-availability of water and shortage of fertilizer. The study recommends that farmers should be advised through the Agricultural Development Programme of Benue, Kogi and Plateau States on how to allocate and the use of their resources in other to enhance their net farm income, productivity, food security and poverty status, since the mean levels of technical, allocative and economic efficiencies were below the optimum level, there is scope for increasing the levels of technical, allocative and economic efficiencies respectively through the adoption of the best technologies or techniques in root and tuber crop production, there is the need for the National Orientation Agencies at both federal and state level should embark on vigorous enlightenment programme on the need for reduction in family size, farmers are encouraged to form cooperative societies to enhance bulk purchase of input which will reduce input cost and ensure timely supply of same, high costs of inputs were identified as a problem in root and tuber crop production and there is the need for policy makers to pursue opportunities for regional cooperation in international input procurement and to facilitate privatization and competition in input distribution.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The National Fadama Development Project (NFDP) was established to guarantee all-year round growing of crops and promotion of simple and low cost improved irrigation under a World Bank financing. Food crops grown on the Fadama include rice, leafy vegetables, okra, maize and other crops including root and tuber. Fadama projects aim at reducing poverty and increasing farm productivity and income of farmer participants Bello, (2008). The projects so far (NFDP I and NFDP II) were adjudged successful by both national and international assessors culminating in Federal Government of Nigeria requesting the World Bank for implementation of the third National Fadama Development Project (NFDP III) Ezeh,(2007),Ike,(2012). The scope of the Third National Fadama Development Project (NFDP III) was extended to involve all 36 states in the federation and the Federal Capital Territory (FCT) as a tripartite funded intervention of the World Bank, the Federal Government of Nigeria and participating States. Funding is by World Bank contributing 55.6%, Federal Government of Nigeria, 5.1%; participating States and Local Governments contributing 17.1% and 8.9% respectively. The World Bank had provided the sum of $200m US Dollars for Nigeria Fadama III project as at August 2013 World Bank, (2013). The NFDP III is aimed at sustainably increasing income of beneficiary groups such as Fadama Users Groups (FUGs) and Fadama Community Associations (FCAs) in all the states, by directly delivering resources to them, empowering them to take decisions collectively on how to effectively and efficiently allocate and manage resources for their livelihood activities Osondu *et al*., (2014). By doing this the project would help reduce rural poverty, increase food security and contribute to the achievement of a key millennium

development goal. The project which started from July 2008 and has an end line to June 2013 has been extended to 2017. It will end in December 2017. The programme strategy included investing in public infrastructure, asset acquisition using matching grants and advisory services on best ways of improving group management mechanisms to avoid and resolve conflict(s) within participating groups FMARD, (2003). In this regard facilitators had been deployed to Nigerian communities to provide training and technical support to all categories of fadama resource users. To improve performance of the programme in each state and ensure welfare delivery, statutory and independent assessments need to be made *with* evidences gathered from farmers themselves. Many similar studies such as Ike, (2012), Adeoye, *et al*., (2011),Agbarevo and Okwoche,(2014),Ajayi and Nwalieji, (2010), Ezeh, (2009), Girei, *et al*., (2013), Iwala, (2014),Mohammed *et al* (2014), Olaolu *et al*, (2010) and Yunana et al., (2013). These studies revealed a significant impact of the project on participants' income, assets and/or poverty status.

In Nigeria, despite agricultural policies and strategies, the population of food insecure households in Nigeria was 18% in 1986 (Babatunde *et. al*; 2007) but had increased to 40% in 2005 and higher in the subsequent years (Sanusi *et al*, 2006, Enete et al, 2008). For instance, although agriculture remains a key component of the Nigerian economy, contributing about 37% of GDP and employing about 70% of the active population, it receives less than 10% of the annual budgetary allocations (Adebayo and Okuneye, 2005). As a result, the agricultural sector has significantly underperformed given its vast potential (Machethe, 2004). Consequently, Nigerian agriculture has failed to supply sufficient food in quantity and quality to feed the constantly growing population. Therefore, the level of food insecurity in Nigeria has continued to increase steadily

since the 1980s. Food security can be defined as the situation when all people, at all times, have physical and economic access to sufficient, safe and nutritious food for a healthy and active life (Franz, et al 2004). Food insecurity rose from about 18%in 1986 to about 41% in 2004 (Sanusi *et al*. 2006),with an estimated population of 150 million, this implies that over 61 million Nigerians are food insecure, that is, are either hungry, under nourished, or starving. This is not surprising given that about 52% of the population live under the poverty line. In 2012, the National Bureau of Statistics (NBS) published a report stating that most of the poor live in the rural areas where the incidence of poverty is highest (NBS, 2012). According to NBS (2005), the North-West and North-East geo-political zones have the highest poverty rates in the country with 77.4 percent and 69.1 percent of the population are poor respectively, these are followed by the North Central with 59.5percent of the population, the South-West zone is the lowest population of the poor with 49.8 percent, while South east had 59.5 percent and South-south 55.5 percent. Furthermore, 60.9 percent of Nigerians were estimated as living in absolute poverty in 2011 as against 54.7 percent in 2004 (NBS, 2012).

Raising agricultural productivity, reducing food insecurity and poverty is an important policy goal for concerned government since agriculture plays a major role in the economy of many developing countries, as it is a significant source of nourishment for citizens and a means of livelihood for the most vulnerable members of this country Adewuyi (2002). Increasing agricultural productivity requires one or more of the following; an increase in output and input with output increasing proportionately more than inputs; an increase in output while inputs remain the same; a decrease in both inputs and output with input decreasing more; or decreasing input while output remains the same (Adewuyi, 2006; Oni *et al.*,2011). Increasing inputs in order to expand output

involves raising both the quality and quantity of inputs, examples of which will include the mechanization of agricultural processes, use of high yield varieties of crop seeds or planting materials, use of fertilizers, irrigation in areas where rainfall is inadequate, and the use of agrochemicals such as herbicides and pesticides.

In order to revamp the agricultural sector, the federal government had embarked on and implemented several agricultural policies and programmes some of which are defunct or abandoned, and some restructured while others are still in place. These policies and programmes include the farm settlement scheme, National Accelerated Food Production Programme (NAFPP), Agricultural Development Projects (ADPs), River Basin Development Authorities (RBDAs), National Seed Service (NSS), National Centre for Agricultural Mechanisation (NCAM), Agricultural and Rural Management Training Institute (ARMTI) and Agricultural Credit Guarantee Scheme Fund (ACGSF). Others were the Nigerian Agricultural Cooperative And Rural Development Bank (NACRDB)/agricultural bank, Operation Feed the Nation (OFN), Green Revolution Programme, Directorate Of Foods, Roads And Rural Infrastructure (DFFRI), Nigerian Agricultural Insurance Company (NAIC), National Agricultural Land Development Authority (NALDA), Specialised Universities for Agriculture, Root and Tuber Expansion Programme (RTEP) and Rural Banking Scheme, Cassava Multiplication Programme, National Fadama Development Programme (NFDP), National Programme on Food Security etc aimed at revamping the sector (NBS, 2005, Ajibefun and Aderinola, 2006).

Root and tuber crops are major sources of dietary carbohydrates and provide food for over 60 million people in Nigeria (Abubakar, 2006). Yam and cassava are the two major root and tuber crops in Nigeria, with cassava's contribution to the Gross Domestic

Product (GDP) increasing from ₦86Billion in 2008 to about ₦110Billion in 2012, while yam's contribution to GDP was 27.22 percent in 2011; (NBS, 2011; Philip *et al.*, 2008).

The productivity and growth rate of root and Tuber crops in Africa and Nigeria especially has been increasing tremendously for the past two and half decades, although such increase has not been meeting with the rising food demand due to high population pressure and poor infrastructural facilities to accelerate processing into food forms. Contributors to this trend in food production include the root and tuber crops sector with increasing annual output and growth rates. Food and Agriculture organization (FAO, 2009) estimated a yearly output of 45 million metric tons for cassava, 32 million metric tons for yam, 1.3 million metric tons for sweet potato, 0.731 million metric tons for potato, 5.0 million metric tons for cocoyam and 0.223 million metric tons for ginger in Nigeria. Growth rate of root and tuber crops shows some upward improvement, as shown below.

Table 1.1: Mean annual outputs in million metric tonns and growth rates of some root and tuber crops

Year	**Cassava annual output (MMT)**	**Growth rate (%)**	**Yam annual output (MMT)**	**Growt rate (%)**	**Irish potato annual output (MMT)**	**Growt rate (%)**	**Cocoyam annual output (MMT)**	**Growt rate (%)**
1975-79	1766	10.8	6518	11.2	102	4.7	1696	13.5
1980-84	2724	10.8	4998	1.7	183	3.8	1187	6.0
1985-89	14542	80.8	6715	19.5	228	3.6	2292	9.64
1990-96	20784	6.1	18263	16.6	557	20.6	7247	30.85

1997-98	34092	2.4	25102	2.1	105	3.9	1450	6.5
2009-11	45000	-	32000	-	-	-	5000	-

Source: ATA, (2012), and FAO, (2010).

Production and growth rates of some root and tuber crops in the past 25 to 30 years ago were drawn by expansion in cultivated area rather than yields. Currently, both production and growth rate of cassava, yam, sweet potato, potato, cocoyam and ginger have expanded in areas cultivated and also yields due to innovation in technologies resulting in high yielding, pest and disease tolerant varieties of root and tuber crops. The result of the National survey conducted by the Central Bank of Nigeria (CBN) showed that the increase recorded in agricultural production during the estimated period was attributable largely to sustained government support for the agricultural sectors (CBN, 2004). Anyanwu *et al*. (2010) reported that there is a strong positive correlation between the root and tuber crops and gross domestic product (GDP).

1.2 Problem Statement

IFPRI (2010) reported that cereals, roots, and tuber crops dominated Nigerian crop production, and Nigeria is the world's leading producer of cassava, yams and cowpea. However, productivity is below potential yields with the farmer yields of most crops are less than half of the yield potential due toincreased population pressure and high demand for land for non-agricultural uses which has led to decrease in available agricultural land and consequently small farm sizes resulting in low food production, low income, high food insecurity and high poverty prevalencedespite the rich resource endowment of Nigeria (Igbenaese and Okojie-Okoedo,2010;Adeolu, *et al*., 2004 and Alimi and Ayanwale. 2006).

Poverty is widespread and high in rural areas, where Nigeria's poverty incidence was 17.7 million poor people in 1980, 34.7 million in 1985, and not minding the drop between 1985 and 1992 (due to the implementation of the structural adjustment programme), about 39 million were poor in 1992. In 1996, however, about 67 million people were poor despite the drop in incidence between 1996 and 2004, about 69 million were poor in 2004 (Omonona, 2009; Diao *et al*., 2009). This increased to 69% (or 112.5 million Nigerians) in 2010 (NBS, 2012). Both the quantitative and qualitative measurements of poverty attest to the growing incidence and depth of poverty in the country, with almost 100 million people living on less than a $1 (£0.63) a day majority of who are in the rural areas and (NBS, 2012).

Food insecurity remains a fundamental challenge in Nigeria. The Food and Agriculture Organization (2002) enlisted Nigeria among countries faced with serious food insecurity problems. The Global Food Security Index (GFSI) of the Economist Intelligence Unit has ranked Nigeria as the 80th among 105 countries with food affordability, availability and quality. According to the Index, Nigeria recorded weak scores in the areas of Public expenditure on agricultural research and development, 0.0; presence of food safety net programs, 0.0; gross domestic product per capita, 3.0; proportion of population under global poverty line, 9.6; food consumption as a share of household expenditure, 9.6 and protein quality, 12.8 (El-Kurebe, 2012).

Small holder agriculture, the dominant occupation of rural Nigerians, is mainly rainfed and characterized by low capital and low productivity. The farming systems in the rural areas are predominantlyupland subsistence agriculture that are highly dependent on the vagaries of the weather while the potential for irrigation, using underground and surface water, remain underdeveloped (World bank,2001). The use of inputs such as fertilizer,

improved seed and mechanization is low and irrigstion efficiency (about 20%) is low (FDP, 2005).

Although, concerted efforts have been made by past and present governments of Nigeria towards improving agricultural productivity and production efficiency and in alleviating poverty among the rural farmers, millions of people in Nigeria are still poor and hungry (Simonyan *et al*., 2010). Hence, the role of increased efficiency and productivity of root and tuber crop farms is no longer debatable but a great necessity in order to reverse the low technical, economic and allocative efficiency of small farms in Nigeria, since root and tuber crops (e.g. cassava, yam and irish potato) have the potential for bridging the food gap, as they have been discovered from research that famine rarely occur where these crops are widely grown (Nweke *et al*., 2002).

Given the fact that a number of root and tuber crop development programmes such as cassava multiplication programme (CMP), root and tuber expansion proframme (RTEP) and the latest being national fadama development programme I, II and III have been implemented to boost the root and tuber sub-sector in Nigeria, there is no comprehensive and up-to-date information on the resource productivities, food security and poverty alleviation of the root and tuber crop farmers involved in the root and tuber crop scheme of the fadama III programme in North central Nigeria.

Fadama I, II and III project were established by the Nigerian government, in collaboration with the World Bank and the African Development Bank in 1996 and 2001. Some of the problems of these two projects were that Fadama I operated a top-bottom approach thereby contributing to reduced crop prices and greater storage losses

while fadama II was challenged by poor monitoring and documentation which provided the basis for poor accountability, lack of transparency and tracking of project planning and implementation. But the low level of monitoring of fadama sub-projects has been a persisitent problem to the successful delivery of fadama development projects in Nigeria (Oredipe, 2007).

Hence, the study seeks to provide answers to the following research questions;

i. What are the socio-economic characteristics of participants in Fadama IIIroot and tuber crop scheme in the study area?
ii. What is the impact of Fadama III programme on the productivity ofthe participants in the root and tuber crop scheme in the study area?
iii. What is the impact of Fadama III programme on food security of the participants in the root and tuber crop scheme in the study area?
iv. What is the impact of Fadama III programme on the poverty status of Fadama III participants in root and tuber crop scheme in the study area?
v. What are the constraints faced by the farmers in root and tuber crops production in the study area?

1.3 The Objectives of the Study

The broad objective of this study is to evaluate the impact of Fadama III programme on productivity, food security and poverty statusamong root and tuber crop farmers in the north central, Nigeria.The specific objectives are to;

i. describe the socio-economic characteristics of participants in Fadama III root and tuber crop scheme in the study area,

ii. determine the impact of Fadama III programme on the productivity of participants in the root and tuber crop scheme in the study area,

iii. determine the impact of Fadama III programme on food security among the participants in the root and tuber crop scheme in the study area,

iv. determine the impact of Fadama III programme on the poverty status of Fadama III participants in root and tuber crop scheme in the study area and

v. identify and describe the constraints faced byroot and tuber crop farmers in the study area

1.4 Justification

Decreasing agricultural productivity, food insecurity and poverty are majorproblems in the developing countries in general andsustained increased agricultural productivity, food security and poverty alleviation will go a long way in repositioning the Nigeria to where she rightly belongs (Jhingan, 2007).Theeconomic analysis of the impact of Fadama III programme on poverty alleviation, productivity and food security among root and tuber crops farmers will help us to critically and objectively bring to the fore the urgent need to give support to this programme as well as replicate such in other parts of the country. In view of the laudable objectives of the Fadama III and the several billions of Dollars that has been invested into this project, it is imperative to know whether these objectives which includes reduction of poverty by 35 percentand increased income and improved agricultural productivity as laudable as they are, translated to sustainable increased production of these crops by the beneficiaries of the programme. Also, it is important to know if this increase translates into the profitability

of this enterprise which will further enhance the ability of these farmers to increase output.

This study will improve the database of Fadama development project for further studies and provide the necessary information on both beneficiary and non-beneficiary farmers in the programme with a viewto improving and modifying the programme design, planning and implementation strategies, thus accelerating the achievement of the set objectives of the programme.

Quite a huge amount of money has been expended both by the World Bank, the Federal Government and State Governments to ensure that farmers are empowered to efficiently utilize their resources with the aim of improving the farmers' income, productivity and reducing poverty among the rural dwellers. The result of this study will go a along way in bringing to the fore whether the huge amount of money expended on this project is justified.

The result from this study will also further provide the necessary data required by policy makers at the World Bank, the Federal Government and State Governments to draft policies that will positively impact the livelihood of the farmers through sustained increase in food production and farm incomes, provision of employment, provision of raw materials to boost the establishment of agro-allied and cottage industries.

An independent and a more objective assessment of the impact of the project which will serve as a means of comparing its results with those obtained from similar programmes in the past, such as Fadama I and II programmes. Finally, the study will suggest

solutions to the problems encountered by both programme beneficiaries and non-beneficiaries.

1.5 Research Hypotheses

(i) Fadama IIIprogramme has no significant impact on the productivity of programme participant in root and tuber crop scheme in the study area.

(ii) Fadama III programme has no significant impact on the food security of programme participant in root and tuber crop scheme in the study area.

(iii) Fadama III programme has no significant impact on the poverty status of programme participants in root and tuber crop scheme in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 Background of Fadama III Programme

Fadama III was introduced and implemented nation-wide from March, 2009 to December, 2013. An integral part of the Fadama III project was the provision of support to up- stream and down- stream activities aimed at streamlining input and output marketing, including ensuring efficient transportation of inputs and outputs, processing, storage (conservation/or preservation), thereby ensuring that beneficiaries' efforts translate to sustained and increased income (NFDP,2003).

The project was designed to take a demand- driven approach. Fadama III, like Fadama II, adopts a community-driven development (CDD) approach. Under this approach, various Fadama resource users, including crop farmers, pastoralists, fishermen and women, and on –and off-farm entrepreneurs, operating through their respective Fadama user groups (FRUGs) and their apex bodies and Fadama community Associations (FCAs) would reach consensus on how to use the common resources for their mutual advantage (NFDP,2003). It also assert that through this process, communities would decide on which advisory services and infrastructures they need to enable them attain development goals they set for themselves based on their own efforts. The concensus so reached would be articulated in the local development plans (LDPs) drawn on the level of Fadama community associations. A typical LDP comprises: (i) an agreed list of priority public infrastructure sub-projects that are technically and economically feasible, environmentally sustainable, consistent with existing development plans of local and state government authorities and that will contribute towards raising the productivity and incomes of all Fadama Users Groups (FUGs); (ii) a list of priority advisory needs;

(iii) agreed mechanisms for financing the operations and maintenance of sub-project investments (including levies and user fees where appropriate); (iv) a plan for training and building the capacity of FCAs in financial management, community – based procurement, social and environment impact screening of sub projects and other aspects of organization and management of the associations; (v) a gender and poverty reduction plans; (vi) an agreed mechanism to manage and resolve conflicts, especially concerning Fadama user right (right to use without owning) (NFDP,2003).

2.2 Farmers' Socioeconomic Characteristics Influencing Agricultural Productivity

Several authors have investigated the relationship between agricultural productivity and various socio-economic variables (Okoruwa *et al*., 2006). Gender is an important socioeconomic factor that can affect agricultural productivity in Africa. For example, in some African societies, assets like land and machines are mostly inherited by the male descendants (Udoh and Nyienakuna, 2008). Oluwatayo *et al.* (2008) on the study of resource use efficiency of maize farmers in rural Nigeria revealed that only 8.5% of women owned farms.

The bedrock of agricultural development is education. Literate farmers can increase production through the use of improved methods by reading extension leaflets. Onyewiaku and Ohiajianya (2005) and (Tanko and Opara, 2010) found a positive relationship between education, technical efficiency and productivity in rice production in their study of swamp and upland rice farms in South-Eastern Nigeria. Farming experience is the the act of gaining knowledge through constant practicing of skill, which brings about specialization (Olaoye, 2010; Adebayo, 2006). Experienced farmers

have the ability to use modern farming gears and read the agricultural environment in terms of when to plant and to market their produce. In his study of socioeconomic determinants of output and profit levels of small-holder rice production systems in Abia State. Ezeh (2006) found that experience enhances more efficient use of scarce resouces by small-farm holders.

Membership of farmers' associations has an influence on the level of production efficiency of the farmer. In their comparative analysis of technical efficiency in swamp and upland rice, Idiong *et al*. (2006) observed that membership of association was positively related to efficiency, and thus resulted to increase in output. Memebership of association provides a network connection among farmers which lead to mutual commitment (Adeola *et al*., 2011). It affords the farmers access to soft loans and productive inputs such as improved seeds and fertilizer which are better sought by group rather than individuals (Shehu, *et al*., 2010: Okike, 2000).

Credit can improve the productivity, income and welfare of rural people. Short term credit may alleviate seasonal needs for working capital, or the problems arsing from crop failure, sickness within the family or unexpected social commitment. Agricultural credit is any of the several credit vehicle used to finance agricultural transaction, including loans, notes, bills of exchange and bankers acceptances. These types of financing are adapted to the specific financial needs of farmers, which are determined by planting, harvesting and marketing cycles. Short term credit finance operating expenses, intermediate term credit is used for farm machinery and long term credit is used for real-estate financing(Adebayo and Adeola, 2008) . Hussein and Ohlmer (2008)

examined the influence of credit constraint on production efficiency of farming households' specific technical efficiency. The study found out that all input variables except herbicide and land variables were found to be statistically significant. The results also showed that credit constrained households have a lower mean production efficiency. Omonona *et al*., (2008) studied credit constrained condition and output supply of COWANN farmers in Oyo state, Nigeria. Descriptive statistical tool, probit regression and switching regression models were used to analyse the primary data. The findings of the study revealed that majority of the farmers (80%) were constrained and therefore this affected their productivity. The results showed that age, sex, farm size, level of education, marital status, and contact with extension agent, land acquisition and income of the household head are the determinants of credit constraint condition. A test of hypothesis on the difference in the value of the output of the farmers showed that credit –unconstrained farmers have their output supply higher than that of credit – conditioned farmers.

Well-organized extension contacts enhance the application and utilization of information on improved technology by the farmers as well as their innovativeness (Umar *et al*., 2009). Interacting with extension workers affords the farmers the opportunity of sharing information on modern agricultural practices. Production advice given to the sorghum producing households had a direct and significant relationship with technical efficiency. Production advice increased technical efficiency. This corroborates with the work of Chiona (2011), Nchare (2007), Amaza *et al*.(2006), Ajewole and Folayan (2008), Javed *et al.* (2010), and Wakili (2012). Through such production advice, farmers were able to get first-hand information on new agricultural innovations and techniques that would ensure increased sorghum production in the

study area. Weir and Knight (2000) and Shanmugam and Venkataramani (2006) found a positive influence of household education on TE.. The latter indicated that although the TE was a decreasing function, no significant relationship was found. Binam *et al*., (2008) found mixed outcomes for education. Of the four West African countries, Ghana and Nigeria had negative education impact while Cameroon and Coted'voire had a positive education impact.

2.3 Agricultural Productivity and Production Efficiency

Production efficiency is concerned with the relative performance of the process used in Transforming inputs into output (Arene, 2003, Eze, 2008)..However, measures of productivity can be divided into partial or total measures, depending on the number of inputs under consideration. Total output as a ratio of some measure of labour quantity, usually man-days in developing countries, is called labour productivity (LP) and provides some notion of output per worker, while output per area of land planted is land productivity (Wiebe *et al*. 2003; Zepeda 2001). These two measures are examples of single factor productivity (SFP), defined as the ratio of a measure of output quantity to the quantity of a single input used (Diewert and Nakamura, 2005). Partial measures of productivity can be misleading because they ignore the role of other inputs in any observed output changes (Zepeda, 2001). As a result of this shortcoming, a total measure of productivity was developed. Total factor productivity (TFP) is defined as the ratio of a measure of total output quantity to a measure of the quantity of total inputs (Wiebe *et al*. 2003; Zepeda 2001).

Agriculture plays a major role in the economy of many developing countries, as it is a significant source of nourishment for citizens and a means of livelihood for the most vulnerable members of these countries. As a consequence, raising agricultural productivity is an important policy goal for concerned governments and development agencies.

Increasing agricultural productivity will result from one of three process; an increase in output and input with output increasing proportionately more than inputs; an increase in output while inputs remain the same; a decrease in both output and input with input decreasing more; or decreasing input while output remains the same (Adewuyi, 2006; Oni,*et al*. 2009). Increasing inputs in order to expand output involves raising both the quality and quantity of inputs, examples of which would include the mechanization of agricultural processes, use of high yield varieties, use of fertilizers, irrigation in areas where rainfall is inadequate, and the use of agrochemicals such as herbicides and pesticides. Though all of these aforementioned activities have the potential for productivity enhancement, smallholder farmers, who account for the vast majority of farmers in developing countries, often cannot afford these investments due to their limited resources and restricted access to credit(Adewuyi, 2006; Oni *et al.*, 2009) .

Farm efficiency measurement is one of the important tools used by both researchers and policy makers in agriculture for evaluating farmers' performance. Farm production efficiency helps to identify source of inefficiency (Shehu, 2013)

Thiam et al, (2001) highlighted the importance of efficiency as a means of fostering production which has led to proliferation of studies in agriculture on technical efficiency around the globe micro economic production function studies have usually been used as

tools for examining problems of efficiency of resource use and productivity at farm enterprise level. This study is based on the theory of resource use efficiency to maximize cocoyam output per hectare of land area by gender, therefore, the problem of low productivity of agriculture can be solved by improving efficiency of resources used (Ojo, 2003).

Technical efficiency refers to the ability of a producing unit to obtain maximum (optimal) output from a given amount of inputs. Formally, the level of technical efficiency is measured by the distance of farm production from the optimal production frontier. A firm that sits on the production frontier is said to be technically efficient (Henderson, 2003). Allocative (or price) efficiency, on the other hand, refers to the ability of the firm to choose its inputs in a cost-minimizing manner (Murillo-Zamorano 2004; Chavas and Aliber, 1993). For allocative efficiency to hold, farmers must equalize their marginal returns with true factor market prices. Thus, technical inefficiency is related to deviations from the frontier isoquant, while allocative inefficiency reflects deviations from the minimum cost input ratios (Bravo-Ureta and Pinheiro, 1997).

In addition to technical and allocative efficiency, Farrell (1957) also defined the concept of overall efficiency (or economic efficiency). Economic efficiency refers to "the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology" (Farrell 1957) and is derived by multiplying the technical and allocative components of efficiency (Bravo-Ureta and Pinheiro, 1997). All three measures are bounded between zero and one (Murillo-Zamorano, 2004).

2.3.1 Measurement of production efficiency

Parametric and non-parametric methods are often utilized to measure economic efficiency. Parametric methods assume that the functional form of the production function is known while non-parametric methods do away with the restrictive functional form assumptions, instead relying on the data to specify the production frontier. Stochastic Frontiers are the most common specifications of the parametric methods Data envelope analysis (DEA) models are the most commonly used forms of non-parametric models (Ajibefun,2008). Using either methodology (parametric or non-parametric), it is possible to estimate technical efficiency and allocative efficiency for each observation in the dataset. Most studies report mean levels of technical and allocative efficiency for the sample under observation. Studies that have applied both methodologies report no substantive differences in estimates of efficiency (Ajibefun, 2008). Data required for the parametric and non-parametric method depend on the model used. Both uses sectional and panel data can be used under both the parametric and non-parametric approaches (Porcelli, 2009).

2.3 Agricultural Productivity and Production Efficiency

According to Olayide and Heady (1982), farm productivity is the index of the ratio of the value of total farm output to the value of the total inputs used in farm production.

However, measures of productivity can be divided into partial or total measures, depending on the number of inputs under consideration. Total output as a ratio of some measure of labour quantity, usually man-days in developing countries, is called labour productivity (LP) and provides some notion of output per worker, while output per area of land planted is land productivity (Wiebe *et al*. 2003; Zepeda 2001). These two measures are examples of single factor productivity (SFP), defined as the ratio of a

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Resource productivity is the quantity of good or service (outcome) that is obtained through expenditure of unit resources (Hargroves and Smith, 2005). Resource productivity and resource efficiency are two concepts closely tied to production function. They concern the relative performance of resources used in production process Eze (2008). Ogundari *et al* (2004) in the study of impact of economies of scale and cost efficiency in small scale, resource poor farmer are efficient intheir use of resoures and the expansion of their level of expansion will reduce cost per output.

Technical efficiency refers to the ability of a producing unit to obtain maximum (optimal) output from a given amount of inputs. Formally, the level of technical efficiency is measured by the distance of farm production from the optimal production frontier. A firm that sits on the production frontier is said to be technically efficient (Henderson, 2003). Allocative (or price) efficiency, on the other hand, refers to the ability of the firm to choose its inputs in a cost-minimizing manner (Murillo-Zamorano 2004). For allocative efficiency to hold, farmers must equalize their marginal returns with true factor market prices. Thus, technical inefficiency is related to deviations from the frontier isoquant, while allocative inefficiency reflects deviations from the minimum cost input ratios (Tijani *et al.*, 2006).

In addition to technical and allocative efficiency, Economic efficiency is the ability of a firm to maximize profit. It is also known as production efficiency and it is described as the product of technical and allocative efficiencies. An economically efficient

input/output combination would be both on the frontier and the expansion path way (Ogundari and Ojo; 2006). Economic efficiency exists when the MVP is not significantly different from MFC. (MVP = MFC). To achieve economic efficiency, the ratio of MVP to MFC must be equal to one. Economic efficiency is concerned with maximum profit. That is when a firm chooses resources in such a way that its marginal value product is sufficient to offset marginal cost. The MVP is calculated from the respective regression coefficients using appropriate optimum levels of output price depending on the lead equation of the functional forms. The MFC is the market price of one unit of input. A ratio of less than one implies that input is being over utilized while a ratio greater than one implies that input is under utilized (Onojah 2004; Haruna *et al*; 2008). All three measures are bounded between zero and one (Murillo-Zamorano, 2004).

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2008). The parametric approach involves modelling the production frontier using various econo-metric techniques. Its most popular representative is stochastic frontier analysis (SFA). Its main advantage over its non-parametric counterpart lies in its stochastic nature, which enables it to distinguish between the eects of noise from those of inefficiency, thereby providing the basis for statistical inference (Fried, 2008).

2.3.2 Factors affecting farm households' agricultural productivity

The issues that determine the levels of agricultural productivity attained by farm households in developing countries are multidimensional and complex. Following the categorizations devised by Hussain and Perera, (2004), the constraints and opportunities for agricultural productivity in Nigeria are identified below:

(a) **Land and water related factors:** For many farmers in the South South region of the country, pollution due to petroleum exploration is a major issue that has important implications for the quality of land and water (Idumah 2006). Farmers in this region frequently have to increase their input use, particularly fertilizer, while having to settle for suboptimal output levels and lower revenues despite the higher input costs (Idumah 2006). Idumah's 2006 study of food crop farmers in two states of the South South revealed that soil degradation effects arising from the combined effects of oil pollution and other soil related issues like flooding accounted for about 21 percent of the difference in farm revenue between polluted and non-polluted farms. There are problems with soil quality in other regions of the country as well. Farmers in the Northern states of the country have to contend with the threat of desert encroachment (Akinyosoye 2000), while Southern soils are often low in

nutrients arising from long exposure to sunshine and rain, leading to erosion problems (Akinyosoye 2000; Adejoh 2009).

(b) **Climatic factors:** The implications of climate change for agriculture are also a major concern in Nigeria. Desert encroachment due to unpredictable and extreme weather associated with climate change reduces the production possibilities of rural farmers by drastically reducing the available cultivable land. Currently desert encroachment threatens about 35 percent of Nigeria's landmass (NISER 2010). Consequently, farmers in northern Nigeria are facing accelerated desertification due to limited rains and shrinking water sources. For instance, from a peak of 25,000km^2 in the 1960s, Lake Chad has shrunk to approximately 1,000km^2 today, due to drastically reduced precipitation and an increase in irrigation demands by surrounding farmers (Coe and Foley 2001). Similarly, farmers in southern Nigeria face several challenges. While some face the late onset of rains, early cessation of rain, shortened length of the rainy season, and reduced annual amount of rain (Adewuyi 2002), others experience increased flooding due to excessive precipitation (Egwuda 2001).

(c) **Agronomic factors:** A large variety of studies in different regions of the country have identified the scarcity and high cost of inputs (labor, agrochemicals, and fertilizer) as major impediments to raising the productivity of smallholder farmers (Egwuda 2001; Ojo 2005; Adejoh 2009; Peke 2008). Other related problems include the difficulty in maintaining seed quality due to susceptibility to disease, perishability, and the low multiplication rate of seeds (Ojo, 2005; Adejoh 2009).

In addition, low skilled and poorly educated family labor is the primary factor of production, often supplemented by hired labor where necessary (Ogunsanya

2009; Ekunwe, Orewa, and Emokaro 2008). Labor is also combined with mostly rudimentary tools such as hoes and cutlasses and ox-drawn ploughs in some parts of Northern Nigeria (Baiyegunhi 2003). Farming methods are also traditional (Ogunsanya 2009; Ajani 2000; Akintayo 2011; Oladeebo 2006; Fasoranti 2006; Ajibolade 2005; Peke 2008; Fanegan 2010; Oviasogie 2005), as mechanization of farm processes is rare (Ogunsanya 2009; Adeyemo, Oke and Akinola 2010; Ajani 2000).

(d) **Farm management factors:** In addition to crude farm implements, production technologies in Nigeria are often substandard and farming methods outdated. Also, common practices like bush burning tend to destroy soil and plant quality (Adewuyi 2002; Oseni 2001). Mixed cropping is commonly practiced in many regions of the country (Ajibolade 2005; Ajibefun 1998; Akintayo 2011; Adejoh 2009; Idumah 2006). Adewuyi's 2002 study of food crop farming in Kwara state revealed the dominance of sole cropping (68% of cultivated area) in the region covered by the study. Deriving optimal productivity from a crop often depends on the cropping pattern utilized. For instance, mixed cropping was more productive than sole cropping for maize farmers in Niger State where the Yam/maize mix yielded better returns than sole maize (Amos, Chikwendu, and Nmadu 2004). Similar results were found for yam farmers in Edo State (Oviasogie 2005).

(e) **Poor supporting infrastructure:** These include inadequate storage and marketing facilities, inadequate extension services, poorly organized rural input, output and financial markets, and substandard rural infrastructure. Many farmers report limited contact with extension agents and consequently receive no information on improved production technologies and practices (Adejoh

2009). For instance Egwuda's 2001 study of Lowland rice production in Kogi State revealed the complete absence of extension services in the region. Other challenges include poor feeder roads and limited access to clean potable water, good health services, electricity, telephone and educational facilities. These factors raise transaction costs and with low and unstable agricultural output prices, reduce productivity incentives for farmers (Fasoranti 2006; Okafor 2004; Adewuyi and Okunmadewa 2001; Yusuf *et al.* 2009; Peke 2008; Adewuyi 2006; Adejoh 2009).

(f) **Socioeconomic factors:** In Nigeria, small scale, resource poor farmers, the majority of whom are engaged in subsistence or near subsistence farming, produce the majority of aggregate agricultural output via rudimentary farming systems (Oviasogie 2005; Ajibolade 2005). Farm holdings across Nigeria are generally small with less than 5 hectares on average and are often inherited rather than purchased (Adeyemo, Oke and Akinola 2010; Akintayo 2011; Oladeebo 2006; Adewuyi 2002; Egwuda 2001; Ojo 2005; Ekunwe, Orewa, and Emokaro 2008; Adejoh 2009; Oviasogie 2005; Haruna *et al.* 2009; David *et al*. 2009; Yaro 1999). However, Baiyegunhi (2003) found that Sorghum farmers in Kaduna state resorted to buying or renting more land to augment their farm holdings. Fragmentation of farm holdings is also an issue, as farmers often have more than one location for their farms due to factors like variation in soil fertility and accessibility to land (Abubakar 2006; Adewuyi 2002; Okafor 2004; Akinyosoye 2000). While a study of small scale food crop farmers in the South South (Idumah 2006) also revealed small land holdings with an average of 1.56 hectares), most respondents farmed on communal land and leased land. Incomes from farming are generally low. Consequently, many

farmers engage in other occupations to supplement their incomes such as hunting, trading, crafts, and fishing (Adewuyi 2002; Ogunsanya 2009; Ajani 2000 and Ojo 2005). Many farmers also face limited access to credit facilities due to high interest rates and lack of collateral and often have to rely on personal funds or loans from friends and relatives to fund any farm expenses (Oladeebo 2006; Adewuyi 2002; Egwuda 2001; Adejoh 2009). In terms of demographics, the average farm household head/farmer is middle aged, poorly educated (primary school or less), male, married, and has been farming for both subsistence and commercial purposes for ten years or more (Ogunsanya 2009; Ajani 2000; Akintayo 2011; Oladeebo 2006; Fasoranti 2006; Ajibolade 2005; Peke 2008; Fanegan 2010; Adeyemo, Oke and Akinola 2010; Oluwatayo, Sekumade and Adesoji, 2008; Adewuyi 2002; Olawepo 2010; Egwuda 2001; Ojo ,2005; Ekunwe, Orewa, Emokaro 2008); Adejoh 2009; Oviasogie 2005; David *et al*. 2009; Abubakar 2006; Abubakar 2010). However, many farmers in the northern part of the country acquire Islamic/Quranic education in lieu of western education (Baiyegunhi 2003; Haruna *et al.* 2009; Abubakar 2006). There are some exceptions. For instance, Idumah's 2006 study of food crop farmers in the South South revealed that over half of the sample acquired post primary education. Average household sizes are large (7–12 persons on average) as households are the primary sources of farm labor (Ogunsanya 2009; Ajani 2000; Akintayo 2011; Olawepo 2010; Egwuda 2001; Ekunwe, Orewa, Emokaro 2008; Adejoh 2009; Oviasogie 2005; Baiyegunhi 2003; David *et al*. 2009; Idumah 2006). The previously mentioned factors combine to create a situation of low agricultural productivity. They create a production structure dominated by barely literate

subsistence and semi-subsistence smallholders who cultivate no more than 5 hectares, with poor access and limited ability and willingness to adopt production-enhancing inputs such as improved seeds, fertilizer and irrigation. Farmers are dependent on labor-intensive, low input-output technologies and often face high levels of post-harvest losses due to poor handling, inadequate development of agro-processing, as well as poor rural infrastructure, particularly rural roads and storage facilities, and limited access to marketing opportunities (Fasoranti 2006; Okafor 2004; Ekunwe, Orewa and Emokaro 2008; Adejoh 2009). Policy related factors: There have been several attempts by the federal government to create programs to improve agricultural productivity in Nigeria; many of which are developed with the aid and inputs of international organizations. Agriculture specific programs that have been implemented include Agricultural and Coopereative Bank (1973); National Accelerated Food Production Programme (1973); Agricultural Development Projects (1975); River Basin and Rural Development Authorities (1976); Operation Feed the Nation (OFN) (1976); Agricultural Credit and Guarantee Scheme (1977); Land Use Decree (1978); The Green Revolution Program (GRP), (1979/1980); and the Cassava Multiplication Program (1985–1999). Several institutions were also set up in order to facilitate these programs including the Agricultural Credit Guarantee Scheme (ACGS); Rural Banking Scheme (RBS); Nigeria Agricultural Insurance Company (1984); Directorate for Food, Roads and Rural Infrastructure (DFRRI) (1986); Nigerian Agricultural Development Bank (NADB); and the National Agricultural Land Development Authority (NALDA) (1991) (Adewuyi 2002; Okafor 2004). Many of these initiatives were not successful because they were ad hoc

programs that lacked focus. They were poorly conceived and implemented and were duplicates of already existing programs and organizations (Fasoranti 2006). In addition, government policy was inconsistent and projects were improperly monitored and implemented (Okafor 2004; Adewuyi 2002). Also in existence was an unfriendly macroeconomic policy environment characterized by an overvalued exchange rate, a mismanaged subsidy regime and bad export crop pricing schedules (Adewuyi and Okunmadewa 2001). This environment encouraged imports at the expense of local crops, which led to crowding out of local production (Yusuf *et al.* 2009; Adewuyi 2002; Muhammad-Lawal and Atte 2006). Several food crops (particularly tubers) were also neglected in favor of cash crops, while government invested very little funding in support of agricultural related research. More recent programs created to improve agricultural productivity include several presidential initiatives on selected crops (rice, cassava, vegetable oil); Root and Tuber Expansion Program (RTEP); the National Special Program on food security (NSPFS);

Community Based Agriculture and Rural Development Project (CBARDP); various phases of the National Fadama Development program (NFDP), amongst several other efforts. There is preliminary evidence that some of these programs are improving productivity of farmers by encouraging technology adoption and expanding farmer access to inputs, credit, and extension services (Olawepo 2010; Abubakar 2010). Assessment of the impact of these programs is ongoing (Oruonye 2011; IFAD 2009).

2.3.3 Agricultural productivity in Nigeria

Empirical analysis of regional technical, allocative and economic efficiency among Nigerian farmers. Nigeria is comprised of 36 states and the federal capital territory (Abuja), which are further categorized into six geopolitical regions namely the South West, South East, South South, North Central, North West, and North East regions. The North West region, with a population of 36 million, contains the highest proportion of Nigerians with 25 percent, while the South East is the least populated with 9.7 percent. The country also has a very diverse agroecology characterized by numerous farming systems including Pastoral, Agro-Pastoral (millet/sorghum), Irrigated, Cereal-Root Crop Mix, Highland Temperate Mix, Root Crop, Tree Crop, and Coastal Artesian Fishing (FAO 2001). In addition, as many as seven major agroecological zones exist within Nigeria's geographical confines. These zones cut across the six geopolitical regions and include:

1. The mangrove swamp, which characterizes the coastal areas of the delta region, and is not widely cultivated except for swamp rice and fish.

2. The tropical rain forest made up of the eastern, central, and western rain forest in the states of Ogun, Ondo, Oyo, Edo, Ekiti, Imo, Anambra, and Cross Rivers. Common crops in this zone include cocoa, kolanuts, palm produce, and timber. Root crops such as cassava, yams, and potatoes are also extensively cultivated.

3. The Savannah zone comprising the middle belt region including Kwara, Benue, Niger, Adamawa, and Taraba States. Main crops are cereals, roots, tubers, cotton and groundnuts.

4. The guinea savannah zone comprising the Southern parts of Sokoto, Kaduna, Katsina, Bauchi, and Borno states. Main crops are groundnuts, cotton, sorghum, millet, and rice.

5. The dry savannah which covers the northern parts of Kano, Bauchi and Borno States

with the most common crops being groundnuts, sorghum, millet, cowpeas and livestock (Fasoranti 2006; Sowunmi and Akintola 2009).

Efficiency levels including Technical Efficiency (TE), Allocative Efficiency (AE) and Economic Efficiency (EE) and productivity differ by crop, location, and cropping system. Discussions below provide available estimates of different measures of efficiency for all six socio- political regions. While there are exceptions, Nigerian farmers across all regions are below their production frontiers and consequently the opportunity exists to increase their productivity above existing levels, even given their current levels of inputs.

South West: Some studies report very high levels of efficiency given the available technology and input quality. For instance, Fasoranti's 2006 TE study of cassava farms in Ondo State revealed mean TE values ranging from 0.85 to 0.98, with the figures implying the superiority of mixed cropping in cassava production. AE values were similarly high, ranging from 0.82 (cassava sole cropping), to 0.93 (cassava plus maize). Oladeebo (2006) also estimated similarly impressive levels of efficiency in the production of rain-fed upland rice in Osun and Oyo states with mean TE and AE estimates of over 0.90 and mean EE levels of over 0.80 in both states. Levels of efficiency of these rice farmers were comparable to those derived in other settings for upland rice production (Oladeebo 2006). Adeyemo, Oke, and Akinola (2010) also reported high levels of technical efficiency by small scale cassava farmers in one local government in Ogun State. TE levels ranged from 0.86 to 1, with a mean of 0.89. However, there are other crops and settings for which efficiency could be greatly improved. Ajibefun (2003) provided efficiency estimates for small scale food crop

farmers in Ondo State for four different agricultural zones in Ondo State. Mean TE in Akure zone was 0.66, mean TE in Ondo zone was 0.56, mean TE in Akoko was 0.57, while mean TE in Owo zone was 0.61. He also provided values for the mean levels of AE, which were 0.71 (Akure zone), 0.60 (Ondo), while Akoko and Owo had 0.66 respectively. Mean values of economic efficiency were Akure (0.5), Ondo (0.35), Akoko (0.44), and Owo (0.42). The authors also computed values of the different efficiency components using non- parametric methods, specifically data envelope analysis, for comparison and derived similar results. Mean TE in Akure was (0.6), Ondo (0.53), Akoko (0.58), and Owo (0.59). Mean AE was Akure (0.66), Ondo (0.56), Akoko (0.61), and Owo (0.60). Combining the two measures to compute EE, mean EE ranged from 0.33 in Ondo to 0.44 in Akure. In Ekiti, Oluwatayo, Sekumade, and Adesoji (2008)'s study of maize farmers revealed a mean TE of 0.68. Oluwatosin (2011)'s study of yam farmers in Osun state reported TEs ranging from 0.343–0.962 with mean 0.698, while Ogunniyi (2011)'s study of leafy vegetable farmers in Oyo State produced a mean EE score of only 0.42.

North Central: Available studies in this region also reveal differences in estimated levels of efficiency by crop, cropping system, and location. Amos, Chikwendu, and Nmadu (2004) studied small scale food farmers in Niger State and revealed that the TE of sole maize cropping was 0.53 while the TE for yam/maize cropping was 0.72. Overall TE for all crops was 0.62. Mixed cropping was evidently superior to sole cropping, as over 50% of mixed crop farmers had TE values exceeding 0.70, compared to 100% of sole farmers who had TEs less than 0.60. Adejoh (2009) studied yam farmers in Kogi State and reported a TE of 0.73, while Ekunwe, Orewa and Emokaro (2008) reported a lower TE of 0.65 among yam farmers in Kogi. In this study, TE

values ranged from 0.2 to 0.95 and only 23 percent of farmers had TE greater than 0.8. Ojo *et al.* (2009) also studied yam farmers, this time in Niger state, and reported a TE ranging from 0.3 to 0.95 with a mean of 0.75. According to Shehu *et al.* (2010), the most technically efficient yam farmers in the North Central region are in Benue State, as estimated TE values ranged from 0.67 to 0.99 with average TE levels of 0.95. Finally, Otitoju and Arene's 2010 study of soybean farmers in Benue State revealed a mean TE of 0.73.

South South: Ebong, Ukoro, and Effiong (2009) in their study of food crop farmers in Akwa Ibom revealed TE values that ranged between 0.1 and 0.95 with mean of 0.81. Ekunwe, Orewa and Emokaro (2008) reported high average levels of TE for yam farmers in Delta State with a mean TE of 0.85 and about 80 percent of farmers with TE exceeding 0.8. Idiong, *et al*. (2009) also reported high mean levels of TE for rice farmers in Cross River. Mean TE was 0.7 for swamp rice and 0.87 for upland rice. Economic efficiency was, however, much lower, having values of 0.17 (swamp rice) and 0.22 (upland rice). Oviasogie (2005) examined the mean TE for four different cropping patterns of yam in Edo State. Mean TE for sole yam was 0.84, yam/maize mixture was 0.59, yam/groundnut mixture was 0.39, while mean TE for yam/maize/melon/cassava mixture was 0.24. TE reduced with the increase in the number of crops due largely to interaction effects for nutrients, water, and light among competing crops in the yam based cropping pattern. Idumah (2006) examined the impacts of pollution on efficiency of small food crop farmers in two states of the South South and found that pollution reduced TE and overall efficiency. TE with pollution was 0.78 compared to 0.88 in the absence of pollution, while EE with pollution was 0.68 compared to 0.72 for farmers who did not have polluted farmlands.

South East: Raphael's 2008 study of cassava farmers in the two South East states of Abia and Imo revealed a mean TE score of 0.77. A similar study of eggplant farmers in Abia state showed that mean TE was 0.78, while Onyenweaku and Ohajianya's 2009 study of rice farmers in Ebonyi State revealed a mean TE of 0.65.

North East: Available studies in this region reported very high levels of TE for cereals. For instance, Sheu and Msheila's 2007 study of rice farmers in Adamawa state revealed a TE of 0.96. Other studies of rice farmers in the same state revealed TEs of 0.96 (Sheu *et al*. 2007), and 0.89 (Amaza and Maurice 2005). In addition, Taru *et al*. (2011) reported a mean TE of 0.95 for cowpea farmers also in Adamawa State. The lowest TE from available studies in the region was for food crops in Borno State, with Amaza and Maurice (2005) reporting a mean TE of 0.68.

North West Fewer efficiency studies were available for this region. Ojo *et al*'s 2009 study of onion farmers in Sokoto revealed a TE of 0.95, while Usman *et al.*'s 2010

study of sesame farmers reported a much lower mean TE of 0.57. Finally, Tanko and Jirgi's 2008 study of arable crop farmers in Kebbi State revealed an overall AE of 0.59.

Table 2.2: Regional Technical, Allocative and Economic Efficiencies in crop production

Region	State	Crop	Cropping System	Location	T.E	A.E	E.E
South West	Ondo	Cassava	Mixed		0.85–0.98	0.82–0.93	-
	Osun/Oyo	Rice	Sole		0.90	0.90	0.80

	Ogun	Cassava	Sole		0.89	-	-
	Ondo	Food crops	-	Akure	0.66	0.71	0.50
				Zone			
				Owo	0.61	0.66	0.42
				Ondo	0.56	0.60	0.35
				Akoko	0.57	0.66	0.44
North central	Niger	Maize	Sole	-	0.53	-	-
		Yam/Maize	Mixed	-	0.72	-	-
		All crop	-	-	0.62	-	-
	Kogi	Yam	-	-	0.73	-	-
	Niger	Yam	-	-	0.65	-	-
	Benue	Yam	-	-	0.75	-	-
	Benue	Soybean	-	-	0.95	-	-
		Soybean	-	-	0.73	-	-
South-south	Akwa ibom	Food crops	-	-	0.81	-	-
	Delta	Yam	-	-	0.85	-	-
	Cross river	Rice(Swamp)	-	-	0.70		
		Rice(Upland)	-	-	0.87		

2.4 Concepts of Food Security and Insecurity

Food security at the individual, household, national, regional and global levels (is achieved) when all people, at all times have physical and economic access to sufficient,

safe and nutritious food to meet their needs and food preference for an active and healthy life (FAO, 2002).The term, has, however, gone through stages of definition and redefinition. According to Olaolu *et al*., (2013), approaches to the definition of the term have ranged from an emphasis on self-sufficiency to an emphasis on coping with vulnerability and risk in food and nutrition access. In the 1970s, food security was equated to adequate food production. In the 1980s, food security was considered to refer to the security of food access and availability. In the 1990s, the importance of nutrition was recognized, and hence the concept of food security was combined with that of nutrition security, in the 2000s, the concepts of food and nutrition security were integrated with vulnerability, risk coping, and risk management (Franz*et, al.*, 2004).

The main goal of food security, therefore, is for individuals to be able to obtain adequate food needed at all times, and to be able to utilize the food to meet the body's needs. Accordingly, the World Bank (2001) identified three pillars underpinning food security: food availability, food accessibility and food utilization. This concept infers that food security is not just a production issue. Food availability for a farm household means ensuring sufficient food is available for them through production. However, due to lack of adequate storage facility and pressing needs, the peasant farmers, mostly end up selling excess produce during harvest period, and sometimes rely on market purchase during the off-farm season. According to Capone et al (2014), food accessibility means there is the economic power to obtain food. Simply making food available and accessible.This can be increased by investing in complementary resources such as nutrition, education, health care, provision of water and better sanitation, instituting gender symmetry and removal of child abuse practices (Doppler, 2002). Food availability can be achieved when sufficient supply of appropriate quality of foods is

consisitently available to all individuals. Conclusively, therefore, food security is principally a function of availability, affordability (accessibility) and utilization of food in the right quality and time. FAO (2004) generated some indicators for these functions. For food availability, the indicators include among others:

(1) Dietary Energy Supply (DES) in Kcal/day per person.

(2) Share of cereals, roots and tubers in total dietary energy supply as a percentage of the total food available (a high percentage indicate a low diversity of the food supply)

(3) Availblility of cereals, total protein, fat, fruits, and vegetable per person

(4) Availability of animal protein per person.

For food accessibility,

(i) Percetage of householdspending 70% of their income (or total expenditure) on food.

(ii) Elasticity of food consumtion relative to income.

(iii) Percentage of households' income spent on food (or percentage of household food expenditure relative to total expenditure).

(iv) Percentage of population with income (or expenditure) below the level of absolute poverty below which minimum food of adequate nutritional quality and essential non-food goods are not economically accessible.

For food consumption,

(i) Number of meals per day

(ii) Percentage of households consuming less than two meals per day

2.4.1 Food insecurity and types in Nigeria

Food insecurityrepresents lack of access to enough food and can be either chronic or temporary. Food insecurity may be chronic or transitory. In chronic food insecurity, there is contonous inadequate diet and nutrition caused by household's inability to acquire food. It therefore afflicts households that persisitently lacks the abilty to either buy food or produce their own. On the other hand, transitory food insecurity results from a temporary decline in household access to food due mainly to inability in food prices, production, household income or a combination of these facors. In Africa, food insecurity remains a fundamental challenge and both cases of food insecurity abound often existing together and jointly, predisposing affected individuals to disease and reduced vigour, vitality and strength needed for physical tasks. The issue of food security is of high importance to Nigeria because; with an arable land area of 71.2 million hectares but with less than 34 million hectares under cultivation (FAO, 2005). She is among the counries in sub-saharan Africa experiencing significant food shortages and over 40 percent of the country's population is estimated to be critically food insecure (Idachaba, 2004).

2.4.2 Causes of food insecurity in Nigeria

Food insecurity exists when people are undernourished as a result of the physical unavailability of food, their lack of social or economic access to adequate food. Food insecure people are those whose food intake falls below their minimum energy requirements as well as those who exhibit physical symptoms caused by energy and nutrient deficiencies resulting from an inadequate or unbalanced diet or from the body‘s inability to use food effectively because of infection or disease. According to FAO (2010) food insecurity refers to the consequences of inadequate consumption of

nutritious food, considering the physiological use of food by the body asbeing within the domain of nutrition and health. Malnourishment also leads to poor health; hence individuals fail to provide for their families. If left unaddressed, hunger sets in motion an array of outcomes that perpetuate malnutrition, reduce ability of adults to work and to give birth to healthy children and erode children‘s ability to learn and lead productive healthy and happy lives. This truncation of human development undermines a country‘s potential for economic development for generationsto come.

Famine and hunger are both rooted in food insecurity. Food insecurity can be categorized as either chronic on transitory, chronic food insecurity translates into high degree of vulnerability to famine and hunger, ensuring food security presupposes the elimination of that vulnerability. Chronic insecurity is similar to undernourishment and is related to poverty existing mainly in poor countries. No problems can be solved unless its causes are known: therefore, knowing the causes of food insecurity will help us to locate the solutions. Discussing the causes of food insecurity in Nigeria is a very difficult task; this is because most Nigerians develop apathy towards locally produced food and prefer imported food which they consider as superior to domestically produced ones.The emergence of oil sector and the substantial revenue accruing from the sector shifted emphasis from agriculture to the extent that even domestic food production is not given the desired requirement. The government felt that it was better to import food than to embark on local production, especially when oil money has changed the tastes of most Nigeria in favour of foreign imported goods. The above reasons notwithstanding, the causes of food insecurity in Nigeria can be discussed under the following:

1. Genderinequality

Gender inequality is a major cause of hunger and poverty. Food security can be a major concern for people who are incapable of or denied access to participation in labour - formal, informal or agricultural. In 2009, the UN estimated that 60 percent of the world‘s chronically hungry people are women and girls, 98% of which live in developing nations, when women have income, substantial evidence indicates that the income is more likely to be spent on food and children‘s needs. Women are generallyresponsible for food selection and preparation and for the care and feeding of children. Women play many roles in land use, production, distribution, processing, marketingaccessing, and trading and food availability. They often work asunpaid and self-employed workers on and off farm employees, entrepreneurs, traders, providers of services and caretakers of children and elderly, women farmers represent more than a quarter of the world population, comprising on average 43 percent of the agricultural workforces, ranging from 20 percent in Latin America to 50 percent in Asia and sub-Saharan Africa. However, women have less access than men to agricultural assets, inputs and service. Analysts suggest that if women have the same access to productive resources as men, women would have boost yield by 20 –30 percent, raising the overall agricultural output in developing countries by two and half to four percent. This gain in production could lessen the number of hungry people in the world. Reducinggender inequality and recognizing the contribution of women to agriculture is critical to achieving global food security, there is consistent and compelling evidence that when the status of women is improved, agricultural productivity increases, poverty is reduced and nutrition improves.(DFRRI) have contributed to low agricultural and food productivity inNigeria.

2. Poverty and hunger

Poverty and hunger prevent people from working hard to increase productivity. Food and agricultural productivity is both capital and labour intensive. Unfortunately, it is the poor peasant farmers that produce the bulk of food needs in Nigeria, due to their level of poverty, they find it very difficult to learn, work and care for themselves and their family members, let alone getting the necessary inputs and energy to produce for others. Apart from the inconsistence in policies most of these policies are neo-liberal which work against the interest of the domestic economy such as the devaluation of naira which made the importation of farm inputs very difficult and out of the reach of peasant farmers.

3. Conflicts

The ethnic or religious conflicts have devastating effects on the economic activities especially food production in the areas that they take place. Conflicts here do not necessarily mean physical fighting of wars. It means a disarticulated country or society that is experiencing structural violence without official declaration of war such as pervasive poverty, oppression of the poor by the rich, police brutality, intimidation of ordinary people by those in power, oppression of women and children and monopolization of resources and power by some sections of the society. It will be wrong to say there is peace in such a country like Nigeria where Boko Haram and other sects are threatening the unity of the country. Consequently, it is quite possible not to have peace even when there is no war (Oke Ibeanu, 2009).

4. **Natural disasters**

Frequent climate changes leading to shortage of rainfall and persist drought in Northern part of the country and excessive rainfall and flood in southern and middle belt regions of the country contributed immensely to low food production in Nigeria.

5. Low level of technology, low agricultural financing and rural-urban migration pose serious threat to food production in Nigeria.

2.4.3 Methods food security measurement

The measurement of food security, an important dimension of wellbeing has been approached by diverse methodologies by different researchers. As a matter of fact, no single method has been agreed on by researchers however, they all seem to have similar objectives. According to Hoddinott and Yohannes (2002), the various methods of food security measures seek to address one or all of the following: identify the food insecure; characterize the nature of their insecurity; monitor changes in their circumstances and assess the impact of interventions. In this section, different methods of food security measures have been reviewed with their strength and weaknesses.

Dietary Diversity: This method of food security measure uses the number of different food or food groups consumed over a given reference period as an indicator security under a variety of circumstances, including poor and middle-income countries, rural and urban areas and across seasons (Hoddinott and Yohannes, 2002). It is a qualitative measure of food consumption that reflects household access to variety of foods and is also a proxy for nutrient adequacy of the diets of individuals (Kennedy, Ballard and Dop, 2010). According to Hoddinott and Yohannes (2002), its strength is that respondents find the questions straight forward and non-demanding on time or recall to

answer. Also, its instrumentation represents a rapid, user friendly, and easily administered, low-cost assessment tool (Kennedy, Ballard and Dop, 2010). Dietary diversity measure of food security reflects nutrients adequacy and the economic ability of a household to access a variety of food in fact, it has been reported that there is a direct relationship between dietary diversity score and nutrient adequacy (Kennedy, Ballard and Dop, 2010). Hoddinott and Yohannes (2002) noted that it increase in Dietary Diversity is associated with socio-economic status and household food security. However, if the data thus collected is to be used to create an alternative measure, it is necessary to show a strong correlation with more traditional measures of food security. Despite this weakness, Swindale and Bilinsky (2006) have referred to Household Diversity has been adjudged an attractive proxy indicator of food security based on the following reasons:

(i) A more diversified diet is an important outcome in and of itself,

(ii) A more diversified diet is highly correlated with such with such factors as caloric and protein adequacy, percentage of protein from animals (high quality protein) sources and household income,

(iii) Questions on dietary diversity can be asked at the household or individual level making it possible to examine food security at the household and intra-household levels.

(iv) Rashid, Smith and Rahman (2006) added that the Dietary quality measure can be carried out using the daily household protein availability per adult equivalent (in which an adult is defined as a male between 30 and 60 years of the reference category). In constructing this measure, the cleared metric quantities of foods acquired by households were multiplied by the food's protein value, which was

then multiplied by the food's edible proportion, which is finally divided by the number of days in the reference period and the number of adult equivalents.

Cost of Calories (COC): In this method of food security measure, the cost of buying the minimum calorie intake is used to establish a food security line which is used to classify respondents as food secure or food insecure (Amaza, Umeh, Helsen and Adejobi, 2006). According to Ojogho (2010), it satisfies the monotonicity axiom, focus axiom, symmetry axiom, transitivity axiom and decomposability by population sub group.

Caloric intake Estimation: In this method, according to Orewa and Iyanbe (2010), questions on food consumed the previous day and the day after on information such as the types of food and the quantity consumed per meal per day are asked. The data gathered from such information are then used. The calorific content in each food item consumed are then used in estimating the proportion in the total food intake. The complexity of this method of measure makes it a little difficult in useage.

Food Security Index (FSI): This way of measuring food security involves the construction of a food security index. In studies like Omotesho *et al*(2006), the construction of the index involves two steps. The first one is identification which is the process of defining the minimum level of nutrition necessary to maintain healthy living. This is the food security line. The second step is aggregation which derives food security statistics for the household. As observed, using the method of Food security Index also incorporates the use of daily calorie consumption. The following equation is used in estimating the food security index.

$$Food\ Security\ Index = \frac{Household\ per\ capita\ calorie\ availability}{Household's\ daily\ per\ capita\ calorie\ requirement}$$

Other Methods: There are other methods that have been used to measure food security. Nanama and Souli (2007) did comparism between the Months of Adequate Household Food Provisioning (MAHFP) and FANTA/Cornell methods a joint design of the Food and Nutrition Technical Assistance (FANTA) and the Cornell University Division of Nutritional Sciences. The MAHFP was developed in the late 90's as a tool for identifying vulnerable groups and measuring the impacts of a project on increasing or decreasing the number of people classified in the most vulnerable groups. FANTA/Cornell, a questionnaire based method was also used for the same project. Nanama and Souli (2007) reviewed that even though the FANTA/Cornell method provides a more structured systematic mechanism for learning about the quantitative and qualitative aspects of food security, it has a setback in that it is biased in that it elicits information from the household heads (most times males) which often are not fully aware of the survival strategies adopted. One advantage of the FANTA/Cornell method again is that it has the capacity to highlight the special needs and concerns of the most severely food insecure group. The major weakness of the MAHFP is that as it requires women to estimate the quantity of food intake, there was no uniformity in the units of measurements which brought a major bias.

Head Count Method is another method of food security measures that have been used. It measures the percentage of the households that are food insecure. When calculated, it provides an index called the food insecurity index that is obtained by estimating the percentage of the food insecure households under study (Idrisa, Gwary and Shehu, 2008). When used along with the food insecurity gap (FIG), the depth of food insecurity

could be measured. The FAO method for measuring food depravation and is based on a comparison of energy requirement norms with usual food consumption and is expressed in terms of dietary energy (Cunningham, 2005). One of the ways it is measured is the use of the Body Mass Index (BMI) which is used to determine the height to weight relationship. It is assumed that the underweighted individuals are food insecure. The BMI is the ratio of weight (Kg) to Height (square meters) those with BMI> 18.5 are considered to have adequate energy reserves (Cunningham, 2005).

2.4.4 Generalsolutions to the problems of food insecurity in Nigeria

It is widely accepted that Nigeria is not a poor country except that it has been poorly managed by those entrusted with its development. It is also widely accepted that Nigeria is rich enough to feed herself and the rest of Africa. The major hindrance to this are:

1. The ethnic and religious conflicts which claimed many lives and the destruction of food crops with able men and women staying in refugee camps for two or three years.

2. Those who rule Nigeria do not believe in Nigeria because of that they lack political will and patriotic zeal to deal with the problem of food insecurity in Nigeria; hence they adopt all forms of neo-liberal economic policies recommended by the World Bank and IMF for personal profits.

These are the man made problems, so that if properly addressed sanity will return and people‘s confidence in food production will be restored. The other solution to food insecurity lies with paying attention to the natural disasters such as flood, drought and pest control. Fortunately, we are going to have new generation of leaders who will have faith in Nigeria and strongly believe that Nigeria must take

responsibility for its own destiny, that Nigeria will uplift herself only by her own efforts in partnership with those who wish her well (Otaha 2013).

3. *Food storage policy:* It should be emphasized that food insecurity problem in Nigeria may not be solved through the maintenance of large silos of grain reserves across the country. In recent months, government has reportedly released thousands of metric tons of grains from the National Strategic Food Reserve to bring down food prices, yet food prices have remained largely unchanged. In other words, the effects of the grains released are yet to be felt. Also to note is the inefficiency and corruption associated with government business and the difficult logistic problems of opening and maintaining the system of buying, transporting, storing and release of grains, the program may soon turn into another drain pipe. The food insecurity problem may be better addressed through a food storage policy that place emphasis on small scale food storage operations by farmers at the farm levels, and by traders/processors for sustainable development.
4. *Mechanization and Food Production Policy:* The vast majority of Nigerians are small holders and as such to put it point blank, there is yet no agricultural mechanization policy in Nigeria. No wonder, according to Wainana (1990), the Nigerian agricultural sector remains an industry of inherent toilage, indigence, a world of drudgery for losers peopled by aged and ageing Nigerian, shunned and despised by Nigerian youths who regard the peasant farmers today as dreadful-anachronism. Furthermore, Odigboh, (2000) indicated that this state of affairs has persisted apparently because of faulty mechanization policies; there is over dependence on foreign or alien ideas and advice and almost exclusive reliance on imported machines and equipment. To succeed, the mechanization of Nigerian

agriculture must be based largely on indigenous engineering initiative, thus, the slogan: appropriate technology comes to play for sustainable development and reduction of food insecurity in Nigeria.

5. *Food Importation Policy:* In the case of food importation, capital which could have been conserved or accumulated for reinvestment in the Nigerian economy to further produce more goods and services or develop more social infrastructure is fritted away on food importation. It is therefore important to alert policy-makers of the great harm inflicted on the national economy by the liberal import and spendthrift policies. Rice importation for instance, dealt a heavy or killer blow to the farms and farmers in Okpoma, Ogoja, and Abakaliki and exposes our poor farmers to uncertainties bearing in mind the issue of balance of trade. Therefore, to solve the food insecurity problems confronting the nation, there is an urgent need to reverse this policy in order to encourage local food production, thus making food available and accessible by all Nigerians.

6. *Agricultural Research Policy:*the significance and impact of research on agricultural development in Nigeria would appear to be little , in view of the fact that farmers' yields are generally still far below yields obtained under experimental conditions in the research stations. Lack of enabling environment has been the failure to create the desirable complimentarity between agricultural research system and extension system. Today, research findings are left to gather dust on the shelves in research laboratories instead of getting to farmers. In other words, inadequate funding and staffing and poor coordination of research activities is the order of the day. It is on this note that asserted that government policies and agricultural development efforts should focus on small holder in Nigeria. The policy of establishing research

institutes without adequate funding arrangement does not augur well with the situation of food in the country while it is difficult to properly conceptualize the nature of food security in Nigeria, a wide variety of measures have been utilized in an attempt to begin to quantify its scope. In this section, trends in the evolution of definitions of food security are explained, while the state of food security in the country is assessed based on the four broad categories food security measures, namely food availability, food access, stability of access, as well as food utilization. Food security is a multidimensional concept that has evolved over time and space. Concern about food security originated in the mid-1970s due to the international food problems that emerged as part of a larger global economic crisis. The initial food security focus was macroeconomic in nature and was mainly concerned with assuring the availability and price stability of foodstuffs at the international and national levels. Consequently, food security was traditionally measured through aggregate food supplies, food availability, accessibility, and adequacy (FAO 2003a and FAO 2003b). In addition to economic factors, the preponderance of drought and famine in some developing regions of the world led to further rethinking and refinement of the concept. His contribution extended the concept beyond mere availability of food in the macro sense to considerations of the constraints on individual access to food (Webb *et al.* 2006).

2.4.5 Empiricalevidence of food security in Nigeria

Food security in Nigeria The acknowledgement of the importance of food security as a concept has led to the development of a growing robust literature devoted to the topic. Most of the available studies are not nationally representative, but are instead regional

in nature. However, they provide an excellent overview of the causes, incidence, and methods of measuring food insecurity in different regions in Nigeria in the recent past.

Determinants of food security Food security and agricultural productivity are closely related in a country like Nigeria with a very large rural and agrarian population. Therefore, factors that affect the agricultural industry also have direct impacts on food security. In Nigeria, the following factors were identified as inhibiting food security, in seven different categories and include:

(1) land and water related factors such as pollution, desertification, and erosion (Akinyosoye 2000; Adejoh 2009; Idumah 2006),

(2) climatic factors, particularly climate change leading to adverse and inconsistent weather patterns (Adewuyi 2002; Egwuda 2001),

(3) agronomic factors mainly related to the scarcity and high cost of quality inputs (Egwuda 2001; Ojo,2005; Adejoh 2009; Peke 2008),

(4) farm management factors which emphasize the production technologies as well as the relevance of cropping patterns used for particular crops (Adewuyi 2002; Oseni 2001),

(5) factors related to poor supporting Infrastructure including inadequate storage and marketing facilities, inadequate extension services, poorly organized rural input, output and financial markets, and substandard rural infrastructure including poor feeder roads and limited access to clean potable water, good health services, electricity, telephone and educational facilities (Fasoranti, 2006; Okafor, 2004, Adewuyi and Okunmadewa, 2001; Yusuf,*et al*. 2009; Peke, 2008; Adewuyi, 2006; Adejoh, 2009), and

(6) Policy related factors where poorly conceived, poorly funded and inconsistent government policy add another layer of constraints to the agricultural industry and reduce the productivity of poor farmers (Adewuyi, 2002; Okafor, 2004). A related macro factor is trade liberalization because globalization makes it difficult for developing countries to develop an appropriate apparatus for equitable food production and distribution (Usman and Ijaiya, 2010). The socioeconomic factors identified as impacting agricultural productivity in Nigeria are the attributes that make small scale farmers ill-equipped to deal with the demands of modern farming (Ogunsanya, 2009; Ajani, 2000; Akintayo, 2011; Oladeebo, 2006; Fasoranti, 2006; Ajibolade, 2005; Peke, 2008; Fanegan, 2010; Adeyemo, Oke, and Akinola, 2010; Oluwatayo, Sekumade, and Adesoji, 2008). There are, however, other socioeconomic attributes identified in the literature that lead to increases in food insecurity. Household size is important because it increases the number of consumers putting pressure on household resources particularly food (Ayantoye, 2009; Ibrahim,*et al*. 2009; Agbola, 2005), and households with a high dependency ratio are particularly prone to food insecurity (Ayantoye, 2009). In addition, households with farming as a primary occupation and with many years of farming experience are also more likely to be food insecure, as most rural farmers are subsistence or semi subsistence farmers with low incomes. Despite being food producers, their productivities are so low that they can barely feed their families (Ayantoye, 2009). Other characteristics of households that experience food insecurity include households with older heads, male headed households, as well as farm households that experienced food shortages prior to harvest (Ayantoye, 2009; Agbola, 2005). Factors that have been found to provide a buffer against food insecurity include the education level of the household head, the size of the

farm (households with larger farms are more food secure) (Ayantoye, 2009; Ibrahim,*et al*. 2009), as well as remittances received from relatives working in other towns and cities (Agbola, 2005; Ayantoye, 2009; Ibrahim,*et al.* 2009).

2.5 TheImportance of Root and Tuber Crops in Developing- Country Food Systems

Most crops use for human food, animal feed, religious and traditional ceremonial events in Sub-Saharan Africa centre on root and tuber crops. These crops comprise yams, cassava,sweetpotato,cocoyam,ginger and irish potato.Accordingto Eke-Okoro(2011),root crops are the arable energy-rich underground plant structures developed from modified roots while tuber cropsare thosecrops in which the edible energy-rich storage organsdevelopwhollyor partly from underground stems.Thus, the storage organ of root crops is of root originwhile that of tuber crops is of stem origin. The major root crops are cassava and sweet potatoes while themajor tuber crops are yam cocoyam, potato andginger.These crops are important for food and non-food uses and most of them are grown in every statein Nigeria.They are eaten as staple food in some rural areas and are marketedbothin local and urbanmarkets.Most of our rural farmers anchored their livelihoods on the production, processing and marketing of these crops. The crops can be processed into various food forms, while some are used in industries and confectionaries for manufacturing of industrial products.

The productivity and growth rate of root and Tuber crops in Africa and Nigeria especially has been increasing tremendously for the past two and half decades, although such increase has not been meeting with the rising food demand due to high population pressure and poor infrastructural facilities to accelerate processing into food forms.

Contributors to this trend in food production include the root and tuber crops sector with increasing annual output and growth rates. Food and Agriculture organization (FAO, 2009) estimated a yearly output of 45 million metric tons for cassava, 32 million metric tons for yam, 1.3 million metric tons for sweet potato, 0.731 million metric tons for potato, 5.0 million metric tons for cocoyam and 0.223 million metric tons for ginger in Nigeria. Growth rate of root and tuber crops shows some upward improvement, as shown below.

Table 2.1: Mean annual outputs in million metric tonns and growth rates of some root and tuber crops

Year	**Cassava annual output (MMT)**	**Growth rate (%)**	**Yam annual output (MMT)**	**Growt rate (%)**	**Irishpot atoannu aloutput (MMT)**	**Growt rate (%)**	**Cocoyam annual output (MMT)**	**Growtr ate (%)**
1975-79	1766	10.8	6518	11.2	102	4.7	1696	13.5
1980-84	2724	10.8	4998	1.7	183	3.8	1187	6.0
1985-89	14542	80.8	6715	19.5	228	3.6	2292	9.64
1990-96	20784	6.1	18263	16.6	557	20.6	7247	30.85
1997-98	34092	2.4	25102	2.1	105	3.9	1450	6.5
2009-11	45000	-	32000	-	-	-	5000	-

Source: ATA,(2012), and FAO, (2010).

Production and growth rates of some root and tuber crops in the past 25 to 30 years ago were drawn by expansion in cultivated area rather than yields. Currently, both production and growth rate of cassava, yam, sweetpotato, potato, cocoyam and ginger have expanded in areas cultivated and also yields due to innovation in technologies

resulting in high yielding, pest and disease tolerant varieties of root and tuber crops. The result of the National survey conducted by the Central Bank of Nigeria (CBN) showed that the increase recorded in agricultural production during the estimated period was attributable largely to sustained government support for the agricultural sectors (CBN, 2004). The subsidy on the supply of fertilizer and other inputs was maintained. Purchases under the strategic grain reserve programme shored up prices and reduced price fluctuations, thereby sustaining farmer's confidence. The reconstruction activities and the building of new dams also encouraged increased land-space for farming activities.

The economic importance of root and tuber crops in the overall economy of the sub-Sahara countries cannot be overemphasized. Yam, cassava, potato, ginger, cocoyam, sweet potato, and minor root and tuber crops (Arrow root, turmeric, sugar beet, risga, etc.) play vital roles in the food basket of Nigerians. Apart from being principal food sources, they constitute the single most important occupational group in Nigeria. IDA (2009) reported that 70% of the Nigerian population was engaged in Agriculture, forestry and fishing. Root and tuber crops generate income for Nigeria. Food crops such as cassava and yam contribute about 40% of household income with the recent development and release of Provitamin A cassava varieties, TMS 03/1368, 1371, 1412 and NRCRI, 2011. Nutritional status of resource poor farmers are bound to improve with increased consumption of these provitamin A cassava varieties and malnutrition rate is bound to slow down in Nigeria.

Root and Tuber crop are important to Nigeria' economy. Yam and cassava are the two major root and tuber crops in Nigeria, with cassava's contribution to the GDP increasing from ₦86Billion in 2008 to about ₦110Billion in 2012, while yam's contribution to

GDP was 27.22 percent in 2011; (NBS, 2011; Philip,*et al*., 2014). The total area planted to cassava increased from 2415.7 hectares in 1999 to 3,289.6 hectares in 2007, yams from 2001.76 hectares in 1999 to 2353.50 hectares in 2007, cocoyam from 249.69 hectares in 1999 to 3120.39 hectares in 2007, sweet potato from 180.52 hectares in 1999 to 291.39 hectares in 2007 and irish potato from 76.52 hectares in 1999 to 291.19 Hectares in 2007. Cassava production increased from 28,686.10 metric tonnes in 1999 to 41,656.47 metric tonnes in 2007, yam from 23,021.71 metric tonnes in 1999 to 30,196.16 metric tonnes in 2007, cocoyam from 2,626.63metric tonnes in 1999 to 3,120.39 metric tonnes in 2007, sweet potato from 1,163.29 metric tonnes in 1999 to 1,984.58 metric tonnes in 2007 and irish potato from 446.37 metric tonnes in 1999 to 1202.17 in 2007(Azih, 2008). According to Anyanwu *et al.,* (2010) reported that there is a strong positive correlation between the root and tuber crops and gross domestic product (GDP). This implies that increases in the output of these crops will lead to increases in the GDP. While the correlation between GDP and yams, cocoyam and potato is statistically significant at 1 percent level of probability, that of cassava is statistically significant at 5 percent (Anyawu *et al*., 2010).This means that these root crops are statistically significant determinants of the GDP in Nigeria.

Table 2.2 : Contribution of root and tuber crops to the GDP and production.

	Contribution to GDP				**Land area cultivation to crop**			
Crop	**Year**	**Amount/ %**	**Year**	**Amount / %**	**Year**	**Ha**	**Year**	**Ha**
Cassava	2008	86 Billion	2011	110 Billion	1999	2415.7	2007	3289.6
Yam			,,	27.22%	,,	2001.76	,,	2353.5
Cocoyam					,,	249.69	,,	3120.39
Sweet potato					,,	180.92	,,	291.39
Irish potato					,,	76.52	,,	291.19

Production figures in metric tonnes

Cassava	,,	28,686.1	,,	41,656.47
Yam	,,	23,021.71	,,	30,196.16
Cocoyam	,,	2,626.63	,,	3,120.39
Sweet potato	,,	1,163	,,	1,984.58
Irish potato	,,	446	,,	1,202.17

Nigeria, in her fifty years as an independent nation has witnessed the birth and death of several notable Agricultural programmes fashioned to develop Agriculture, reduce rural poverty and earn foreign exchange. A few of these programmes made positive impact to the economy while others could not. To boost food production, some of the introduced programmes included the following (Obiechina, 2003): National Accelerated Food Production Programme (NAFPP) in 1972, Operation Feed the Nation (OFN) in 1975, Agricultural Credit Guarantee Scheme (ACGS) in 1977, River Basin Development Authority RBDA in 1978, Green Revolution (GR) in 1980, National Directorate of Employment (NDE) in 1986, Rural Agro-Industrial Scheme (RAIDS) in 1990, Directorate of Food, Roads and Rural infrastructure (DFRRI) in 1986, Nigeria Agricultural Credit Bank (NACD) in 1973, National Agricultural Land Development Authority (NALDA) in 1991, AgriculturalProjects Monitoring and Evaluation Unit (AMPEU) in 1984, National Tree Crops Development Unit NTCAU, in 1984, Agricultural Development Programme (ADP) in 1975, Nigerian Agriculture Insurance Co-operation (NAIC) in 1990, National Accelerated Industrial Crops programme (NAICP) in 1981, Special Rice Programme (SRP) 1997, Agricultural Research Council of Nigeria 2007, Sasakawa Global (SG) 2000, Universities of Agriculture, and Agricultural Transformation Agenda 2011.

In early years of Nigerian independence, cash crops such as Cocoa, Rubber, Cashew, Groundnut, Oil palm etc, were major crop where the economy revolved, but today there is a shift to alternatives for biofuel, pharmaceutical starch and derivatives using root and tuber crops. However, the young Agricultural Transformation Agenda Programme rests its oasis on the fortunes of root and tuber crops. Root and tuber crops have continued to play a significant role in the Agricultural production and revolution in Nigeria. Nigeria is the largest producer of most of the root and tuber crops in the world with a yearly output of 45 million metric tons for cassava, 32 million metric tons for yam, 1.3 million metric tons for sweet potato, 0.731 million metric tons for potato, 5.0 million metric tons for cocoyam and 0.223 million metric ton for ginger. The growth rates of root and tuber crops show some upward improvement of between 2 to 80% from 1975 to 2011 (FAO, 2009). It is obvious from the above estimates that the resource for the Agricultural Transformation Agenda could be found extensively in root and tuber crops. The primary objective of the Transformation Agenda with respect to root and tuber crops is mainly to engineer bulk of the root and tuber crops in the country into value-added products to match the increasing new tastes and individual needs for root and tuber crops products. Nigeria produces root and tuber crops in large quantities. Ninety-five percent of what is produced is consumed internally in limited value forms; hence Nigeria continues to import starch, flour, sweeteners and adhesives that can be made from root and tuber crops. The above scenario limits the propensity of Nigeria to export and compete in products markets in the world. The strategy of the Agricultural Transformation is to turn the root and tuber crops sector in Nigeria into a major player in both local and international starch sweetener, ethanol, high Quality cassava flour, high quality starch and chips markets by adopting improved production and processing

technologies. This will stimulate new food firm along the value chain, reduce drudgery in production, and stimulate commercialization and marketing. This is assured by the development of new varieties of root and tuber crop especially cassava and yam. The new varieties of root and tuber crop including the recently released Pro -vitamin A cassava, early maturing, enhanced starch and high quality flour varietieswill automatically expand the tempo of the transformation Agenda. The new varieties of root and tuber crops have high yields. This inherent high yields will definitely assist in meeting the volume of raw materials needed to transform and make the industries produce at full capacity. The potentials of root and tuber crops in the Agricultural transformation Agenda cannot be over- emphasized. Root and tuber crops have the complimentary capacity to key into the existing government action plan of diversifying the economy of Nigeria. This will drive the economy into multiple facet economy in addition to petroleum resources.

2.6 The Nature and Concepts of Poverty in Nigeria

Meaning and Measurement of Poverty

Poverty can be defined as lack of material well-being, insecurity, social isolation, psychological distress, lack of freedom of choice and action, unpredictability, lack of long-term planning horizons because the poor cannot see how to survive in the present, low self confidence and not believingin one self (Narayan 2000) Sengupta (2003) defined poverty as not only an insufficient income to buy a minimum basket of goods and services but as the lack of basic capabilities to live in dignity. This definition recognizes poverty's broader features, such as hunger, poor education, discrimination,vulnerability and social exclusion. In the light of the International Bill of

Rights, poverty is defined as a human condition characterized by sustained or chronic deprivation of the resources, capabilities,choices, security and power necessary for the enjoyment of an adequate standardof living and other civil, cultural, economic, political and social rights (see also UN 2001; and Hunt, *et.al* 2004). As observed by Kankwanda, et.al (2000) poverty is either absolute or relative or both. Absolute poverty being that which could be applied at all time in all societies, such as the level of income necessary for bare subsistence, while relative poverty relates to the living standard of the poor to the standards that prevail elsewhere in the society in which they live. Related to the definition of poverty are the measurements of poverty whose importance is to know who is poor, how many people are poor, and where the poor are located. According to Foster, et.al (1984), the most frequently used measurements are:

(i) the head count poverty index given by the percentage of the population that live in the household with a consumption per capita less than the poverty line;

(ii) (ii) poverty gap index which reflects the depth of poverty by taking into account how far the average poor persons' income is from the poverty line; and

(iii) the distributionally sensitive measure of squared poverty gap defined as the means of the squared proportionate poverty gap which reflects the severity of poverty. Studies by UNDP also advocate the use of Human Development Index (HDI) and Capability Poverty Measure (CPM). According to UNDP (various issues) HDI combines three components in the measure of poverty which include: longevity as measured by life expectancy at birth; educational attainment as measured by a combination of adult literacy (two-thirds weight) and combined primary, secondary and tertiary enrolment ratios (one-third weight); and improvement in standard of living as measured by real GDP per capita income (PPP$). The first relates to survival vulnerability to death at a relatively early age. The second relatesto knowledge – being excluded from the world of

reading and communication. The third relates to a decent living standard in terms of overall economic provisioning. On the other hand, CPM focuses on the average state of peoples' capabilities by reflecting on the percentage of people who lack basic or minimally essential human capabilities that are ends in themselves, needed to lift one from income poverty and sustain strong human development.

Poverty is a general phenomenon as old as human history in Nigeria, it is a common status which cannot be easily wiped off except available basic needs and resources are acquired and evenly distributed among the citizens to alleviate their Poverty which requires some concerted efforts by the government and individuals to shift the status to a more positive direction in nature Olaitan, (2000). Olaitan, (2000) further stated that Nigerians in the early times regard poor people as those who are unable to take up wedding, manage large families and own domestic animals like Goats, Cattles, and Poultry etc.Olaitan *et al.* (2000) also asserts that these are attributes or layers of status or wealth on which individuals worshipped as wealth. At present, modern development recognizes these attributes to be of short span with low materials and sustainable value when human needs are in question; that is, if somebody at present marry many wives and Children without work or habitable houses commensurate to the large families or important means of transportation, good education for the Children and so on is still regarded as poor.

Poverty in Nigeria is essentially a rural phenomenon—the majority of those in poverty are disproportionately located in the rural areas, where they are primarily engaged in agricultural production and allied activities. NBS (2007) revealed that rural poverty incidence increased by 22 percent points in the period 1980-1985 (from 29.3 percent to

51.4 percent), decreased slightly during the period 1985- 1992 from (51.4 percent to 46.1 percent) but soared by 23 percent in the following four-year period 1992-1996 (from 46.1 percent to 69.8 percent). However, in the period 1996-2004, rural poverty incidence decreased from 69.8 percent to 63.8 percent. On the other hand, urban poverty incidence stood at 17.2 percent in 1980 but rose to 37.8 percent in 1985 and remained relatively stable up to 1992 from where it rose to 58.2 percent in 1996 and again dropped to 43.1 percent in 2004.

2.6.1 The causes ofpoverty

Obadan (2003) identified some factors as the causes of poverty.These included inadequate access to employment opportunities, inadequate physical assets, inadequate access to markets, destruction of natural resources, lack of power to participate in design of development programmes and inadequate access to assistance for those living at the margin. The CBN (1999) summarized the causative causes of poverty as;

(i) **The stage of economic and social development:** Even when a country's export earnings might be abundant, a situation of economic under-development might pose a management constraint on absorbtive capacity or use of funds for development projects which are either not available or properly targeted.

(ii) **Low productivity:** In this case, the consuming unit (individual households) is unable to earn enough income which will enable them to maintain adequate living standards. This would result from the low utilization or low acquisition of human skills due to low education, poor health or physical incapacity and inadequate access to productive assets. This leads to unemployment.

(iii) **Market imperfections:** These are factors which through institutional distortions, would not allow equal access to productive assets and introduce forms of discrimination that prevent the advancement of people. These factors could arise from ignorance, culture, sex, age, race and so forth. Market imperfections also arise from distortions in the umemployment market and skewed income distribution structure that favours some classes in the society and the less favoured class poorer.

(iv) **Structural shift in the economy:** This result from inadequate macroecononmic management policies in which undue concentration is given to a particular sector of the economy to almost total neglect of others. In Nigeria's case, from independence (1960 – 1970), her major export commodities were cocoa, palm produce, rubber and groundnut (agricultural goods) which provided jobs for the rural poor. But by 1971, Nigeria's structural shift occurred in favour of crude oil, due to its greater foreign exchange earnings. As such, the country became a mono-export country, such that agriculture suffered a setback and mass poverty became the lot of the rural farmers, and rural labour had to seek for alternative jobs in the urban cities.

(v) **Political instability:** The failure to successfully actualize political transition programmes result in social and economic unrest domestically and internationally. Productive ventures were unable to flourish with restricted outputs and market for sales, investments are withdrawn, jobs are insecure, and the general citizenry faces economic insecurity.

(vi) **Corruption:** in an attempt to measure corruption, a non-governmental organization. Transparency international, developed the perception of corruption in the world wich placed countries on a scale of 1 – 10, where a score of 10

implies that a country is free of corruption, and a score of 1 implies that a country is completely corrupt.

2.6.2 Characteristics of poverty

1. **Low income:** When the income per individual is low, the country is below poverty line. Nigeria is poor because the standard of living by the citizens is pegged at ₦300 a day Olaitan, (2004). This shows that the greater percentage of Nigerians have low standard of living beyond the datum or benchmark of U.S $1 per day. Hence, the degree of poverty is enormous Olaitan, (2004).

2. **Large family size:** The decision to have many children can be a poverty indicator because large family size is an attribute of low income per capita in a population. Large family size facilitates ill health, malnutrition, illiteracy, high dropout rate as a result of low level of education Olaitan, (2004).

3. **Low level of productivity:** It is generally evident that productivity connotes efficiency and where there is shortage of complementary factors like infrastructure, management and efficient administration Olaitan, (2003). Olaitan further assert that Other cases are the use of primitive implement, high illiteracy rate among the Citizens, lack of appropriate training, low motivation, and poor attitude to work and so on Olaitan, (2003).

4. **Political instability:** Constant changes in government without democratic system results in serious political instability. Most importantly there is a striking evidence of unequal distribution of the economy and earnings and this gives rise to poverty Olaitan, (2003).

5. **High dependence:** Inability to generate a commensurate income for the poor except from the magnanimity of the rich to assist through aids in order to eradicate poverty –so that the rich produce more for their sustenance (Olaitan *et al*, 2003).

The poverty experienced by Nigerians is pervasive, multifaceted, and chronic, affecting the livesof a large proportion of the populace. The Nigerian situation presents a paradox because thecountry is rich but the people are poor. This has been captioned, 'poverty in the midst of plenty'by the World Bank (World Bank, 1996). The incidence of poverty in Nigeria has been on theincrease since 1980. The National Bureau of Statistics (NBS, 2007) revealed that theincidence of poverty increased sharply both between 1980 and 1985 (from 28.1 percent to 46.3percent) and between 1992 and 1996 (from 42.7 percent to 65.6 percent) though there weredeclines between 1985 and 1992 (from 46.3 percent to 42.7 percent) and between 1996 and2004 (from 65.6 percent to 54.4 percent). However, while the poverty incidence reduced from 65.6percent in 1996 to 54.4 percent in 2004, the number of poor people increased fromabout 67 million people to about 70 million people. The reasons for the increased poverty incidence between 1980 and 1985 were multiple. According to World Bank (2001), these reasons include:the falling oil revenue arising from sharp decreases in the international price of oil,coupled with decreased production—oil revenue crashed from US$26 billion in 1980to US$6 billion in 1986;the Nigerian government seeing these declines as temporary and continuing toborrow externally against the expectations of a return of higher oil prices, resulting indebt overhang; andthe slow, even negative, growth in the economy, especially in agriculture, whichresulted from government policies that induced adverse relative price changes, encouraged imports, including food, thereby stifling nonoil production.

The decline in poverty incidence between 1985 and 1992 was the product of the Structural Adjustment Programme (SAP) that was initiated in 1986(World Bank, 1996). Some of Nigeria's earlier anti-export bias in manufacturing disappeared, with the producers in agro-processing and textile manufacturing switching from imported to local inputs. This made the manufacturing industry that had declined annually by 4.8 percent on average between 1981 and 1986 to grow by 5 percent per year from 1987 to 1992. Within the same period, production of traditional food crops and cash crops increased and agricultural output grew at 3.5 percent per year on average, compared with only 0.6 percent between 1981 and 1986. In addition, by 1992, Nigeria was spending only one-fifth of what it had spent in 1986 on food imports.

The increase in poverty incidence between 1992 and 1996 was the outcome of the reversal ofmany of the policies that contributed to growth and poverty reduction during the 1986-1992.Real gross domestic product (GDP) and consumption per capita fell by 5 percent between 1992and 1994 while the resumption of rapid inflation further eroded many of the earlier benefits—from 49 percent in 1992 to 77 percent in 1994. In fact, the country returned during the 1992/94period to the exchange rate, fiscal and monetary policies that were operated before 1986 (the onset of SAP). The decline in poverty incidence that was again witnessed between 1996 and 2004 was, among others, the product of rationalization and streamlining of the activities of poverty alleviation institutions and agencies in order to enhance effective performance and reduce overlapping functions. In addition, the establishment, for the first time, of the National Poverty Eradication Programme (NAPEP) in 2001 to replace the ad hoc Poverty

Alleviation Programme (PAP) of the year 2000 also accounted for the reduced poverty incidence within the period (NBS, 2007).

Rural poverty incidence, therefore, was higher than urban poverty incidence between 1980 and 2004. This is a reflection of the disparities in the access to opportunities and infrastructure among the different households. For instance, infrastructure such as roads, water and sanitation, education, and electricity are not readily available in the rural areas of the country. In the samevein, opportunities such as off-season employments, credit availability, and access to timelyagricultural inputs are not commonplace in the rural areas. The drastic rise in urban poverty incidence is connected with the declining state of infrastructure such as roads, water andsanitation, education, and electricity (NBS, 2007). The majority of the rural poor in Nigeria derive their livelihood from subsistence agriculture and from the provision of services such as blacksmithing, tailoring and carpentry. The areas where the poor live are served with bad roads, making them to lack access to productive inputs as well as the output market arid other facilities like health clinic/hospitals in the nearby urban centers. Consequently, they have small-sized farms, use traditional farming inputs, and face food insecurity during the rains just before harvest. This period is characterized by the simultaneous prevalence of malnutrition (as diets are limited to starch-based ones), poor food availability, sickness, indebtedness, hard work, and discomfort(NBS, 2007). All these make the chronically poor in Nigeria to eat stale food and leftovers. The chronically poor has been described by World Bank (1996) as one that does not have access to adequate shelter (manifested in poor houses and overcrowding), have only one or two pairs of clothing worn at all times, do extensive physical work either in the farm or in other occupations and the children in poor households cannot afford school uniforms and fees and/or transportation costs to and from school. Therefore, they resort to doing menial jobs like

collection and sale of firewood, hawking of ready to eat food and load carrying in the markets and other public places.

Poverty, which has become pronounced and widespread in Nigeria, was not so until after the end of the oil boom era which started with the collapse of oil prices in the internationalmarket in the early 1980s. The emergence of oil in the Nigerian economy in the 1970s made the agricultural sector, which hitherto was the mainstay of the economy, to be neglected. This was attributed to the shift in the terms of trade together with the heavy spending in unviableinvestments, designed to raise the economy's productive capacity and human capital (NBS, 2007).Consequently, farm resources (most especially labour) migrated to the urban areas to supply themuch-needed labour in construction works at a wage higher than what was obtainable on the farms. Hence, agricultural production fell considerably, making Nigeria (an almost food self-sufficient nation) to become a net importer of food. Oil also turned Nigeria into a mono-export-product economy. In addition, when oil prices fell (leading to a fall in revenue and per capitaincome), the government increased borrowing abroad to sustain its pre-oil shock expenditurepattern instead of cutting them. As a result, foreign debt accumulated which led to the short fallin social sector expenditure and consequently, a fall in social services, making the welfare system to fall apart (NBS, 2007).

Though the military government of 1983 introduced across-the-board budgetary cuts and administrative restrictions on import and foreign exchange transactions, the welfare status of the people only increased marginally. This is because of their failure to address the economy's structural weakness of low productivity in the agricultural sector, uncompetitive manufacturing sector, significant trade distortions, and cumbersome regulatory framework. In 1986, a further collapse in oil prices to US$14 per barrel made

the government adopt the Structural Adjustment Programme (SAP) supported by the World Bank and International Monetary Fund. This programme was undertaken with exchange rate and trade policy reforms aimed at revitalizing the non-oil economy especially agriculture with stabilization policies designed to restore price stability and balance of payment equilibrium. This policy change brought mixed feelings. The farmers and agro-allied industries gained from the rise in the prices of food and cash crops and so were other industries competing with imported goods. However, other industries depending on imported raw materials suffered (World Bank, 2005). Furthermore, it was claimed by WorldBank (undated) that the adjustment brought about a decrease in poverty with 1.3 million people moving out of poverty and mean per capita household expenditure rose by 34 percent between 1985 and 1992.

Since 1992, the country witnessed the expansion of fiscal deficit, mismanagement of public resources and half-hearted implementation of structural reforms leading to economic crises. But the new government in 1994, instead of tackling the causes of the mounting economic crises, attempted to suppress its symptoms by centralizing all foreign exchange transactions, maintaining an increasingly over-valued official exchange rate, setting up of committee to ration foreign exchange to the private sector, and placing a ceiling on interest rates significantly below the prevailing inflation levels made poverty to be on the rise again.

The consequent drastic fall in human welfare conditions made the federal government in 1994to launch a poverty assessment scheme in partnership with the World Bank, United Nations Children'sFund (UNICEF), and the Overseas Development Administration (ODA) now Department forInternational Development (DFID). The results of the

poverty assessment led to the development of a strategy for poverty relief by setting up a Poverty Alleviation Programme Development Committee (PAPDC). A draft national strategy called Community Action Programfor Poverty Alleviation (CAPPA) was formulated. By 1997, the Family Economic Advancement Programmne (FEAP) was started with Decree No. 11 of August to reduce poverty in Nigeria. The FEAP was established to stimulate economic activities by providing loans directly to Nigeriansas the capital required to set and run cottage industries. The design and manufacturing of appropriate plants, machinery, and equipment of the industries are to be sourced locally. Since1997, the federal government has allocated a sizeable chunk of resources to this programme. In 1997 and 1998, a sum of ₦7.6 billion loanable fund was allocated to the programme. By 1997, the programme's loanable fund was boosted by ₦1.1 billion, bringing the total loanable fund at its disposal to ₦8.7 billion. According to Ilori (1999), a total of ₦1.675 billion has been disbursed as loans to cooperative groups.

Despite this huge allocation to FEAP, it has not produced the needed relief. This is probably due to the hijacking of the programme by unintended beneficiaries who are not poor but are able to comply with the guidelines for the award of the credit. Inaddition, one can conclude that the program (FEAP) was not based on any rigorousanalysis of poverty in Nigeria. The country since the inception of democratic government in 1994 has not left out the effort to reduce poverty. An *ad hoc* poverty reduction program, Poverty Alleviation Programme, (PAP) was implemented in 2000 basically to provide jobs for the poor unemployed for a time period. However, this was replaced by the National Poverty Eradication Programme (NAPEP) in 2001 to coordinate and monitor all poverty eradication efforts at federal, state, and local government levels. It also assists the federal government to formulate poverty reduction policies nationwide, and

intervenes in specific poverty reduction areas to provide social protection through economic empowerment as may be needed(NBS, 2007).

2.6.3 Consequencesof poverty on Nigeria

On the consequences of poverty, Aku *et al* (1997) opined that there is general loss of confidence in a society stricken by poverty and this renders government policies ineffective. Poverty also results in increasing the fragility and vulnerability of members of society to external influences. Furthermore, poverty makes production remain largely subsistence due to lack of capital needed for expansion. Labour becomes intensive and marginal productivity remains low.

Consequences of poverty on people: The vicious cycles of poverty mentioned before mean that lifelong handicaps and troubles that are passed on from one generation to another. To name just a few of these hereditary plagues: no school or education, child labor to help the parents, lack of basic hygiene, and transmission of diseases. Unemployment and very low incomes create an environment where kids can't simply go to school. As for those who can actually go to school, they simply don't see how hard work can improve their life as they see their parents fail at the task every day.

Other plagues associated with poverty:

a. Alcohol & substance abuse, from kids in African slums to adults in the US, this is a very common self-destructing habit often taken as a way to cope with huge amounts of stress and well, despair;

b. Crippling accidents due to unsafe working environments (machinery in factories or agriculture) as well as other work hazards such as lead poisoning, pesticide poisoning, bites from wild animals due to lack of proper protection;
c. Poor housing & living conditions, a classic cause of diseases;
d. Water and food-related diseases, simply because the poor can't always afford "safe" foods.

Effects of poverty on society as a whole: In the end, poverty is a major cause of social tensions and threatens to divide a nation because of the issue of inequalities, in particular income inequality. This happens when wealth in a country is poorly distributed among its citizens. In other words, when a tiny minority has all the money. The feature of a rich or developed country for example is the presence of a middle class, but recently we've seen even Western countries gradually losing their middle class, hence the increasing number of riots and clashes. In a society, poverty is a very dangerous factor that can destabilize and entire country. The Arab Spring is another good example, in all of the countries concerned, the revolts started because of the lack of jobs and high poverty levels. This has led to most governments being overthrown).

Powerless victims: Ever since the 1960s, the share of children affected by poverty has only got bigger and bigger. Children are those who have the least choice and ability to change what happens to them. There isn't much they can do to help their families, nor should they have to. Until they can stand firmly on their two legs, usually by the age of 6, then they can be enrolled willy-nilly in child labor. Nearly all possible effects of poverty have an impact on children' lives. Poor infrastructures, unemployment, lack of

basic services and income reflect on their lack of education, malnutrition, violence at home and outside, child labor, diseases of all kinds, transmitted by the family or through the environment.

Women and poverty: If in absolute terms (i.e. concerning most basic needs) less women live in poverty than fifty years ago, in fact there has been an increasing share of women in poverty in the global worldwide. This trend is also known as the feminization of poverty. This is yet another of the clear-cut effects of poverty. The trend toward more single-parent families has only made things worse and women have become more and more vulnerable to their environment. They find themselves forced to feed the poverty cycle by living in poverty with their children.

Feminization of poverty: Almost everywhere in the world, women are segregated, have very limited access to education (for political, religious or social reasons) and are sometimes forbidden to work or restricted to tedious ones. There are obvious (political & social) interests in keeping women in this state, and it's always recommended when fighting against poverty to start with empowering women in every possible way to solve a great deal of problems. Being the cornerstone of the family, women can have a great impact not only on the household income, but also on the education of children (including sanitation), and avoiding early child deaths due to bad habits, sanitation or improper food or water.

Backward industry and lifestyle issues: There is no proof that poverty, especially in cities, has an impact on the environment. On the other hand, backward (or not so developed) technologies and an industry's energy efficiency (how much energy it needs to produce an amount of goods) will greatly affect the environment. On the whole, the middle- and upper-classes lifestyles are also greatly responsible for the depletion of natural resources and the production of (toxic) waste. Or at least lifestyles based on over-consumption are the true responsible, which is often disregarded in public debates (as humans it is kind of hard to resist to so much temptation). Consequences of poverty on the environment: If there is any common association of poverty with bad environment, it's probably because of those pictures of children running around in waste dumps. In fact there is no link between any effects of poverty and the environment, quite the opposite. Those toxic places prove very harmful to the poor, who actually tend to reuse, recycle or resell whatever they can find in there, thus getting *us*rid of that dangerous garbage.

Good governance and good management of resources remains the best way to tackle both problems of environment and poverty. It's in fact quite ironic that thanks to poverty and the very low levels of consumption it implies, the extent of the damage done to the environment and the depletion of natural resources have been relatively limited. It's only with the rise of China, India and other BRICs that rich countries have started worrying about limited resources for everyone and problems of over-consumption and energy efficiency.

Life expentancy: A universal and simple measure of poverty consists in looking at different populations' health and life expectancy. It's no surprise that anywhere on earth, poorer communities fare worse than richer ones. But people's health is affected

not only by material poverty but also by social exclusion, yet another of the neglected effects of poverty. No matter if poverty affects someone's mental or physical health, the end result is the same: on average the poor live shorter lives than the rich. This is all the more true of ethnic minorities in whichever country, where they're often the first groups to suffer from discrimination and unfair treatments. This implies that the impact of poverty is not exclusively physical but also very much psychological: it affects in many ways mental health and human behavior. Every form of poorness, every form of social exclusion – be it material or racial – has its impact on people's health. After all, philosophers and sociologists often agree that man is but a social animal. So, living without a society or a group you belong to can have a huge impact on your mental health (though we wouldn't know for hermits). This has massive consequences for policymakers concerned not just about poverty but also about reinforcing social cohesion.

2.6.4 Measures of poverty reduction in Nigeria

The World Bank (2000) identified four major measures to increase the income of the poor. These are: Increasing the demand and therefore, the price for those factors of production that the poor own (e g their own labour) Transferring current income to the poor through cash or food subsidies. Although evidence shows that economic growth is a powerful means of reducing poverty, not all patterns of growth have the same impact. For example, production incentives that encourage growth in rural areas will likely directly benefit farmers but also indirectly benefit the landless through an increased demand for labour and those involved inagricultural marketing. Labour intensive agricultural growth is particularly important for poverty reduction because agriculture in

Nigeria provides employment for up to 70% of the labour force in the rural areas. To achieve this, group or cooperative farms need to be developed and funded at strategic villages depending on the comparative advantages of the selected communities.

Increasing the access of the poor to land and other assets, will alleviate the poverty of the masses masses, as they will be able to cultivate land and rear animals. Enhancing the access of small scale farmers and traders (particularly women) to credit, will lift up theirproductive capacities as they will be able to invest more on agriculture and increase food supply alleviation. Development of infrastrutural facilities in the rural areas is sine qua non to developing agriculture. Even though this is a medium term approach, it can be commenced now using a number of Local Government Areas in each state as pilot programmes. Such facilities like good feeder roads will enhance the evacuation of output and transportation of inputs to the rural areas. In particular, on-farm storage facilities appropriate for specific agricultural enterprises should be designed and commercialized for use in villages/rural areas. Inputs such as improved seeds, seedlings, cuttings and suckers need to be commercialized through incentives to the private sector. Other inputs that need to be commercialized are fertilizers, herbicides and insecticides. Undoubtedly, the price response of farmers to these inputs, is very low. However though, a strong farm advisory service, the adoption of these technologies will be enhanced in a profitable and environment friendly manner.

A major step to take is to increase the irrigated areas for food production. In the first place, yield is higher during the dry season as photosynthesis occurs more then than during the wet season. todischargeHence, River Basin Development Agenciess should

be funded more and monitored this role. Furthermore, processing and marketing of food items offer a veritable avenue for job creation. Small scale processing facilities for cassava, yam, rice, millet, sorghum have been identified as having high labour absorptive capacities. Apart from the employment potentials, processing offers a value added to agricultural output thereby increasingfarmers' income. Other areas include providing market information to farmers' and traders associations, informal educational programmes to small scale farmers and directly assisting the resource poor Nigerians with funds to engage infarming and trading through subsidies and other incentives.

2.6.5 Measurement of poverty

Derivation of the Poverty Line

A poverty line is often defined as a predetermined or well-defined standard of income orconsumption, which is deemed to represent the minimum, required for a productive andactive life or even survival (Okunmadewa*et al*., 2005). However, there is no official poverty line in Nigeria, and as such, many earlier studies used poverty lines, which were set as proportions of the average per capita expenditure (Canagarajah and Thomas 2001). The kind of poverty line that is obtained for any poverty study depends on the kind ofanalysis that the researcher is interested in. In quantitative analysis, most poverty lines areobjective while for qualitative, it is mostly subjectively determined. Objective poverty lines areusually of two types. These are relative and absolute poverty lines. It is very easy to seemany studies using the relative poverty line approach due to its ease of computation (Manyong *et al*., 2009). Thestudies reviewed here did not show any exception.Aigbokhan (2000) was the first to use an absolute poverty line on national data. He used thefood energy intake (FEI) method to generate an absolute poverty line. This approach reliedon actual food consumption expenditure and the calorie content of

the food consumed. Therecommended dietary allowance (RDA) used was 2,030 calories. This amount of calorieswas far below the 2900 calories used by the NBS (2007), which also used the FEI method indetermining the absolute poverty line using the NLSS data of 2004. The computation of theabsolute poverty line based on daily intake of 2,900 calories resulted in a food poverty line of₦21, 743.00 per annum while the food plus nonfood poverty line was ₦30, 128.00 per annum.

The choice of calorie level determines the number of people in poverty. The level of 2900calories per adult equivalent used was higher than in many studies. According to NBS(2007), choosing a calorie requirement closer to those used for the Burkina Poverty.Assessment of 2005 (2283 calories) and the Jordan Poverty Assessment of 2004 (2309calories) would have given a much lower percentage of the population in poverty. Forexample, 2300 calories would have produced a poverty incidence of 41.4 percent and whichwould have been lower than the poverty incidence obtained using the relative poverty line. Olaniyan and Bankole (2005), Okunmadewa *et al.* (2005), Canagarajah *et al*. (1997) in (Manyong *et al*., 2009) used the relative poverty line of 1/3 or 2/3 mean per capitahousehold expenditure (MPCHE). The 1/3MPCHE was referred to as the core poverty linewhile the 2/3MPCHE was the moderate poverty line. The NBS (2007) apart from using the2/3MPCHE also used the absolute poverty line required to meet 2900 calories and aminimum nonfood items, US$1 per person per day as poverty lines and subjective povertymeasure using a self-assessment of poverty where households were asked to say if theywere poor or nonpoor8. Olaniyan (2000) derived a poverty line from the relative poverty lineobtained from the 1985 NCS data as contained in FOS (1999a) by multiplying the 1985relative poverty line of ₦359.4 with a raising factor obtained from a ratio of the compositeprice index of 2000 to that of 1985. The FOS (1999b) also used the raising factor approachto derive relative poverty lines for 1980, 1992, and 1996

by multiplying the1985 poverty livewith the respective ratio of composite price indices of the particular year in question (1980or, 1992, or1996) to that of 1985 consumer price index (CPI).Those studies that have analyzed vulnerability to poverty or expected poverty generatedtheir own vulnerability to poverty lines or expected poverty lines differently from those thatconducted traditional poverty analysis. Typically, in such studies, the per capita expenditureof each household was converted into an index ranging from greater than zero to less thanone using the principle of normal distribution in statistics. And thereafter, the mean of thesum of the possible index was taken to be the vulnerability index (Alayande and Alayande,2004; Oyekale and Oyekale 2008; Oni and Yusuf 2007). However, Oni and Yusuf (2007),and Oyekale and Oyekale (2008) used the vulnerability level of 0.5 as the threshold sincethe equation for the estimated vulnerability followed a normal distribution. After thevulnerability indices were generated for each household, those with indices equal to orabove 0.5 were termed vulnerable while those below 0.5 were termed non-vulnerable. Thisallowed the generation of the proportion of the population that was vulnerable both in thetotal population of rural households at large and within various segments of the ruralhouseholds Subjective poverty lines were also used by some studies. Among those studies with national coverage, NBS (2007) used the perception of the individuals concerned to determine their poverty levels. The NBS (2007) reported a self-assessment ofpoverty in which households were asked to say if they were poor or non-poor. This gave a national poverty incidence of 75.5 percent. Self-assessed poverty was much higher in all regions with much less variability across regions. There was also little variation across expenditure quintiles, with 17 percent of the households in the wealthiest quintile feeling they were very poor compared to 24 percent of the households in the poorest quintile. Apparently 70–80 percent of the population felt poor

regardless of their actual expenditures. The study by Ayoola *et al*. (1999) was carried out in 16 communities in 13 states – 8urban and 8 rural sitesand provided perspectives of poverty from the four zones of Nigeria included in the study. The study teams also explored key issues that emerged by culture,social group, gender, age, occupation and other dimensions of difference which were locallysignificant to an understanding of poverty.

Finally, those studies (Omoke undated) that used the computable general equilibrium (CGE)to study the impact of a change in a policy on the poverty level of the households did not estimate any poverty line. They simply relied on either income or expenditure of the households. Their assumption was that any increases in income or expenditure would likely bring down poverty rate.

2.7 Impact Assessment of Agricultural Technology Concept

The term impact, assessment or evaluations are used in many different ways by different ways by different people. Impact assessment involves observing, measuring, and describing how the condition being assessed (e.g., poverty) has been influenced by intentional human action. It should compare achievements withplanned targets, or how things were before and after the intervention, and include a critical review of the assumed chain of causal influence. A classic understanding of impact is that of direct effects on income from increased adoption and use of technologies, as measured by numbers of farmers or area planted with an improved technology, yield increases, productivity growth, and the economic effects of adopting new technologies. Yet there is increasing recognition of the need to go beyond these forms of understanding of impact and include other and more comprehensive measures. (La Rovere and Dixon, 2007)

According to Alene *et al*., (2006), impact assessment of agricultural research is viewed as an important activity to ensure accountability, maintain credibility and improve internal decision making processes and the capability to learn from the past experience. Impact assessment is seen as a critical component of agricultural research that helps to define priorities of research and facilitate resource allocation among programme, guide researchers and those involved in technology transfer to have a better understanding of the way new technologies are assimilated and diffused into farming communities, and show evidence that clients benefit from the research products (Manyong *et al.*, 2001). Impact studies is of great importance in agricultural research because it is used to identify alternative technologies that would address the major production constraints while at the same time taking into consideration farmers preferences and farming condition (Alene, *et al*., 2006).

Despite the importance attached to agricultural development as a key factor to rural development, literature by IIED (1998) have shown that very few impact studies on Agricultural Development Programme has been undertaken probably due to methodological difficulties in estimating the benefits and attributing such benefits to the program intervention. Several methods both qualitative and quantitative methods have been used by many researchers (Baker, 2000, Maredia *et al*, 2003, Bantilan and Dar, 2001) to assess program impact. However very few of these methods are effective for measuring program impact. According to Nkonya,*et al.*, (2008) and Chen *et al* 2006, double difference methods compares change in outcomes pre and post program for participants and non-participant. It is mostly used especially if selection bias is additive and time invariant. Using this technique, outcome is not affected by expectations of

participation because it's usually nets out the selection bias (Nkonya *et al.,* 2008). This method is said to be sensitive to data quality as measurement error is likely more serious in comparing changes in variables than comparing levels.

2.7.1 Techniques used in impact assessment studies

Broad categories of Impact assessment methods are;

(i) Econometric methods

(ii) Programming methods

(iii) Double difference (with/without, before/after) methods;

(iv) Economic surplus methods

2.7.3 Double – difference estimator method

The double-difference estimator analytical tool is a quantitative method often used to measure impact assessment research. It is used to estimate and compare change in outcome or any other means of measurement determined pre and post programme for participants and non-participants (Chen, *et al*., 2006). In order to use the estimator in question, there must be information on both participants and non-participants and all individuals must be observed both before and after the programme (Verner andVerner, 2006). Therefore, to estimate programme impact, Verners in their double difference estimator model version gave a model as;

$$DD = \left[\frac{1}{P}\sum_{i=1}^{P}(Y_{lia} - Y_{lib})\right] - \left[\frac{1}{C}\sum_{i=1}^{C}(Y_{oja} - Y_{ojb})\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where

DD = Income difference between respondents

P = number of participants

C = number of individual control group (non-participant)

Y_{lia} = Income variable of participants after programme

Y_{lib}= Income variable of participants before the programme

Y_{oja} = Income variable of non-participants after the programme

Y_{ojb}= Income variable of non-participants before the programme

However, in order to take observable heterogeneity of individuals into account, Verners calculated the double difference estimator from a regression model including other personal characteristics. They modeled the value of this variable as;

Y_{ia}= α + β_{pi} + yX_{ia}+ℓ_{ia}……(2)

Where

α= common error term

P_i= indicator for participants in the programme

B= estimable effect of participants in the programme

X_{ia}= vector of observable characteristic of the individual

ℓ_{ia}= error term

Y_{ia}= outcome of a programme

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

The study was conducted innorthcentral or the middle belt of Nigeria. It is made up of Benue, Kwara, Kogi, Nassarawa, Niger and Plateau states and Federal capital territory. This is also known as the middle-belt area of Nigeria. The temperature throughout the year in the area ranges from 28°C – 34°C and the annual rainfall varies from 1500mm to 1200mm. The rainfall decreases in amount and distribution from the southern to the

northern part of the zone. Ethnically, Benue State is dominated by Tiv, followed by Idoma, Igala, Yoruba, Egbira, Nupe and Bassa form the main ethnic groups in Kogi State.Plateau State is dominated by Beroms in the northern zone, the Magavhus in the entral and the Taroks in the southern zone.

The north-central zone has a total land area of 281,796 km^2 representing almost 30 percent of the country's total land area. It is situated between latitude 11^0 20'. The zone has a population of 17 million (NPC, 2006), with a projected population of 22.3 million (2015)and with an average population density of 99 persons per km^2. Its rural population constitutes 77 percent of the zone. The total arable land in the zone is estimated at 23.2 million hectares, but only 5.9 million hectares is under cultivation annually. The mean annual rainfall for the zone ranges from 800 – 2,000 mm with an average of 187 – 220 rainy days per annum.Agriculture forms the principal means of livelihood of 80 percent of the population of the zone (Idachaba, 2005). The crops grown include maize, rice, guinea corn, millet, cowpea, soya beans and tuber crops such as cassava, yam, irish potato, sweet potato and cocoyam. They also keep livestock such as sheep, goat, pigs as well as poultry. Artisanal fishing is also done.

Figure 1: Map showing States in North Central Nigeria

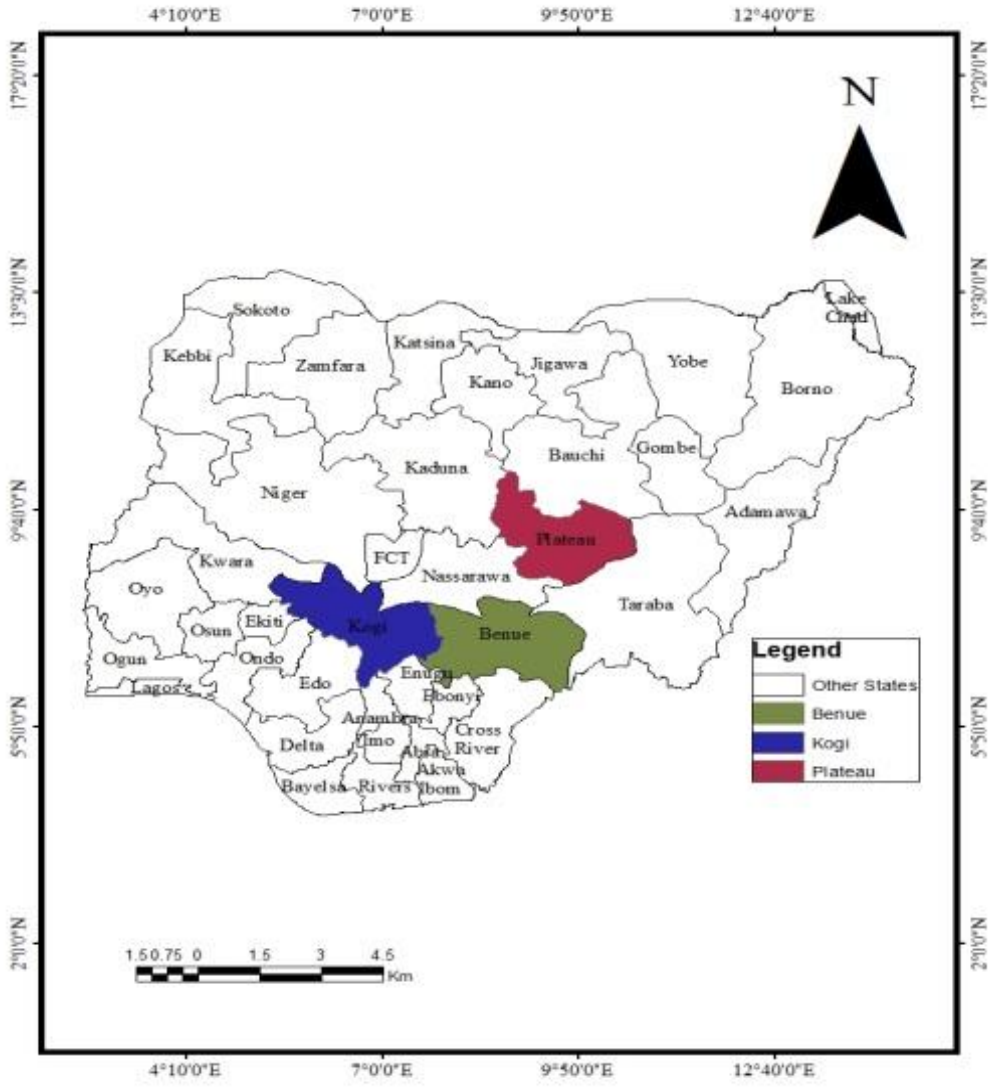

Figure 2: Map of Nigeria Showing the States of the Country

3.2 Sampling Technique and Sample Size

A multi-stage sampling technique was used for this study. In the first stage, three states namely; Benue, Kogi and Plateau States under the Fadama III root and tuber crop programme were purposively selected from the states in the central state based on the targeted root and tuber crops adopted for the National Fadama Development Project. In

the second stage, four local government areas were purposively selected from Benue state agricultural zones with at least one from each zone, three local government areas from Kogi state with one each agricultural zoneand one local government area was purposively selected from northern agricultural zone being the zone where irish potato is grown. In the third stage, from the sample frame, 10% representing a total of four hundred and twenty seven participants were randomly selected. Finally, five hundred and seven non-participating root and tuber crop farmers were randomly selected from the villages where the Fadama III participating root and tuber crop farmers were selected to give a grand sample size of 934root and tuber crop farmers.

Table 3.1: Sampling design for respondents

State	**Sample Frame**		**Sample Size**	
	Participants	Non-participants	Participants	Non-participants
BENUE	2238	2638	224	264
KOGI	1214	1514	121	151
PLATEAU	818	918	82	92
Total	4,270	5,070	427	507

3.3 Method of Data Collection

Primaryand secondary data was collected from participants and non-participants of Fadama III root and tuber crop scheme in the study area were used for this study. Primary data was collected from participants of fadama III programme and non-participants involved in root and tuber crop production through interview method using questionnaire, which was administered on the two groups of respondents'

socioeconomic, demographic and institutional characteristics such as age, household size, education,farming experience, farm size, extension contact, membership of cooperative societies; (ii) participants and non-participants output and inputs used in root and tuber crop production and associated sales of output and costs of inputs (iii) their food security and poverty status. Secondary data in the form of base line and end line data on the income of the programme participants and non-participants obtained from Fadama III programme coordinating offices in Makurdi, Lokoja and Jos werealso used for this study. The reason for this is due to limitation of getting base line and end line data of poverty, the food security status and productivity levels of the farmers from the Fadama III office participation in the Fadama III root and tuber crop scheme.

3.4 Analytical Tools

The following analytical tools were used;

Descriptive statistics

Net Farm Income Analysis

Double-difference Estimator

Stochastic Production Function

F-Chow Statistic

Logit Regression Model

FGT Food security index

Propensity Score Match (PSM)

3.4.1 Descriptive statistics

Descriptive statistics such as mean, frequency distribution and percentages was used to actualize Objectives one and five.

3.4.2 Impact of fadama III programme on productivity

i. Net farm income analysis

Net farm income(NFI) determines the return to unpaid family labour, operator's land, labour, capital and management Olukosi and Erhabor (2008). It is represented in equation (12)

NFI =$\sum P_y - \sum P_X - \sum P_K$ …… (12)

Where:

NFI = Net Farm Income (₦/hectare)

$\sum$ = Summation sign

$P =$ Unit price

$y =$ Output

X= Input (Variable)

K= Input (fixed)

Note: % change in income = $\frac{Income\ After - Income\ Before}{Income\ After} \times 100$

% change in Net Farm Income (NFI) =$\frac{NFI\ After - NFI\ Before}{NFI\ After}$

The fixed cost is the depreciation for farm tools used by the farmer (hoes cutlasses, wheel barrows and knapsack sprayers). The straight line method of depreciation was used to calculate the rate of depreciation.This method of depreciation assumes that an asset loses value at a constant rate. Depreciation by this method is the difference between the purchase price (P) and the salvage value (S) divided by the number of years of the life of the asset (n).This was used to actualize part of objective two.

Depreciation = $\frac{Principal\ cost - Salvage\ value}{Expected\ Asset\ Life\ span}$ ……(13)

3.4.3 Double difference estimator

(Verner and Verna, 2006) double difference version model was obtained as shown in equation (14):

DD =$\left[\frac{1}{P}\sum_{i=1}^{P}(Y_{lia} - Y_{lib})\right]$ - $\left[\frac{1}{C}\sum_{i=1}^{C}(Y_{oja} - Y_{ojb})\right]$…….. (14)

Where

DD = Net farm income difference between respondents

P = number of participants

C = number of individual control group (non-participants)

Y_{lia} = Net farm income variable on root and tuber crop of participants after programme

Y_{lib}= Net farm income variable on root and tuber crop of participants before the programme

Y_{oja} = Net farm income variable on root and tuber crop of non-participants after the programme

Y_{ojb}= Net farm income variable on root and tuber crop of non-participants before the programme

This was used to achieve part of objective two.

ii. Stochastic frontier:

This was used to estimate the economic efficiency of Fadama III participants and non-participating farmers. The farmers' economic efficiency was estimated as the product of technical and allocative efficiency. This was used to actualize part of objective 2

i. **Model specification;**

The stochastic frontier production and cost functions:

The Stochastic frontier production function model of Cobb-Douglas functional form was employed to estimate the farm level technical efficiency of food crop farmers. The Cobb-Douglas functional form was used because the functional form meets the requirement of being self-dual, it allows the examination of economic efficiency and it has been applied in many empirical studies (Battese and Coelli, 1988; Amaza and

Olayemi, 2002). The Cobb-Douglas productionfunctional form is specified as:

$Y_i = f(X_i; \beta) \exp V_i - \mu_I$ …….. (15)

The technical efficiency of individual farmers is defined in terms of the ratio of observed output to the corresponding frontier output conditioned on the level of input used by the farmers. Hence, the Technical Efficiency (TE) of the farmer is expressed as:

$TE_i = Y_i/Y_i^* = f(X_i; \beta) \exp (V_i - \mu_i) / f(X_i; \beta) \exp V = \exp (-\mu_i)$ …… (16)

Where,

Y_i: The observed output

Y_i^* : The frontier output

TE : Ranges between 0 and 1

The corresponding cost frontier of Cobb-Douglas functional form which is the basis of estimating the economic efficiency of the farmers is specified as:

$C_i = g(_{Pi}; \alpha) \exp(V_i + \mu_i)$ …… (17)

where,

Ci: The total input cost of the ith farms

g : The suitable function

pi: Input prices employable by the ithfarm in food crop production measured in naira

α: The parameter to be estimated

Viand μiare defined below. The cost efficiency (CEi) of individual farmers is defined in terms of the ratio of the predicted minimum cost Ci* to observed cost (Ci).

That is:

$CEi = Ci^*/Ci = g(Pi; \alpha) \exp\mu i / g(Pi; \alpha) \exp(Vi + \mu i) = \exp(Vi)$ ……. (18)

Hence, CEiranges between zero and one. The farmer's Economic Efficiency (EEi) was estimated as the inverse of cost efficiency i.e.,

$EEi = 1/CEi$ …… (19)

The production technology of the food crop farmers was specified by the Cobb-Douglas frontier production function defined as follows:

$\ln Yi = \beta_o + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_3 i + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + V_i - \mu_I$ …….. (20)

where,

$\ln Y_i$: Farm Output (Grain Equivalent (Kg)) from farm i

X_{1i}: Farm Size (hectare)

X_{2i}: Planting materials (Kg)

X_{3i}: Fertilizer (Kg)

X_{4i}: Agrochemicals (li)

X_{5i}: Labour used (Manday)

V_i:`Random variability in the production that cannot be influenced by the farmer. Vis are assumed to be independent and identically distributed random errors having normal N ~(0, δv^2) distribution and independent of μiμi : Deviation from maximum potential output attributed to technical inefficiency. The μis are assumed to be non-negative truncation of the half-normal distribution N~(μ, $\delta\mu^2$)

β0: Intercept

β1-β6: Production function parameters to be estimated i : 1, 2, 3, ... n farms

The Cobb-Douglas cost frontier function for the food crop farmers is specified as:

$\ln C_i = \alpha_0 + \alpha_1 \ln P_{1i} + \alpha_2 \ln P_{2i} + \alpha P_{3i} + \alpha_4 \ln P_{4i} + \alpha_5 \ln P_{5i} + V_i + \mu_I$ …….. (21)

Where:

C_i= Total input cost of the ith farms (naira)

P_{1i}= Rent on land per hectare (naira)

P_{2i}= Average price of planting materials (naira)

P_{3i}= Average price of fertilizer (naira)

P_{4i}= Average price of agrochemicals (naira)

P_{5i}= Average price of labour (naira)

The technical and cost inefficiency effects, μi is defined as:

$\mu i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6$…….. (22)

Where,

μ_I: Inefficiency effect

Z_1: Age of the farmer (years)

Z_2: Educational level of farmer (years)

Z_3: Extension contact (number of contact)

Z_4: Household size (Number of persons)

Z_5: Farm size (male = 1, female = 0)

Z_6: Farming experience (Years)

Z_7: Fertilizer use (Kg)

Z_8: Access to credit (Access = 1, No access = 0)

Z_9: Membership of cooperative societis, farmers association (1 = Membership, 0 = otherwise)

The δ_0 and δ_I coefficients are un-known parameters to be estimated along with the variance parameters $\delta_2$andγ.

The variances of the random errors, $\delta v^2$and that of the technical and cost inefficiency effects $\delta\mu^2$ and overall variance of the model δ^2 are related. Thus $\delta^2 = \delta v^2 + \delta\mu^2$. The δ^2 indicate the goodness of fit and the correctness of the distributional form assumed for the composite error term.

The ratio $\gamma = \delta\mu^2/\delta^2$, measures the total variation of output from the frontier which can be attributed to technical or cost inefficiency. The sigma square (δ^2) and the gamma (γ) coefficients are the diagnostic statistics that indicate the relevance of the use of the stochastic production frontier function and the correctness of the assumption made on the distribution form of the error term. The estimates of all the parameters of the stochastic frontier production function and the inefficiency model were simultaneously obtained using the program FRONTIER version 4.1 (Coelli, 1996).

These were used to achieve objective 2 which is to determine the impact of fadama III on productivity

3.4.4 Chow test statistics

According to Doughery (2007), Chow test statistics is often used in programme evaluation to determine whether the programme has impacts on different subgroups population. The Chow test is an application of the F- distribution test; it requires the sum of squared errors from three regressions, one from each sample group and one from the pooled data. If F-Chow is greater than the F-table, then there is project impact on the beneficiaries otherwise, there is no impact. This was used to test the hypothesis of project impact on beneficiaries' level of poverty in the study area. The model is specified as follows:

$$F^* - Chow = \frac{RSS(RSS_1+RSS_2)/k}{RSS_1+RSS_2/[n-2k]} \quad \text{..... (21)}$$

Where

R_{ss} = Sum of squared residual from pooled data

R_{ss1} = Sum of squares from the first group (participants)

R_{ss2} = sum of squares from the second group (non participants)

N_1, N_2 = Are the number of observation in each group

K = Total number of parameter.

This was used to achieve part of objective 2 which is to determine the impact of fadama III programme of productivity.

3.4.5 Definition and a *priori* expectations ofterms used in the stochastic equations

Dependent variable (Y)

Quantity of root and tuber crops produced (Y): This was the total quantity (output) of root and tuber crops in kilogramme/hectare obtained in 2013/2014 farming season.

Independent variables (X_i)

Farm Size (X_1): This refers to the amount of land put to cultivation, and measured in hectares. The postulation is that the relationship between efficiency and land usage will be positive. This is because the more the land that is engaged in crop production, the more the yield that will be obtained. This agrees with the findings of Eyoh and Igben (2002).

Quantity of Planting Materials Used (X_2): This refers to the products of the quantity of seeds/ planting materials in kilogramme/Basket/Bundles/Hectare used in production. The a priori expectation is that there would be a positive relationship between the planting materials and efficiency. This is in agreement with the findings of Edet *et al.*, (2006).

Fertilizer (X_3): Fertilizer when added to the soil improves plants' growth and yield. Modern synthetic fertilizers are composed mainly of nitrogen, phosphorous, and potassium compounds with secondary nutrients added. For this study, fertilizer used was measured in kilogrammes per hectare. This variable is expected to have a positive relation with efficiency.

Agrochemical (X_4): These are inputs such as fungicides, insecticides or soil treatment chemicals that protect root and tuber crop from pests. This is quantity of pesticides applied to crops on the farm to control infestation in litres /hectare. Most improved seeds require chemical treatment for preservation and against pest attacks. Pesticides used for this study was measured in litres per hectare. This coefficient of this variable is expected to have a positive sign.

Labour (X_5): This is made up of both familyand hired labour. Family labour was evaluated using the principle of opportunity cost; it is assumed that family labour served as a substitute for hired labour (Ogah, 2004). Children were given a value of 0.33, women 0.67 and men 1. Labour input was measured in labour hours and multiplied with unit cost to get the labour cost (both family and hired labour). Labour is expected to relate positively with efficiency. Labour was measured man-days per hectares.

Age of household head (δ_1): The age of household head (in years) is expected to have impact on his labour supply for root and tuber crop production. It is expected to have impact on ability to seek and obtain off-farm jobs and income which could increase household income. Young people are stronger and are expected to cultivate larger farms than old people. Therefore, this variable is expected to have a positive relationship with efficiency.

Household size (δ_2): This refers to the number of individuals living in a household under the household head.

Educational status of the house-hold head (δ_3): Education is a social capital which could impact positively on household ability to take good and well informed production decisions. For this study, education was used as a proxy for management and was measured by years of schooling. This variable is expected to relate positively with the efficiency.

Membership of a cooperative (δ_4): A cooperative is a social system consisting of two or more persons who stand in status and role relationship with one another and

possesses a set of values which regulate the attitudes and behaviours of the individual members in matters of consequence to the group. Membership of associations empowers people in their businesses and farming activities thereby improving their economic status. Membership of association was measured as the number of years a member has spent in the association. It is expected that the coefficient of this variable will be positive.

Farming experience (δ_5): This indicates the number of years spent so far in root and tuber crop production. Based on their exposure it could be adjudged that farmers posses great ability to predict possible problems and likely solutions that results to higher efficiency level. It is therefore expected that the processing experience should have a positive relationship with efficiency. It was measured in years.

Farm equipment (δ_6) All fixed items were depreciated using straight line method of depreciation in order to guard against over valuation of the cost incurred in each production year. It represents the implements used by the farmer in root and tuber crop production. Examples of farm tools are knapsack sprayer, cutlasses, hoes etc. For this study, the depreciated value of the fixed asset (naira) was used.

Access to credit (δ_7): This represents farmers' access to credit facilities received either in cash or in kind from lending agencies (banks, government, friends, money lenders, relatives, non –governmental organizations). This was measured as amount of credit in francs. In the study area, amount or quantity received depends on the farmers'

participation in the group. It is expected that access to credit should increase household ability to invest more and have higher income and increased production.

Extension contact (δ_8): This involves the application of scientific research and new knowledge to agricultural practices through farmer education. The field of extension encompasses a wide range of communication and learning activities organized for rural people by professionals of agriculture. Agricultural extension contact for this study was measured in terms of the number of times the famers were taught by extension agent.

Table 3.2: Description of variables in the inefficiency model

Variable	**Unit of measurement**	***a priori* expectation**
Age of farmer (δ_1)	Years	Negative
Household size (δ_2)	Number	Negative
Educational status (δ_3)	Years	Negative
Membershipof cooperative (δ_4)	Years	Negative
Farming Experience (δ_5)	Years	Negative
Farm equipment (δ_6)	Naira	Nagative
Amount of credit (δ_7)	Naira	
Extension contact (δ_8)	Number of times	Negative

3.4.6 Foster, Greer and Thorbeeke (FGT) food security index

The approach taken in this study for the determination of food security index index follows the identification and aggregation procedures. Identification is the process of defining a minimum level of nutrition necessary to maintain healthy living. This is

refered to as the ‘‘Food Security Line’’, below which people are classified as food insecure and subsisting on inadequate nutrition. The food security line to be used in this study was based on the daily –recommended level of calorie and protein, which are 2260 Kcal and 65g respectively (Babatunde *et al*.(2007). In order to generate food security indeces, the nutrient content of the crop consumed was used to derive both calorie and protein availability.

$$\text{Food Security Index (k)} = \frac{\boldsymbol{Household\ daily\ per\ capita\ calorie/proteinconsumed(X)}}{\boldsymbol{Household\ daily\ per\ capita\ calorie/proteinrequired(Y)}} \ldots\ldots (25)$$

For household to be food secure, k must be greater than or equal to 1 ($k \geq 1$).If k is less than 1 ($k<1$) the household is food insecure. It must also be noted that the above criterion must be satisfied for both protein and calorie requirements. The quantity of crops produced and purchased was converted to kilogramme and further to calorie and protein respectively and was then divided by adjusted household size and by 365 days to obtain the calorie and protein consumed per day per household and then compared with the standard (2260 kcal and 65 gramme) respectively.

For the purpose of this study, a farm household is a group of individuals who contributed to and shared a common economic resource base and relied on the income from that base for the greater part of their food acquisition and utilization. The nutrient composition of commonly eaten foods in Nigeria (Oguntona and Akintele, 1995) was used to estimate the calorie intake of households. On the other hand, the equivalent male aduly scale to determine adjusted household size computed by Falusi, 1985 was used.

Most studies focused on calorie availability and consumption in assessing food security status of respondents (Makinde, 2000, Lawal, 2003); because according to them, most diets contain adequate amount of all other required for good and healthy living once it is taken in quantity that is enough to meet the individual's requirements.

3.4.7 Determinants of food security

The binary logit model was used to investigate the determinants of household food security among the rural households surveyed. The USDA Household Food Security Scale (Revised in March 2000) was used to disaggregate the households into food secure and food insecure households. The dependent variable in this case, food security, was a binary variable which took a value of one if a household was found to be food secure, and zero if otherwise. A variety of models can be used to establish the relationship between the potential determinants and food security. The study employed the logit model in line with earlier researchers. Following Bogale (2009), the cumulative logistic probability model can be econometrically stated as:

$$Pi = F(Zi) = 1\ 1+e-(\alpha+\sum\beta iXi) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(26)$$

W here: Pi = the probability that an individual is being food secure given Xi

Xi = a vector of explanatory variables

α& β = regression parameters to be estimated.

e = the base of the natural logarithm.

For ease of interpretation of the coefficients, a logistic model could be written in terms of the odds and log of odd. The odds ratio is the ratio of the probability that a household would be food secures (Pi) to the probability of a household not being food secure (1-Pi).

That is: $Pi\ 1-Pi=ezi$ …… (27)

Taking the natural logarithm of the equation yields:

Ln ($Pi\ 1-Pi$) =Zi =α+β1x1+β2X2 +…+βmXm……. (28)

If the error term, εi is taken into account the equation becomes:

Z_i= α+∑ βi mi=0 Xi +εi ……. (29)

In this study the explanatory variables used in the model included:

X_1 = Age of Household Head (AGE) in years

X_2 = Gender of Household Head (GEND) – Male =1, Female = 0)

X_3 = Marital Status of household Head (MSTAT) – Married =1, Otherwise=0)

X_4 = Household size (Number)

X_5 = Number of years of formal education

X_6 = Farm size (hectres)

X_7 = Off-farm income (₦)

X_8= Access to Credit (if yes =1, otherwise= 0)

X_9= Fertilizer Application (Kg)

X_{10}= Remittance (₦)

The parameters of the logistic regression model were estimated using the maximum likelihood approach.

3.4.8 Propensity score match (PSM)

The most common evaluation parameter of interest is the Average Treament Effect on the Treated (ATT), which is defined as;

ATT = E($Y_1 - Y_0/P = 1$) – ($Y_1/P = 1$)…… (22)

The propensity score is the probability of the participation for farm household, I given a set X = xi of characteristics

P(X) = Pr ($P = 1/X = xi$)(Pufahl and Weiss, 2009)…….(23)

The propensity scores are derived from the regression models in which these characteristics were compared. The impact of treatment on the treated (causal effect of project participants) was estimated by computing the differences across both groups:

ATT = $\frac{1}{N\,1}(Y_1 - Y_0)$ …… (24)

Where ATT = Average impact of Treatment on the treated,N_1 = Number of matches (from regression model), Y_1 = The productivity index by Participants, Y_0 = The productivity index by non-participants. A positive (negative) value of ATT suggests that farm household beneficiaries in the project have higher (lower) outcome variable than non-participants. This was used to achieve part of objective 3 which is to determine the impact of fadama III root and tuber crop scheme on food security.

3.4.10 Poverty indices

This will be used to achieve part of objective 5.

Although there are a lot of methods for measuring thepoverty of a group, this study used the Foster-Greer-Thorbecke (FGT) weighted poverty index to measure poverty due to its additive decomposability into sub - groups. This FGT weighted poverty measure, otherwise called the Pα measure, is used to obtain the incidence, depth and severity of poverty.

The FGTmeasure for the ith subgroup (Pαi) is given as:

$$P_{ai} = \frac{1}{n}\sum_{i-1}^{q}\left[(z-y)/_{Z}\right]^{a} \quad \text{……. (33)}$$

$Where\ a = 0,\ P_o = \frac{1}{n}\sum_{i-1}^{q}\left[{(z-y)}/{z}\right]^0 = \frac{q}{n} \longrightarrow$ Poverty incidence or head count

$Where\ a = 1,\ P_1 = \frac{1}{n}\sum_{i-1}^{q}\left[{(z-y)}/{z}\right]^1 \rightarrow$ Poverty deph

$Where\ a = 2,\ P_2 = \frac{1}{n}\sum_{i-1}^{q}\left[{(z-y)}/{z}\right]^2 \rightarrow$ Poverty severity

Where

a= degree of poverty aversion

n = number of households in a group

q = the number of poor households

z = poverty line

y = the per capita expenditure (PCE) of the ith household.

The 2/3 mean per capita expenditure was referred to as the moderate poverty line while its 1/3 is referred to as the core poverty line. I limitedmyself to the moderate poverty line because it closely approximates the $1/day international poverty line(NLSS, 2004; and NBS, 2007).

α = degree of poverty aversion

Per capita expenditure = $\frac{Total\ expenditure}{household\ size}$ ..... (34)

Mean per capita household expenditure (MPCHE)

$=\frac{Total\ household\ PCE}{Total\ number\ of\ Households}$ ..... (35)

The categorization of the poverty line is given as:

Extreme poor: those spending < 1/3 of MPCHE

Moderately poor: those spending < 2/3 of MPCHE

Non-poor: those spending > 2/3 of MPCHE

This was used to actualize part of objective part of 5.

3.4.11 Hypotheses testing

Z – Statistic

The Z statistic was used to achieve part of objective 4 which was to test for the significance of impact of the Fadama III root and tuber crop scheme on poverty.

$$Z = \frac{Y_1 - Y_2}{\sqrt{\frac{S_{12} + S_{22}}{n_1 + n_2}}} \quad \text{..... (36)}$$

Where

Z = the value of the statistic,

Y_1 mean of the annual crop production by the programme participants,

Y_2 = mean of the annual crop production by the non-participants,

S_{12} = variance of the annual crop production by the programme participants,

S_{22} = variance of the annual crop production by the non- participants,

n_1 = number of participants,

n_2 = number of non-participants.

CHAPTER FOUR

RESULTS AND DISCUSSION

In this chapter, the various data collected were subjected to different analyses in accordance with the stated objectives. The results of the analyses are hereby presented as follows;

4.1 Socio-Economic Characteristics of the Respondents

The socioeconomic characteristics of Fadama III participating and non-participating farmers were discussed. The various data collected were subjected to different analyses in accordance to the analytical techniques stated in chapter three. The results of the analyses are therefore presented in this section.

4.1.1 Age of respondents

The results of the study shows in Table 4.1 that minimum age of the farmers cultivating root and tuber crops in the study is made up of 22 years and 30 years, maximinum age is 70 years and 78 years and the mean age are 22 years and 34 years for participants and non-participants respectively. The root and tuber crop farmers in the study area are within the age bracket of 20 – 40 years. The standard deviation for the participants is 10.98 while that of the non-participants is 11.50. This implies that root and tuber farming in the study area is embraced predominantly by middle-aged men. The role of age of farmers is very critical in agricultural production. The result of the study shows that age of farmers affects their ability.This agrees with the findings of Ogundari and Ojo(2007) on the economic efficiency of small scale food crop production in Nigeria where they found that rising age of farmers would lead to a decline in their

level of efficiency. This finding by Udoh and Nyienakuma (2008) on the socioeconomic characteristics and adoption trend of artisanal fishers in Akwa Ibom State, Nigeria showed that farmers within the active age groups are able to withstand stress and put more time in various farming operations. In their estimation of technical and allocative efficiency analysis of Nigerian rural farmers, Asongwa *et al*. (2011) observed that age of farmers have a positive effect on technical inefficiency effects. This is because old people are less energetic and less receptive to agricultural innovations and hence develops inefficient production routines and practices. Older farmers may have more resources that make it more likely for them to try new technologies. On the other hand, younger farmers are more likely to adopt innovations than older farmers. Ogundari and Ojo (2006) in their work on the economic efficiency of small-scale food crop production in Nigeria stated that rising age of farmers would lead to a decline in their level of efficiency.

Table 4.1: Distribution of respondents according to age

Variables	**Participants**		**Non-participants**	
Age	Frequency	Percentage	Frequency	Percentage
20– 30	31	7.26	62	12.23
31– 40	108	25.29	148	29.48
41– 50	152	35.60	125	24.90
>50	136	31.85	172	34.26
Total	427	100.00	507	100.00

Min = 22 Max =70 Mean = 46,Std.Dev=10.98 Min = 30 Max = 78 Mean = 34, Std. Dev.=11.50

4.1.2 Respondents years of farming experience

The result in Table 4.2 shows the distribution of respondents based on years of farming experience in root and tuber crop production. The results shows that the minimum faming experience in root and tuber production ofparticipants and non-participants are 2 years each, maximum farming experience is 50 years each for both participants and non-participants, the mean experience is 23 years and 22 years for the participants and non-participants respectively. The standard deviation for the prgramme participants is 11.47 while that for the non-participants is 22. 86.In the study of resource use efficiency and multiple production objectives of pastoralists dairy in Adamawa state, Adebayo (2006) observed that the longer a person stays on a particular job, the better the job performance tends to be.

Table 4.2: Distribution of respondents according years of experience

Variables	**Participants**		**Non-participants**	
Farmin Exp	Frequency	Percentage	Frequency	Percentage
1– 10	76	17.79	148	29.48
11 – 20	123	28.81	159	31.67
21 – 30	96	22.48	62	12.23
31 – 40	63	14.75	96	19.12
>40	69	16.16	42	8.37
Total	427	100.00	507	100.00

Mean= 23.2, Min=02, Max=50, Std. Dev. = 11.47, Mean=22.3, Min = 02, Max = 50, Std.Dev.=24.86

4.1.3 Respondents' level of education

The result in Table 4.3 shows the educational level of the respondents. The analysis shows that the minimum years spent on education is 6 years each for both programme

participants and non-participants , maximum years spent on education is 16 years each for both fadama III participats and non-participats. The standard deviation for the programme participants is 1.29 while that for the non-participants is 1.46. The mean years spent on education for the programme participants and non-participants is 8 tears and 9 years respectively.Educational level of the farmers is known to affect their farming activities. According to Imonikhe (2004), education would significantly enhance farmers' ability to make accurate and meaningful management decisions, it could also enhance the knowledge of improved techniques such as how to read and interprete recommended packages. The level of awareness and adoption of agricultural innovations are affected by the literacy status of farmers. Those who are literate are expected to be more innovative because of their ability to get information more quickly and their ability to take more risk. Oluwatayo *et al*. (2008) in their studies on resource use efficiency of maize farmers in rural Nigeria observed that the more educated a farmer is, the more the chances that the farmer will adopt innovations than the uneducated ones. Therefore, there is a high probability that farmers in the study area will easily adopt new farming practices since 96.1% of them were literate.

Table4.3: Distribution of respondents according to education

Variables	**Participants**		**Non-participants**	
Education	Frequency	Percentage	Frequency	Percentage
No formal edu	61	14.29	60	11.95
Primary	160	37.47	191	38.05
Secondary	178	41.69	197	39.24
Tertiary	28	6.56	54	10.76
Total	427	100.00	507	100.00

Mean = 8, Min = 6, Max =16, Std. Dev. = 1.29; Mean = 9, Min = 6, Max =16, Std.Dev. = 1.46

4.1.4 Respondents membership of cooperatives

The result in Table 4.4 shows the distribution of respondents based on years of membership of cooperatives. The minimum years of cooperative involvement is 1 year each for both programme participants and non-participants of Fadama III root and tuber farmers, maximum years in cooperative is 25 years and 26 years for participants andnon-participants of Fadama III root and tuber farmers while the mean years of involvement in cooperative is 7 years and 6 years for participants ans non-participantsrespectively. The Membership of a cooperative enables farmers to interact with other farmers, share their experiences and assist themselves. Interaction of farmers with other farmers is an avenue through which innovation diffusion can occur. According to Oboh and Kushwaha (2009), membership of a cooperative or any farming group is a strong determinant of adoption of cassava varieties in Benue State. Similarly, Gashaw *et al* (2013) found that membership of cooperatives enhances members' efficiency by easing access to productive inputs and facilitating extension linkage compared to those who were not members.

Table 4.4: Distribution of respondents according to membership of cooperatives

Variables	**Participants**		**Non-participants**	
Cooperative	Frequency	Percentage	Frequency	Percentage
None	0	0	261	51.99
1 – 5	135	31.62	91	18.13
6 – 10	200	46.84	106	21.12
11–1+5	37	8.67	42	8.37
> 15	55	12.88	2	0.4
Total	427	100.00	507	100.00

Mean = 7, Min =1, Max = 25, Mean = 6, Min = 1, Max =, 26

4.1.5 Respondents'farm size

The sizes of the respondents' Root and tuber crops farmsare shown in Table 4.5. The minimum hecterage cultivated by the Fadama III root and tuber crops participants and non-participants is 1 hectare and 1.5 hectares respectively, the maximum hecterage cultivated is 10 hectares each for both programme particioants and non-participants, while the mean farm size cultivated is 2.6 hectares and 1.5 hectares for programme participants and non-participants respectively. The standard deviation for the programme participants is 1.55 while that for the non-participants is 1.08. The distribution according to farm size indicates that Fadama III Root and tuber farmers were made up of small, medium and large-scale farmers. This is based on Olayide's (1980) classification of farms as follows: 0.1 to 5.0 hectares (small-scale); 5.1 to 10 hectares (medium-scale); and 10 hectares and above (large-scale). Since the majority of respondents have farm holdings between 0.1 and 5.0 hectares, it means that these farmers cannot achieve economies of large-scale production. Small farm size is an impediment to agricultural mechanization because using farm machineries like tractors to control weeds will be difficult. The size of farm cultivated by farmers is a function of population pressure, family size, labour productivity, financial background and experience of the farmers (Imonikhe, 2004).

Table 4.5: Distribution of respondents according to farm size

Variables	**Participants**		**Non-participants**	
Land size(Ha)	Frequency	Percentage	Frequency	Percentage
0.5 – 1.0	98	22.95	210	41.83
1.1 – 2.0	163	38.17	172	34.26
2.1 – 3.0	88	20.61	86	13.80
3.1 – 4.0	28	6.56	14	12.50
4.1 – 5.0	27	6.32	12	7.55
>5	23	5.39	09	1.79
Total	427	100.00	507	100.00

Mean = 2.6, Min = 1, Max = 10, Std. Dev. = 1.55, Mean = 1.5, Min = 0.5, Max = 10, Std. Dev = 1.08

4.1.6 Respondents'marital status

Table 4.6 shows the distribution of respondents based on marital status. About 10% and 8% participants and non-participants of the Fadama III root and tuber cropfarmers were singles, 61% and 68% of the participants and non-participants were married, 0% and 11% of participants and non-participants were divorced, and 29% and 11% were widowed. The standard deviation for the programme participants is 0.91 while that for the non-participants is 0.68. In their study of gender differentials in technical efficiency among maize farmers in Essien Udim Local Government Area-Nigeria, Simonyan *et al.* (2012) observed that marital status was positive and significantly related to the productivity of the male farmers.

Table 4.6: Distribution of respondents according tomarital status

Variables	**Participants**		**Non-participants**	
Farming Expr (Yrs)	Frequency	Percentage	Frequency	Percentage
Single	42	9.84	34	8.00
Married	260	60.90	341	68.00
Divorced	0	0	55	11.00
Widow	125	29.27	65	13.00
Total	427	100.00	507	100.00

Std. Dev. = 0.91, Std.Dev. 0.68

4.1.7 Respondents household size

Table 4.7shows the distribution of respondents based on the size of their household. The minimum household size of the participants and non-participants is 5 persons and 2 persons; the maximum household size is 68 persons each for the participants and non-participants respectively, while the mean hosehold size is 10 persons each for the fadama III root and tuber crop participants and non-participants respectively. The standard deviation for the programme participants is 9.64 while that for the non-participants is 9.38. This implies that farming households have a good source of family labour for the farm business.This is a positive indication that there would be more availability of family labour for farm work and therefore, a need to increase farm size. In his study of productivity and technical efficiency of smallholder cocoa farmers in Nigeria, Amos (2007) found that family size was a significant variable which greatly influenced the technical efficiency of farmers. According to him, farmers keep large family members to increase farm labour during peak season.

Table 4.7: Distribution of respondents by their household size

Variables	**Participants**		**Non-participants**	
Household size	Frequency	Percentage	Frequency	Percentage
1 -5	135	31.62	108	21.51
6 – 10	183	42.86	312	62.15
11 – 20	87	20.37	75	14.14
Above 20	22	5.15	7	1.50
Total	427	100.00	507	100.00

Min = 5, Max = 68, Mean = 10, Std. Dev. =9.38, Mean=10, Min = 2, Max = 68,Std.Dev. = 9.64

4.1.8 Respondents extension visits

In Table 4.8, 0% and 62%of the Fadama III participants and non-participants root and tuber crop farmers had no contact with extension workers throughout the root and tuber growing season in the study area, 28% and 13% of the participants and non-participants had weekly contact with extension agents, 24% and 4% of the participants and non-participants had a forthnightly contacts with extension agents, 21% and 14% of the participants and non-participants had monthly contacts with the extension agents, and 21% and 8% of the participants and non-participants had Bi-monthly contacts with extension agents and 3% and no participants and non-participants had twice-yearly contacts with the extension agents. The average number of contacts for the Fadama III root and tuber crop participants was approximately 2 with a standard deviation of 0.76, while that for the non-participants was approximately 1 time with a standard deviation is 0.18.. Umar *et al.* (2007) observed that higher extensions contact would increase

adoption of improved farm production technologies. They further observed that the frequency of extension contact is very essential as it guides the farmers from awareness to the adoption stage.

Table 4.8: Distribution of respondents according to extension contact

Variables	**Participants**		**Non-participants**	
Land size(Ha)	Frequency	Percentage	Frequency	Percentage
None	0	0.0	310	61.75
Weekly	120	28.10	60	11.95
Forthnightly	101	23.65	20	3.98
Monthly	107	21.31	72	14.34
Bi-Monthly	86	20.14	40	7.90
Twice Yearly	13	3.04	0	0.00
Total	427	100.00	507	100.00

Std. Dev. = 0.76, Std. Dev. = 0.18

4.2 Input-Yield of Respondents

Table 4.7 below shows the recommended planting materials and fertilizer for yam, cassava and irish potato in Nigeria, the actual planting materials and fertilizer used as well as the recommended expected yield and the actual yield obtained by the respondents in the study area. Sixty (60) bundles of Cassava cuttings was recommended for Cassava cultivation, 3 to 5 tonnes/ha of seed yam for Yam cultivation while 2 – 3 tonnes/ha of Irish potato seeds for Irish potato cultivation for optimum yield. The actual planting materials used by the respondents in the study area revealed that 56 and 55 bundles/ha of cassava cuttings were used by the participants and non-participants

respectively. For yam, 3.8 tonnes/ha and 3.6/ha tonnes of seed yam were planted by the participants and non-participants respectively while for Irish potato cultivation, 2.6 tonnes /ha and 2.43 tonnes/ha of Irish potato seeds were used by the participants and non-participants in the study area.

Participants' usage of planting materials in Cassava, Yam and Irish potato cultivation were slightly higher than that of the non-participants. The reason for this may be as a result of training and monitoring carried out by the officials of Fadama III root and tuber crop scheme on the participants. It is impotant to observe here that neither the participants nor the non-participants planted the recommended seed rate for the root and tuber crops.

The result of yields obtained from Cassava, Yam and Irish potato cultivation in the study area by both the programme participants and non-participants shows that 19.2tonnes/ha and 16.3 tonnes/ ha of Yam were obtained by the participants and the non-participants respectively as against the recommended 18 tonnes/ha to 22 tonnes/hectare. For Cassava, 27.6tonnes/ha and 25.5tonnes/ha were obtained by the participants and non-participants respectively as opposed to the recommended yield of 25 – 30tonnes/ha while for Irish potato, 19.2 and 17tonnes/ha were obtained by the participants and non-participants respectively as compared to 18 to 20 tonnes/ha yield expected. From this result, participants obtained higher yields from Cssava, Yam and Irish potato than the non-participants. The reason for this difference may be due to the adherent to the recommended cultural practices by the fadama III root and tuber crop participants. It is impotant to stress here that the yields obtained by both the programme

participants and non-participants were below the maximum expected yield. This may be due to low efficiency in root and tuber crop production.

Table 4.9: Input-yield relationshipof respondents

Input	Recommended	Participants	Non-participants
i. Cassava (Tonne/ Ha)	60 (bundles)	56	55
ii. Yam (Tonne/Ha)	3 – 5 (tons)	3.80	3.6
iii. Irish potato (Tonne/Ha)	2 – 3 (tons)	2.6	2.43
iv. Fertilizer (kg/Ha)	400 – 500 Kg)	446	440
Yield	**Recommended**	**Participants**	**Non-participants**
v. Yam (Ton/Ha)	18 – 22 (tons)	19.2	17.3 (tons)
vi. Cassava (Ton/Ha)	25 – 30	27.6	25.2
vii. Irish potato (Ton/Ha)	18 – 20	19.2	17.0

4.3 Impact of Fadama III Programme on Participants' Productivity

4.3.1 Net farm income analysis

The net farm income statement is a summary of revenue and expenses for a given accounting period. It is sometimes called an operating statement or a profit and loss statement. The purpose of Net Farm Income (NFI) in this study is to measure the difference between revenue and expenses of participants and non-participants. A Positive difference indicates a profit or a positive Net Farm income, and a negative value indicates a loss or a negative Net Farm Income for the accounting period. The average costs incurred and the output in monetary value obtained per hectare by the Fadama III participants and non-participants before and after the programme was estimated for determining the net farm income of root and tuber crops in the study area.

The Total costs incurred and the output in monetary value obtained per hectare by Fadama III participants and non-Participants was estimated for determining their Net Farm Income of Root and Tuber crop production.

As shown in Table 4.10, the total cost of production per hectare of participants and non-participantsbefore fadama III programme interventionwas ₦113, 087.65/Ha and ₦117,614.73/Ha respectively while the total cost after the fadama III programme for the participants and non-participants was ₦128, 233.30 and ₦137,756.57/Ha respectively. The total cost incurred by the participants was lower than that of the non-participants both before and after the programme. The total revenue/habefore the programme intervention is₦381, 282.69/Ha and ₦405, 382.82/Ha while the total revenue/ha after the programme was₦767, 818.05 and ₦649, 271.97/Ha for participants and non-participants respectively. The total revenue before the programme obtained by the non-parcipants was higher than that of the participnats while the total revenue obtained by the participants was higher than that of the non-participants after the programme. The change in total revenue was 50.34% and 37.56% for participants and non-participants respectively. The net farm income (NFI) for Fadama III root and tuber crop participants and non participants was before the programme is ₦268,195.04/Ha and ₦287,768.09 /Ha respectively,while the net farm income after the programme is ₦639,584.75 and ₦511,515.40/Ha for participants and non-participants respectively. The result indicates that root and tuber crop production is profitable in the study area. This is in agreement with the work of Ajayi, (2014) titled ‘comparative economic study of mixed and sole cassava cropping systems in Nigeria. The change in net farm income (NFI) is 58.34% and 43.74% for participants and non-participants respectively. This percentage is however lower than the 134% and 52% respectively for participants and non-participants obtained by Simonyan(2008) in her findings titled ‘impact assessment of

fadama II project on income and productivity of beneficiary farmers in Kaduna State, Nigeria. The return on investment for Fadama III root and tuber cropscheme parrticipantsand non-participants before programme intervention is ₦2.37 and ₦2.44 respectively while the return on investment after programme intervention is ₦4.98 and ₦3.71 programme participants and non-participants respectively. The interpretation of this result for Fadama III participants is that for every ₦1.00 invested, ₦2.37k is their profit while for the non-participants, for every ₦1.00 invested, ₦4.98k is their profit before the programme intervention while for every ₦1.00, ₦4.98 and ₦3.71 is their profit for the prgramme participants and non-participants respectively afeter the programme intervention . The higher difference in net farm income of participants over that of non-participants may be attributed to the increase in farm out put realized by the participants after the fadama III programme. Participant's profitability index is higher because they may have been taught better farming techniques which had impacted on their yield and revenue.

Table 4.10: Net farm income analysis of respondents

	Participants Total cost (₦/ha)		**Non-participants Total cost (₦/ha)**	
Input	**Before**	**After**	**Before**	**After**
A.				
Land Rent	5,395.00	6,743.80	6,990.31	6,341.54
Planting mat.	18,511.60	15,498.07	20,647.42	21,836.33
Fertilizer	19,255.15	19,632.27	18,287.32	19,125.21
Pesticide	5,446.40	6,400.00	6,998.42	8,408.23
Labour	61,853.30	76,836.45	49,906.00	79,215.87
Total Variable Cost/Ha	**110,461.45**	**125,110.59**	**115,529.47**	**134,927.18**
B. Depreciated cost	2,626.20	3,122.71	2,085.26	2,829.39
C.Total cost (A+B)	**113,087.65**	**128,233.30**	**117,614.73**	**137,756.57**
D.**Revenue/Ha**				
Cassava	110,065.69	323,722.61	154,538.26	259,292.39
Irish Potato	64,975.61	120,325.20	56,468.95	93,675.30
Yam	206,241.39	323,770.24	194,375.61	296,304.28
Total Revenue/Ha	**381,282.69**	**767,818.05**	**405,382.82**	**649,271.97**
E. Net Farm Income/Ha (D – C)	**268,195.04**	**639,584.75**	**287,768.09**	**511,515.40**

Farm tools include Hoe, cutlasses, Wheel barrows and Knapsack sprayers

4.3.2 Test of significance of participants and non-participants' net farm income

The hypothesis was analyzed using Z-test. Net farm income was used as proxy for profitability for the two groups. The result as presented in Table 4.11 shows that Z-calculated is greater than Z-critical and is significant at 1% level of probability, thus implying that there is significant difference between the net farm income of fadama III participants and non-participants .

Table 4.11: Z-test of hypothesis on the profitability of the participants and non-participants in root and tuber crop scheme of fadama III programme.

Variable	Participants	Non-participants
	Net farm income (₦)	Net farm income (₦)
Mean	1,821,798	1,404,417
Known Variance	5.26E+12	3.23E+12
Observations	427	507
Hypothesized Mean Difference	0	
Z-stat	3.05***	
P(Z<=z) one-tail	0.00114	
Z-Critical one-tail	1.64485	
P(Z<=z) two-tail	0.00228	
Z-Critical two-tail	1.96	

***P<0.01

4.3.3Impact of socioeconomic factors on net farm income of fadama III participants

The double differences estimates of the impact of Fadama III root and tuber crop scheme on net farm income of participants are presented in Table 4.10. The mean output difference of the beneficiaries was 764286.9 and 1797114.576 before and after Fadama III intervention. The difference between after and before values is 1032827.711, which is the first single difference. The mean output difference of the non- beneficiaries were 575866.40 and 1309914.254 before and after Fadama III intervention. The difference between before and after values is 734047.8485 which is the second single difference. The double difference, that is, the difference between the two output differences

1032827.711 – 7340478485] is 298,779.86.It indicates that the double difference estimates of the net farm income of participants and non-participants of Fadama III root and tuber crop scheme had a positive value. The implication is that Fadama III root and tuber crop scheme had positive impact on the participants' net farm income. A positive mean double difference in output value indicates positive impact of fadama III on participants' net farm income. This is in agreement with (Nkonya *et al*, 2008) work on on the impact of of SACCOS credit on the crop output of beneficiaries and (Simonya, 2010) work on the impact of Fdama II programme on income and productivity of beneficiaries in Kaduna state.

Table4.12: Double-difference result of impact of fadama III on participants' net farm income

Group	Net Farm Income		
	Before (₦)	After (₦)	Difference between periods
Participants	764286.9	1797114.576	1032827.711
Non-Participants	575866.4	1309914.254	734047.8485
Difference between groups	188420.5	487200.3219	298779.8629

4.3.3 Determinants of net farm income of fadama III root and tuber crop scheme participants and non-participants

The estimates of double difference from regression analysis of the impact of Fadama III root and tuber crop scheme on income is presented in table 4.13. It was found that the interaction term (Ti*Pt) had a positive coefficient of 298779.9 and statistically significant at 5% level of significance. It indicates that of the six (6) variables included

in the regression model; age, educational status, household size, farm experience, off-farm income and income size were statistically significant with net farm income at 1% level of significance.

It indicates that the coefficients of the interaction term (Ti*Pt) between the per capita net farm income of the participants and non-participants of fadama III root and tuber crop schemehad apositive value and statistically significant at 5% level of significance. It means that the Fadama III root and tuber crop schemehad a positive and significant impact on the net farm income of the respondents. The implication is that the net farm income of the programme participants is significantly difference from the net farm income of non-participants in the study area. This result is consistent with the findings of Ezeh (2004) and Nkonya *et al*., (2008) who reported that Fadama project beneficiaries were better off than their non-beneficiary counter-part in terms of income and productivity.

Table 4.13: Result of double difference estimates from regression analysis of the impact of fadama III on net farm income of root and tuber crop scheme

Variable	**Coefficients**	**Standard error**	**T-stat**
Constant	412843.2	269223.5	1.533459
Treatment(T*)	95100.8	119542.5	0.79554
Period(Pt)	734626.9	100362.2	7.31976
Interaction term(T*Pt)	298779.9	148269	2.011216**
Age	43578.7	4593.486	9.487066***
Education	24913.9	12137.11	2.052630**

Extension contact	-29241.1	54839.71	-0.53321^{NS}
Household size	12063.9	4826.748	2.499384***
Farm size	135365	31085.27	4.354635***
Farming experience	8691.2	4114.667	2.112293**
Credit access	72685.5	7616.89	9.542674***
Cooperative association	434754.8	83449.51	5.209794***
¤ Gender	81585.41	90092.34	0.905575^{NS}
R Square	0.593		
Adjusted R Square	0.548		

*Note: *** Significant at 1% and ** Significant at 5% levels of Significance*

The coefficient of educational level was found to be positive (24913.9) and significantly related with the participants' net farm income. This implies that increased level of education will lead to increase in the net farm income of the respondents. Education produces labour force that is more skilled and adaptable to the need of changing economy. It helps to unlock the natural talents and inherent enterprising qualities of the farmers. It enhances the farmer's ability to understand and evaluate new production techniques. This translates into higher crop output and productivity (Orebiyi, *et al*., 2013). The coefficient of age was found to be positive **(**43578.7) and insignificantly related with the respondent's net farm income. This means that age is positively related with level of respondents' net farm income.

The coefficient of household size was found to be positive (12063.9) and significantly related with the respondent's net farm income. This result implies that the more the number in the farmer's household the more the net farm income. Relatively large

household size may likely enhance the family labour supply on the farms, hence supporting favourably, productive capacities of the farmers to increase their crop output. This finding is in tandem with the earlier findings of Amos (2007) who noted that farm household size was a significant determinant of cocoa productivity in the study area.

The coefficient of farm size was found to be positive (135365) and significantly related with the respondent's net farm income. This means that farm size is positively related with level of respondentsnet farm income. This implies that any increase in farm size will lead to an increase in the respondents' net farm income. The result is in agreement with the findings of Nwaobiala *et al.*, (2009) where they found a positive relationship between income and output of Agip-Green River Project crop farmers in Rivers State, Nigeria.The coefficient of farm experience was found to be positive (8691.382) and significantly related with the respondent's net farm income. This means that farming experience is positively related with level of respondentsnet farm income. This implies that any increase in farming experience will lead to an increase in the respondents' net farm income.

The coefficient of extension contact was found to be negative (-29241.1) and insignificantly related with the respondent's net farm income. This means that farm size is negatively related with level of respondents' net farm income. This implies that any increase in extension contact will lead to a decrease in the respondents' net farm income. The coefficient of co-operative membership was found to be positive (434754.8) and insignificantly related with the respondent's net farm income. This means that co-operative membership is positively related with level of respondents' net farm income. This implies that any increase in cooperative membership will lead to an

increase in the respondents' net farm income. Co-opratives provides a cheap and an alternative means of raising the required capital for farm operation and expansion, which will have a positive impact on the net farm income of the respondents.

The coefficient of gender was found to be positive **(**81585.41) and insignificantly related with the respondent's net farm income. This means that gender is positively related with level of respondents' net farm income; however, it will not have a significants effect on the net farm income of the respondents.

4.3.4 Technical efficiency of fadama III participants and non-participants root and tuber crop farmers

The Maximinm Likelihood estimates and inefficiency determinants of the specified frontier are presented in Table 4.14. The study revealed that the generalized log likelihood function was -131.431. The log likelihood function implies that inefficiency exist in the data set. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model. Thus, the Cobb-Douglas used in this estimation is an adequate representation of the data. The value of gamma (γ) is estimated to be 0.855% and it was not significant. This is inconsistent with the theory that true γ-value should be greater than zero. This implies that 8.85% of random variation in the yield of the farmers was due to the farmers' inefficiency in their respective sites and not as a result of random variability. Since these factors are under the control of the farmer, reducing the influence of the effect of γ will greatly enhance the technical efficiency of the farmers and improve their yield. The value of sigma squared ($\boldsymbol{\sigma^2}$) was significantly different from zero at one percent level of probability.

This indicates a good fit and correctness of the specified distributional assumptions of the composite error terms while the gamma γ indicates the systematic influences that are unexplained by the production function and the dominant sources of random error. This means that the inefficiency effects make significant contribution to the technical inefficiencies of root and tuber crop farmers in the study area.

The coefficient (0.003938) for planting materials (X_1) is statistically significant at 1% level and has the expected positive sign, which is in conformity with the a priori expectation.The estimated 0.0039 elasticity of seed implies that increasing seed by 1% will increase root and tuber output by less than 1% which means, all things being equal the output is inelastic to changes in the quantity of seed used. The significance of seed quantity is however, due to the fact that seed determines to a large extent the output obtained. If correct seed rates and quality seeds are not used, output will be low even if other inputs are in abundance. This is in consistent with the findings of Shehu *et al* (2010) who observed that the estimated coefficient of seed and labour inputs were positive as expected and significant at 1% level which implies that the more seed is applied and the more labour employed the better the output of cowpea. The coefficient (0.31010) for farm size is statistically significant at 1% level of probability and has an expected positive sign which shows that land as an input has major influence on output. Since the farming activity is traditional, availability of land determines the level of output that can be obtained from the farm.

Table 4.14: Results of pooled maximum likelihood estimates of stochastic frontier production function for fadama III root and tuber farmers

Variable	Parameter	Coefficient	Standard error	T-value
Constant	Bo	10.14798	22.43387	0.452NS
Planting materials	β_1	0.003938	0.001035	3.804***
Farm size	β_1	0.30012	0.01010	3.070***
Fertilizer	β_2	0.03909	0.013543	2.5326***
Agrochemical	β_3	0.01079	0.000683	15.802***
Labour	β_4	0.0164	0.005184	3.1660***
Capital	β_5	0.069726	0.046061	1.514^{NS}
Inefficiency model				
Constant	Z_0	9.459683	12.33203	0.767^{NS}
Age	Z_1	-0.00754	0.003535	2.1326**
Farming experience	Z_2	-0.022898	0.003212	7.128***
Farm size	Z_3	0.362285	0.023764	15.245***
Household size	Z_4	0.01403	0.003712	-3.78***
Extension contact	Z_5	-0.022808	0.03956	0.577^{NS}
Diagnostic statistic	N			
Log likelihood function	*L/f*	-1208.58		
Number of observation		932		

Gamma	(γ)	0.885		
Sigma	(σ^2)	0.88499	0.000766	1155.543***
Mean efficiency		0.585		

*Asterisk indicate significance ***=1% and **=5% levels of significance.*

The coefficient (0.003509) for fertilizer (X_3) is statistically significant at 1% level and has the expected positive sign, which is in conformity with the a priori expectation. This implies that a 1% increase in fertilizer will increase root and tuber crop by 0.004%. Fertilizer is a major land augmenting input because it improves the quality of land by raising yields per hectare. This study is in tandem with the findings of Maurice (2004) and Oladiebo and Fajuyigbe (2007).

The coefficient (0.0164) of labour (X_5) was found to be positive which is consistent with the apriori expactationand significant at 1% level. This means that by increasing quantity of labour use by 1% will lead to 0.012% increase in root and tuber crop output. This shows that labour is an important variable in root and tuber crop farming in the study area. This is in line with several studies by Umoh (2006) and Okike (2000) which show the importance of labour in farming, particularly in developing countries where mechanization is rare on small scale farms. In the study area, human power plays a crucial role in virtually all farming activities. This situation has variously been attributed to the practice of split-plot cropping on small scattered land holdings and lack of affordable equipment (Umoh, 2006). Capital (X_6) was positive according to apriori expectation, but was not statistically significant.

The returns-to-scale estimates (0.440) obtained from the summation of the coefficients of the estimated input elasticities indicates decreasing returns to scale. This shows that if all the inputs included in the production function model are increased by 1 percent, root and tuber output will increase by 0.440 percent. The mean technical efficiency for the farmers was 0.585 percent implying that, on the average, the respondents are able to obtain 58.5% of potential output from a given mixture of production inputs. Thus, in a short run, there is the scope (41%) of increasing the efficiency, by adopting the technology and techniques used by the best root and tuber crop farmer in the study area.

The coefficient of agrochemical is 0.0119 which is positive according to apriori expectation and statistically significant at 1% level. This implies that agrochemicals positively influence the output of root and tuber crop production in the study area. The estimated 0.119 of agrochemical implies that increasing agrochemical by 1% will increase cowpea output by 0.11% which means, all things being equal the output is elastic to changes in the quantity of agrochemical used. However, this finding is in line with the findings of Shehu *et al* (2010) who observed that the estimated coefficient of agrochemical input was positive as expected and significant at 1% level implies that the more agrochemical is applied and the more labour employed the better the output of rice.

The coefficient (0.0697) of capital is positive according to apriori expectation, but not significant. The estimated coefficient of capital is 0.0697 implying that for every 1% increment in capital for root and tuber cropproduction, the output of root and tuber crop will be increased by 0.0697%.

The result of the inefficiency model is contained in table 4.14. The estimated coefficients with negative signs attached indicate that they reduce technical inefficiency among the root and tuber crop farmers, while positive signs indicate that the coefficients increase technical inefficiency or reduce technical efficiency. The results showed that Age, farming experience, farm size, household size and Extension contact were the determinants of technical inefficiency among the root and tuber crop farmers. Age, farming experience farming experience and cooperative association were negatively related with technical inefficiency, while household size and amount of credit were positively related with technical inefficiency.

The coefficient of age (-0.00754) is negative which is consistent with the apriori expectation and significant at 5% level of probability. This implies that holding other factors constant, a unit increase in the age of root and tuber crop farmer will reduce their technical inefficiency by magnitude of 0.00754%. This finding is at variance with Kolawole and Ojo (2007) who in their study of small scale oat growers in Nigeria found age to be positively related to inefficiency.

The coefficient of farming experience (-0.0228) is negative and significant at 1% level of probability. This implies that holding other factors constant, a unit increase in farming experience of root and tuber crop farmer will reduce their technical inefficiency by magnitude of 0.0228%. This finding is in consistent with that of Onu *et al.*, (2000) whose result showed a negative relationship farming experience and technical efficiency in cotton production in Nigeria. The sign of the variable is consistent with the apriori expectation

The coefficient of farm size (0.3628) is positive, inconsistent with the apriori expectation and significant at 1% level of probability. This implies that holding other factors constant, a unit increase in the farm size of root and tuber crop farmer will increase their technical inefficiency by magnitude of 0.3528%.

The coefficient of Household size (0.01403) is positive, inconsistent with the apriori expectation and significant at 1% probability level. This implies as household size increases, the technical inefficiency increases thereby reducing technical efficiency of farmers. It also implies that technical efficiency of farmers can be improved without taken into consideration the household size of the root and tuber crop farmers. This finding agrees with Mohammed Lawal *et al*., (2009) who reported that as household 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. Large household size is expected to enhance labour availability (Nwaru, *et al*., 2004). It has been reported the use of large family labour on small farms result in over-utilization and hence inefficiency (Okike, 2000). Older farmers are often not amenable to changes and are neither likely to adopt improved technologies nor have the physical strength to do manual work as the younger ones Ajibefun and Aderinola, (2003); Nwaru, (2004). This gives credence to why there exists a positive relationship between age and technical inefficiency.The finding of this study on age is in agreement with Kolawole and Ojo (2007) who in their study of small scale farmers in Nigeria found age to be positively related to inefficiency.

The coefficients of Extension contact (-0.0228) is negative, consistent with the apriori expectationbut not significant. This means being an having extension agents introducing innovation and training was not enough to significantly cause a farmer to attain higher levels of efficiency if he cannot afford the technology or put the training to use.

4.3.5 Estimatedstochastic frontier cost functions of root and tuber crop farmers

The Maximum Likelihood (ML) estimates of the stochastic frontier cost parameters for root and tuber crop production are presented in Table 4.15. For the cost function, the sigma ($\sigma^2 = 1.305$) and the gamma (γ=0.834) are quite high and highly significant at 1% level of probability. The high and significant value of the sigma square (σ^2) indicate the goodness of fit and correctness of the specified assumption of the composite error terms distribution (Idiong, 2005). The gamma ($\gamma = 0.834$) shows that 83% of the variability in the output of root and tuber crop farmers that are unexplained by the function is due to allocative inefficiency.

The results of stochastic frontier cost function for root and tuber crop farmers in north central Nigeria are shown in Table 4.13. The estimated coefficients of the parameters of the cost function are positive except that of fertilizer and agrochemical which are negative. The cost variables of planting materials, labour and output are significant at 1% level; capital is significant at 5% level of probability while fertilizer and agrochemical are not significantly different from zero.

The coefficient of the cost of planting materials (0.0112) is positive, consistent with the apriori expectation and significant at 1% level of probability. This implies that planting materials are important in root and tuber crop farms. The implication of this is that 1%

increase in the cost of planting materials will give rise to 0.0112% increase in the cost of root and tuber crop production. The cost of fertilizer (0.0511) is positive, consistent with apriori expectation and insignificant. This implies that 1% increment in cost of labour will increase the cost of root and tuber crop production by 0.0511%. The coefficient of the cost of agrochemical (0.0743) is positive and significant at 1.0% level of probability. This is an indication that 100% increase in the cost of agrochemical will result to 0.074 % increase in the cost of root and tuber crop production.

The coefficient of root and tuber crop output (9.278) is positive, consistent with the apriori expectation and significant at 1.0% level of probability. This implies that as the quantity of root and tuber crop produced increases, the cost of root and tuber crop production increases accordingly by 9.28%. This shows that the cost of production is influenced by the quantity of root and tuber crop output realized. This finding concurs with the one of Ogundari *et al.,* (2006) that reported direct effect of output on cost of production in the study on economies of scale and cost efficiency in small scale maize production in Nigeria.

The result of the inefficiency model of the stochastic frontier cost function revealed that Age, farm experience, farm size, household size and extension contact were the determinants of allocative efficiency among the root and tuber crop farmers. The coefficients of the variables were all significant at 1% level of probability, with exception of age and extension contact that are insignificant.

The coefficient of age (-0.00285) is negative and insignificant at 5% level. This implies that holding other factors constant, a unit increase in the age of root and tuber crop farmer will increase their allocative efficiency by magnitude of -0.00285%.

Farming experience has an estimated coefficient of -0.0205. This implies that the more experienced a root and tuber crop farmer is, the higher will be his allocative inefficiency. The more experienced the farmer the better the ability of the farmer as a decision maker to obtain and process information about prices and technology.

Household size has an estimated coefficient of 0.01401. The implication of this result is that larger the househousehold size are, the less allocative efficient they will be than small root and tuber crop household size. In other words, the smaller a root and tuber householdsize, the more efficient it will be in the allocation of productive resources. This may be due to the fact that larger root and tuber crop households have more mouths to feed than small root and tuber crop households, as a result of this, the ability to make appropriate choices between alternative farm inputs is constrained by the shortage of financial resources. This is not in agreement with the apriori expectation

The coefficient of extension contact is -0.01401. This is an indication that extension contact contributed towards reducing allocative inefficiencies among the root and tuber crop farmers. This finding agrees 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.

Table 4.15: Results of pooled maximum likelihood estimates of frontier cost function for rootand tuber farmers

Variable	Parameter	Coefficient	Standard error	T-value
Cost function				
Constant	B_o	9.278146	0.512128	18.117
Seed	β_1	0.011489	0.001016	11.30852***
Farm size	β_2	0.31012	0.01010	3.0702***
Fertilizer	B_3	0.05111	0.016313	2.5325***
Agrochemicals	B_4	-414699E-04	0.000673	-0.062^{NS}
Labour	B_5	0.148868	0.050897	2.924901***
Capital	B_6	0.096966	0.045631	2.124993**
Inefficiency model				
Constant	Z_0	8.461027	0.134407	62.951***
Age	Z_1	-0.00285	0.003454	-0.826^{NS}
Farming experience	Z_2	-0.020482	0.00312	-6.565***
Farm size	Z_3	0.358551	0.021294	16.838***
Household size	Z_4	0.01401	0.003355	4.177***
Extension contact	Z_5	-0.019515	0.034484	-0.566^{NS}
Diagnostic statistic				
Log likelihood function	*L/f*	-1192.42		
Number of observation	N	934		
Gamma	(γ)	0.834		
Sigma	(σ^2)	1.305681***	0.001122	1163.826

Mean efficiency	0.698

*Asterisk indicate significance ***=1% and **=5% levels of significance*

4.3.6 Pooled technical efficiency of root and tuber crop farmers

The frequency distribution of the technical efficiency estimates for root and tuber crop farmers in the study area as obtained from the stochastic frontier model is presented in Table 4.16. The study revealed that 2% of the root and tuber crop farmers had technical efficiency (TE) of 0.61 and above while 98% of the farmers operate at less than 0.61 efficiency level. The root and tuber crop farmers with the best and least practices had technical efficiencies of 0.90 and 0.087 respectively. This implies that on the average, root and tuber output fall by 10% from the maximum possible level of 1.00 due to technical inefficiencies. The result also showed a mean technical efficiency of 0.59. This means that majority of the root and tuber crop farmers operated closer to their production frontier. Also, this implies that on the average, root and tuber crop farmers are able to obtain 59% potential output from a given mix of productive resources. In the short-run, there is scope for increasing root and tuber crop output by 41% by adopting the techniques and technologies employed by the best root and tuber crop farmers. Furthermore, the study also revealed that for the average root and tuber crop farmer in the study areas to become the most efficient, he will need to realize about 65%[1-(0.59/0.90)*100] cost savings, while on the other hand, the least technically efficient root and tuber crop farmer will need about 90% [1-(0.09/0.90)*100] cost savings to become the most technically efficient root and tuber crop farmer.

4.3.7 Pooled allocative efficiency estimates of fadama IIIroot and tuber crop farmers

Table 4.16 below depicts the frequency distribution of the allocative efficiency estimates of root and tuber crop farmers in the study areas. The result revealed that 2% of the root and tuber crop farmers had allocative efficiency (AE) of 61% and above

while 98% of the root and tuber crop farmers had allocative efficiency (AE) below 61%. This implies that the greater proportion of root and tuber crop farmers were not allocative efficient as 2% of them attained efficiency level in the region of 0.61 and above. In other words, the clustering of allocative efficiencies in the region of 0.61 – 1.00 efficiency range implies that the root and tuber cropfarmers are not efficient. That is, the farmers are not efficient in producing root and tuber crop at a given level of output using the cost minimizing input ratio as about 2% of the root and tuber crop farmers have allocative efficiencies of 0.61 and above. High values of allocative efficiencies represent less efficiency or more inefficiency among the root and tuber crop farmers during the course of root and tuber crop production in the study areas. The estimated allocative efficiencies differ substantially among the root and tuber crop farmers ranging between the minimum value of 0.19 and maximum value of 0.99. This means that the most allocative inefficient root and tuber crop farmers operated closer to their cost frontier or minimum cost of 1.00. The mean allocative efficiency was 0.70. The study also revealed that for the average root and tuber crop farmer in the study areas to become the most allocative efficient root and tuber crop farmer, he will need to realize about 30% cost saving i.e. [1-(0.70/0.99)*100] while on the other hand, the least technically efficient root and tuber crop farmer will need about 81% [1-(0.19/0.99) x100] cost savings to become the most allocative efficient root and tuber crop farmer.

4.3.8 Pooled economic efficiency estimates of root and tuber crop farmers

The frequency distribution of the economic efficiency estimates of root and tuber crop farmers in the study areas is contained in Table 16. Frequency distribution of technical efficiency (T.E), allocative efficiency (A.E) and economic efficiency (E.E) shows that the predicted farm specific technical, allocative and economic efficiencies for root and

tuber crop farmers ranges between 8.7% - 90% with a mean of 58.5%, 19.3% - 99.8% with a mean of 69.8%, 5.6% - 89.8% with a mean of 41.1%. The result also revealed that 1% of the root and tuber crop farmers had economic efficiency (EE) of 0.61% and above while 99% of the root and tuber crop farmers had economic efficiency (EE) below 61%. The mean economic efficiency of the root and tuber crop farmers in the study areas was 0.41. This implies that on the average, there was a fall in the root and tuber crop output level by 59% from the maximum feasible level due to economic inefficiency. The root and tuber farmer with the best and least practice had economic efficiencies of 0.89 and 0.056 respectively.

In the same vein, the study also revealed that for the average root and tuber crop farmer in the study area to achieve economic efficiency of his most efficient counterpart, he will have to realise about 54% [1-(0.41/0.89)*100] cost savings while on the other hand, the least economic efficient root and tuber crop farmers will have to realise about 94% [1-(0.056/0.89)*100] cost savings to become the most economic efficient root and tuber crop farmer. However, the result indicates that the highest number of root and tuber crop farmers have economic efficiencies between 0.41-0.60, representing about 99% of the 934 root and tuber crop farmers. This is an indication that the root and tuber crop farmers were not economically efficient in producing root and tuber crops at a minimum cost for a given level of technology.

Table 4.16: Frequency distribution of pooled technical, allocative and economic estimates from the stochastic frontier model

Efficiency level	Technical efficiency		Allocative efficiency		Economic efficiency	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
<0.20	51	5	62	7	262	28
0.21-0.40	115	12	79	8	52	6
0.41-0.60	747	80	768	82	610	65
0.61-0.80	19	2	23	2	8	1
0.81-1.0	0	0	0	0	0	0
Total	934	100	934	100	934	100
Minimum	0.087		0.193		0.056	
Maximum	0.900		0.998		0.898	
Mean	0.585		0.698		0.411	

4.3.9 Socio-economic factors influencing the economic efficiency of root and tubercrop production

The result of the multiple regression estimates of the factors influencing the economic efficiency of root and tuber farmers is presented in table 4.17. The adjusted R square of 0.66 implies that 66% in the variability in the economic efficiency of root and tuber crop farmers in the study area is explained by the explanatory variables (age, gender, marital status, household size, education, off-farm income, farm size, credit access and remittance) specified in the model. The factors that had significant influence on

economic efficiency of root and tuber crop farmers in the study area were age, marital status, household size, education, farm size and credit access.

The coefficient of age was found to be positive and significantly related with economic efficiency. The estimated coefficient of 4.633429 implies that the economic efficiency of root and tuber crop farmers will increase by a magnitude of 4.633429 as age increases by one unit. Probably because accumulated knowledge and experience of farming systems a farmer acquired pays off over a long period of time (Bonabana-Wabbi, 2002).

The coefficient of marital status was found to be negative and significantly related with economic efficiency at 5% level of probability. The estimated coefficient of -49.3159 implies that the economic efficiency of root and tuber crop farmers will decrease by a magnitude of -49.3159 as age increases by one unit. Probably because as farmers increase in age, strength, agility and vigour decreases.The coefficient of gender was found to be negative and insignificantly related with economic efficiency. The estimated coefficient of -0.71823 implies that the economic efficiency of root and tuber crop farmers will decrease by a magnitude of –0.71823.

The coefficient household size was found to be positive and significantly related with the level of economic efficiency of root and tuber crop farmers. The estimated coefficient of 26.56224 implies that the economic efficiency of root and tuber crop farmers will increase by a magnitude of 26.56224 percent as household size increases by one unit. This means that larger household size also augments the total labour supply of the farm household and thereby enhances its farm income generating potentials. This implication is that majority of the household contributes to farm income by

supplementing its labour supply especially during peak period of labour requirement such as harvest and weeding period (Liverpool-Tasie, 2011). The major contributing factors to efficiency were farmer's years of experience and family size. Oguntade *et al*. (2010) evaluated the technical efficiency of cocoa farmers in Cross River State of Nigeria.

The coefficient ofeducation was found to have a direct relationship with the economic efficiency of root and tuber crop farmers in the study area and is statistically significant at 1% level of probability. The estimated coefficient of 4.621154 implies that the economic efficiency of root and tuber crop farmers will increase by a magnitude of 4.621154 as the number of years spent in school increases by one unit. Education enhances the acquisition and utilization of new technologies by farmers Dey *et al,* (2001); Nwaru, (2004); Effiong, (2005); Onyenweaku *et al*, (2005).

The coefficient ofoff-farm income had the expected positive relationship with the economic efficiency of root and tuber crop farmers and is insignificant. The estimated coefficient of 4.022826 implies that the economic efficiency of root and tuber crop farmers will increase by a magnitude of 4.022826 as their off – farm income increases by one unit. The coefficient offarm size had a negative relationship with the economic efficiency of root and tuber crop farmers and is significant in at 1% probability level. The estimated coefficient of -37.0111 implies that the economic efficiency of root and tuber crop farmers will decrease by a magnitude of 37.0111 as the farm size increases by one unit.

The coefficient of access to credit had the expected positive relationship with the economic efficiency of root and tuber crop farmers but is insignificant. This implies that holding other factors constant, a unit increase in the remittance to root and tuber crop farmers will increase their economic efficiency by magnitude of 0.002629.

The coefficient of remittance had the positive relationship with the economic efficiency of root and tuber crop farmers but is insignificant. This implies that holding other factors constant, a unit increase in the remittance to root and tuber crop farmers will increase their economic efficiency by magnitude of 7.36333.

Table 4.17: Socioeconomic factors influencing economic efficiency fadama III of root and tuber farmers in the study area

Variable	**Coefficients**	**Standard error**	**T- stat**
Constant	574.0608	67.3368	8.525217***
Age(X_1)	4.633429	0.35596	13.01671***
Gender(X_2)	-0.71823	0.864537	-0.83077^{NS}
Marital status(X_3)	-49.3159	20.96573	-2.35222**
Household size(X_4)	26.56224	9.718169	2.733256***
Education(X_5)	4.621154	1.069195	4.322086***
Off-farm income(X_6)	4.022826	6.522779	0.616735^{NS}
Farm size(X_7)	-37.0111	7.183553	-5.15219***
Access to credit (X_8)	0.002629	0.000254	10.34785***
Remittance(X_9)	7.36333	28.57598	-0.25768^{NS}
R Square	0.662		
Adjusted R Square	0.637		

*Asterisk indicate significance ***=1% and **=5% levels of significance*

4.3.10 Test of hypothesis

The null hypothesis (H_o) which stated that there is no significant relationship between socioeconomic characteristics of root and tuber crop producers and economic efficiency estimates was tested using the result of regression analysis presented in Table 4.18. Based on the result the null hypothesis is rejected because of the six variables (age, marital status, household size, education, farm size and credit access) significantly influence economic efficiency.

4.3.11 Test of hypothesis of impact of fadama III on root and tuber crop participants'productivity

The test of the ascersion that the improved root and tuber crop Participants' productivity obtained was as a result of their participation in Fadama III programme was carried out using the Chow test analysis. The application of the chow test statistic involved obtaining the residual sum of squares from regression analysis which involved participants and non-participants separately pooled as their third regression. If the F*-chow statistic is greater than F – table then the impact is from Fadama II, otherwise the impact is outside the programme.As shown in the table 4.18, the F-chow calculated value is 3.729 while that F- tabulated value is 1.95 at 5 percent level of probability for eight degree of freedom and the population (N) was 934. The analysis shows that F* -chow calculated is greater than F-tabulated. This implies that Fadama III had impact on Root and tuber crop productivity of programme participants. This is in agreement with the findings of Simonyan (2010) on the impact analysis of Fadama II project on income and productivity of beneficiaries' farmers in Kaduna State.

Table 4.18: Impact of fadama III programme on the participants' productivity

Group sample	R^2	Residual sum of square	N	K	F-cal	F-tab
Pooled	0.42	1800218000000	934	9	3.729	1.95
Participants	0.51	883553000000	427			
Non-participants	0.43	852899900000	507			

R^2 = regression coefficient, N = numbers of observation and K = numbers of parameters

4.4 Impact of Fadama III Programme on Participants' Food Security

4.4.1 Household food security status

In order to measure household food security, a Food Security Index (FSI) was constructed. The quantity of crops produced and purchased for consumption was converted to Kilogram and further to calorie and protein respectively and then divided by household size adjusted for adult equivalent using the equivalent male adult scale weights. To obtain the calorie and protein per household, the consumed per day per household, the result was further divided by 365 days and then compared with the standard (2260 Kcal and 65 grammes) respectively. The nutrient composition of commonly eaten foods in Nigeria was used to estimate the calorie intake of households. The householdwhose daily per capita calorie intake was up to 2260kcal were regarded as food secure and those below 2260 kcal were regarded as food insecure.

Table 4.18 shows that 63% and 61% of participants and non-participants were food secure respectively. Similarly, the participants had less food insecure households (37%) than non-participants (38%). The Food Security Index was 2.25 and 1.93 for paticipants and non-participants respectivelty.

The average household daily calorie consumption for food secure households was 2978.809 kcal for participants' and2841.632 kcal for non-participants respectively. Based on the recommended daily calorie intake of 2260 kcal, the average household had 581.632 and 718.809 kcal in excess of the recommended intake for the participants and non-participants respectively. On the other hand, the average daily household per capita calorie consumption for food insecure householdwas 1070.6 and 962.52 kcal for participants and non-participants respectively. This means that the average daily households per capita calorie consumption for food insecure households were 1297.48 and 1189.33 kcal below the recommended intake for the participants and non-participants respectively. Further analysis revealed that ₦37,836.22/month and ₦30,232.52/month by participants and non-participants respectively were spent on the average per capita food expenditure respectively. This difference in expenditure on food could be due to the fact that the average crop production (grain equivalent) of participants (7,840.19) is greater than that of non-participants (5,679.01). This indicates that Fadama III root and tuber crop scheme has positive significant effect on food securitystatus of the participants.

Table 4.19: Household food security status of fadama III root and tuber crop farmers

Variables	Participants	Non-Participants
Food secure Household(No)	318	267
Food Security Index	(2.25)	(1.93)
Percentage of the Food Secure Households	63.53%	62.53
Food Insecure Household (No)	160	184
Food Insecurity Index	(0.53)	(0.55)
Percentage of the FoodInsecure households	36.7%	37.53%
Household Size (Adult Equivalent)	7.45	6.73
Per Capita Food Expenditure/Month(₦)	₦37,836.22	₦30,232.52
Crop production(grain equivalent)	7,840.19	5,679.01
Household Daily calorie Consumption (kcal)		
Food Secure	2988.86	2845.48
Food Insecure	972.53	1474.61

4.4.2 Socio-economic determinants of food security status of participants in fadamaIII root and tuber crop production

Tables 4.20 present the results of logit regression on the determinants of farm household's food security status among Fadama III root and tuber crop farmers in north central Nigeria. This method was adopted in line with other studies by Okurut *et al*. (2002), Alemayehu *et al.* (2005), Anyanwu (2010) and Masood and Nasir lqbal (2010).

The model accounted R^2 (0.592) for 60% of the variation in food security status of the Fadama III root and tuber crop households in north central Nigeria.

The result of the logit regression indicates that age(X_1) has a positive coefficient (42.6681) is significant at ($p<0.01$) level of probability, implying that age of farmer will likely influence food security status. The age of the households sampled was found to be positively correlated to the food security status indicating that as the household heads get older, the likelihood of being food secure also increases. This position is consistent with those of Gang *et al.* (2002), Datt and Jolliffe (1999), and Rodriguez (2002) that poverty increases with old age as the productivity of the individual decreases. Gender(X_2) has a negative coefficient (-467.06), but not significant which implies that the gender of a farmer will not likely impact on the food security status of the farmers. This showed that the number of male and female adults involved in income generation activities in a household can be a cause to escape from food insecurity. Hence, the household characteristics and composition play an important role to determine the food security status of a household. The more the number of adult either male female in a household who are educated, the more the opportunity to generate more income which will be available for consumption and the more the likelihood to escape from food insecurity.

Table 4.20: Socio-economic determinants of food security status of root and tuber crop farmers

Variable	**Coefficient**	**Standard error**	**T-value**
Constant	0.293	935.7402	5.966713
Age (X_1)	0.6681	13.34102	3.19826***
Gender(X_2)	-0.06	295.8839	-1.57852^{NS}
Marital status(X_3)	-0.578	151.7871	-3.18589***
Household size(X_4)	-0.97	16.43832	-1.03235^{NS}
Education(X_5)	0.0649	101.548	1.636859*
Farm size(X_6)	0.863	88.58287	1.646628*
Off-farm income(X_7)	0.001968	0.003692	0.533088^{NS}
Credit access(X_8)	0.114	406.6908	2.262441**
Remittance (X_9)	0.104799	0.062972	1.66422*
R Squared	0.592		
Adjusted R Squared	0.573		

*Note: *** Significant at 1% , ** Significant at 5% and *** Significant at 10% levels of Significance*

Marital status(X_3) has a negative coefficient (-483.578) and signicant, thus implpying that marital status is an important factor in food security status determination, house hold size has a negative coefficient (-16.97), but insignificant, thus, household size is not an important variable in food security status determination for as much as a large number of the adult in the family are females and children who not engaged in any productive venture. The results obtained from the study area further revealed that the

likelihood event of being food secure were more with large households. Evidence from other studies point to the same direction between food insecurity and household size (Okurut *et al*. (2002), Gang *et al*. (2002), Bokosi (2006), Anyanwu (2010) and Masood and Nasir lqbal (2010).The larger the household size the more food insecure the household is likely to be because more of the household members will likely be children who are unproductive and yet take a big proportion of household income in terms of school fees, medical bills, food and clothing. Therefore, units increase in the size of the farm household increases the probability of the farm households being food insecure by 16.97%. Off-farm income(X_7) has a positive coefficient (0.001968) but is insignificant, thus implies that off-farm income is not an important variable in food security status determination and will not significantly influence the probability that a household will be food secure or food insecure. Education(X_5) has a positive coefficient (0.951), but an insignificant variable in food security status determination. Education is vital for boosting the productivity of the human factor and making people more aware of opportunities for earning a living or income generation from non-farm sources. In this wise, farm households sampled in the north central Nigeria with educated heads were found to be less likely to be significantly food secure when compared with those that are not educated. Therefore, a unit increase in the level of education of farm household heads increases the probability of the households to escape food insecurity by 156%. Farm size(X_5) has a positive coefficient (145.863) and is significant at ($p<0.10$) level of probability, there implying that farm size is an important food security status determinant in the study area and it will significantly influence the probability that a household will be food secure or food insecure. Access to credit(X_8) by farm households has significant positive relation with food security status and this will aid the households to escape from food insecurity. This is in line with the general

believedthat credit is an anti-food insecurity strategy because of the important role it plays among rural populace (Adeyeye, 2001). Credit assists the farm households in the purchase of farm inputs such as fertilizer, herbicides, improved seeds and investment demand which will ultimately increase their productivity. Therefore, a unit increase in credit access by farm household in north central Nigeria will increase the probability of the households being food secure by 920%., credit access has a positive coefficient (920.114) and is significant at ($p<0.05$) level of probability, and remittance(X_9) has a positive coefficient (0.104799), and will significantly influence the probability that a household will be food secure or food insecure. A unit increase in remittance by the farming household will increase food security by 0.1%.

4.4.3 Impact of fadama III programme on root and tuber crop famers' food security

Insreased income which results from increased crop production was the major objective of Fadama III Development Programme. On the other hand, availability of food is an indicator of farm households' food security status. Therefore, in assessing the impact of Fadama III programme on Root and Tuber crop scheme on food security status of participants using Propensity Score Match (PSM), the annual crop production was used as a proxy for food security. The advantage of this is that there is no need for the assumption of constant additive treatment effect across individuals.

If a project's outcome indicator is household crop production, the average impact of the project on its particiopants is the difference between the quality of crop production by the participants of the project and that of the non-participants. If the difference in crop production between the participants and non-participants is positive, it implies that there was impact of the project on the participants otherwise no impact. Since the average

impact of treatment on the treated as shown in table 4.21 is positive (61.86215), this means that the Fadama III root and tuber crop scheme in the study area had significant impact on the programme participants. This is inconsistent with Adebayo (2011) work on the evaluation of United Nations development programmes microcredit schemes on food security status of farm households in Kaduna State but however, inconsistent with. This is as shown in table 4.20below.

Table 4.21: PSM/ATT result of fadama III root and tuber crop scheme impact on participants

Variable	Result (PSM/ATT)	Standard Deviation	T-Value	Standard Error	Crop Production (Participants)	Crop Production (Non-Participants)
Food Security	61.86215	1476.325	0.5471	0.0684	27,840.19	24,679.01

***** PSM/ATT = Propensity Score Match / Average Treament Effect on the Treated

4.5 Impact of Fadama III Root and Tuber Crop Scheme on the Poverty Status of Programme Participants

4.5.1 Expenditure profile of fadama III households and non-fadama IIIhouseholds

This section focuses on household expenditure on food and non-food items, the estimation of poverty line, expenditure pattern by poor and non poor and the impact of fadama III root and tuber scheme on the poverty status of root and tuber farming households in the study area. Table 4.22presents the summary statistics of the expenditure profile of the households. The table shows that the estimated mean annual household expenditure on food consumed was₦27, 265.09 and ₦23,206.21 and

representing 53% and 45%for fadama III participants and non-participants respectively of the total household expenditure. Other non-food items such as clothing and footwear, health and medicare, education, fuel and lightning, transportation, remittances (to dependants, gift to friends and family members), rent and other unlisted consumption goods accounted for ₦23,850.57 and₦27,909.45 representing 47% and 55% for Fadama III root and tuber crop scheme participants and non-participants respectively.

Table 4.22: Mean annual household expenditure profile root and tuber crop farmers

Fadama III Participants		**Fadama III Non-Participants**	
Item	**Ave. Annual Exp.**	**% Total Exp.**	**Ave. Annual Exp**	**%. Total Exp.**
Food	27,265.09	53.34	23,206.21	45.40
Clothing & footwear	5,162.68	10.10	1,553.92	3.04
Health & Medicare	1,482.35	2.90	1,559.92	3.13
Education	5,178.02	10.13	8,832.79	17.28
Electricity and Lightning	276.02	0.54	1,032.54	2.02
Fuel/Transportation	1,364.79	2.67	2,954.49	5.78
Remittances	3,578.09	7.0	2,596.68	5.08
Kerosene/Firewood	690.06	1.35	2,090.63	4.09
Rent	4,738.42	9.27	4,155.70	8.13
Others	1,380.12	2.70	3,092.97	6.05
MeanHouseholdExpenditure(MHE)=₦51,115.66				

4.5.2 Poverty status of fadama III root and tuber crop farmers

This section focuses on household estimation of poverty line, household poor, non poor and the impact of fadama III root and tuber scheme on the poverty status of root and tuber participating households in the study area. The farm households' poverty status among the Fadama III participants and non-participants were analyzed using the three indicators; prevalence of poverty (Po), poverty depth (P1) and severity of poverty (P2). Prevalence of poverty indicate the percentage of the households falling below the poverty line; poverty depth shows the amount by which the poor fall short of the poverty line and severity of poverty is the sum of the square of poverty depth divided by the number of poor households inthe sample. As shown in Table 4.23, the poverty incidence for the Fadama III root and tuber scheme participants and non-participants was 0.28 and 0.43 representing 28 percent and 43 percent of the farm households in the study area were poor while 0.72 and 0.57 representing 72 percent and 57 percent of the Fadama III root and tuber crop scheme participants and non-participants were non-poor. The prevalence of poverty among the farm households in the study area was 0.28 and 0.43 representing 28 percent and 43 percent of the participating and non-participating Fadama III root and tuber crop farm households with consumption expenditure level below the poverty line. The poverty depth was 0.09 and 0.17 representing 9 percent and 17 percent respectively of the Fadama III participants and non-participants whose average consumption expenditure was below the poverty line. This gap represents the percentage of expenditure required to bring poor households below the poverty line up to the poverty line. The severity of poverty index was 0.04 and 0.10 representing 4 percent and 10 percent respectively of the participants and non-participants of Fadama III root and tuber crop scheme which represents the poorest among the poor farm households who require the attention of policy maker in the distribution of the standard

of living indicators, such as health care services, clean water and income generating activities.

Table 4.23: Poverty status of participants and non-participants of root and tuber crop scheme

Poverty categories	**Participant**	**Non-participant**
Poor	0.28	0.43
Non-poor	0.72	0.57
Poverty indices		
Poverty incidence(P_0)	0.28	0.43
Poverty depth(P_1)	0.09	0.17
Poverty severity(P_2)	0.04	0.10
POVERTY LINE:		
MHE=	₦51,115.66	
2/3*MHE=	₦ 34,077.11	

*MHE= Mean Household Expenditure

4.5.2 Determinants of poverty status of participants in root and tuber crop scheme

Table 4.24 present the results of logit regression on the determinants of farm household's poverty status among Fadama III root and tuber crop farmers in north central Nigeria. This method was adopted in line with other studies by Okurut et al. (2002), Alemayehu et al. (2005), Anyanwu (2010) and Masood and Nasir lqbal (2010). The estimated coefficients for the likelihood ratio chi-square was significant ($p<0.01$) for the State with chi-square value of 507.21. The model accounted R^2 (0.735) for 74%

of the variation in poverty status of the Fadama III root and tuber crop households in north central Nigeria.

The result of the logit regression indicates that age has a positive coefficient (0.054) is significant at ($p<0.01$) level of probability, implying that age of farmer will significantly influence poverty status. The age of the households sampled was found to be positively correlated to the poverty status indicating that as the household heads get older, the likelihood of being poor also increases. This position is consistent with those of Gang et al. (2002), and Rodriguez (2002) that poverty increases with old age as the productivity of the individual decreases. Marital status has a negative coefficient (-0.052), but not significantwhich implies that the marital status of a farmer will not signifinatly impact on the poverty status of the farmers. This showed that the number of male and female adults in the household of a married man or woman involved in income generation activities in a household can be a cause to escape from poverty. Hence, the household characteristics and composition play an important role to determine the poverty status of a household. The more the number of adult either male female in a household who are educated, the more the opportunity to generate more income which will be available for consumption and the more the likelihood to escape from poverty. House hold size has a positivecoefficient (0.069) and significant at ($p<0.01$) level of probability, thus, household size is an important variable in poverty status determinationThe results obtained from the study area further revealed that the likelihood event of being poor were more with large households. Evidence from other studies point to the same direction between poverty and household size (Okurut, et al. (2002), Gang, et al. (2002), Bokosi, (2006), Anyanwu, (2010) and Masood and Nasir lqbal (2010).The larger the household size the poorer the household is likely to be because more of the household

members will likely be children who are unproductive and yet take a big proportion of household income in terms of school fees, medical bills, food and clothing. Therefore, a unit increases in the size of the farm household increases the probability of the farm households being poor by 6.9%. Off-farm income has a positive coefficient (0.375) but not significant, thus implies that off-farm income is not an important variable in poverty status determination and will not significantly influence the probability that a household will be poor or non-poor The increased income will enable the households to move out of poverty. Education has a positive coefficient (0.951), but an insignificant variable in poverty status determination. Education is vital for boosting the productivity of the human factor and making people more aware of opportunities for earning a living or income generation from non-farm sources. In this wise, farm households sampled in the north central Nigeria with educated heads were found to be less likely to be poor when compared with those that are not educated. Bastos et al. (2009) further corroborated that labor is by far the most important asset of the poor and increasing their education will in turn increase labor productivity and wages which ultimately will reduce their poverty. Further evidence was given by Apata and Rahji (2007), to confirm that there is a link between educational attainment, the income earning potential of the household and poverty. He pointed out that there is a minimum level of education necessary to enhance appreciation and adoption of new technologies that can be instrumental in increasing household productivity, and thereby earn more income. Therefore, a unit increase in the level of education of farm household heads increases the probability of the households to escape poverty or being non-poor by 1%. Farm size has a positive coefficient (0.198) and is significant at ($p<0.01$) level of probability, there implying that farm size is an important poverty status determinant in the study area and it will significantly influence the probability that a household will be poor or non-poor. Access to credit by

farm households has significant negative relation with poverty status and this will aid the households to escape from poverty. This is in line with the general the believe that credit is an anti-poverty strategy because of the important role it plays among rural populace (Adeyeye, 2001). Credit assists the farm households in the purchase of farm inputs such as fertilizer, herbicides, improved seeds and investment demand which will ultimately increase their productivity. Therefore, a unit increase in credit access by farm household in north central Nigeria will increase the probability of the households being non-poor by 183%, credit access has a positive coefficient (0.046) and is significant at ($p<0.01$) level of probability, and remittance has a positive coefficient (0.145), but not significantly influence the probability that a household will be poor or non-poor.

Table 4.24: Result of the socioeconomic factors determinants of poverty status of the participants of the root and tuber crop scheme

Variable	**Coefficient**	**Standard error**	**T-value**	**Marginal effect**
Constant	-4.996	2.295	-2.177	0.007
Age	0.054***	0.014	3.857***	1.055
Marital status	-0.052	0.146	-0.356^{NS}	0.949
Household size	0.069***	0.028	2.464***	1.071
Education	0.08	0.099	0.808^{NS}	1.084
Farm size	0.198**	0.083	2.386**	0.821
Off-farm income	0.375*	0.199	1.884*	1.456
Credit access	-1.833***	0.563	-3.256***	0.160
Remittance	0.145	0.125	1.160^{NS}	1.156
Log likelihood function	-221.077			
Pseudo R^2	0.735			
Number of observation	427			
Chi-square	507.21***			

P-value	0.000
Overall % prediction	71.9

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

4.5.4 Test of significance of impact of fadama III on poverty alleviation of participants

The hypothesis was analyzed using Z-test. Crop output was used as proxy for poverty status. The result as presented in Table 4.25 shows that Z- calculated is greater than Z-critical and is significant at 5% level of probability, thus implying that there was impact of Fadama III root and tuber crop scheme on the alleviation of the participants from poverty.

Table 4.25: Result of Z-test of the impact of fadama III on the poverty status of participants root of tuber crop farmers

Variable	**Participants**	**Non-participant**
Mean	14805.41	9091.703
Known Variance	1.49E+09	1.25E+09
Observations	427	505
Hypothesized Mean Difference	0	
Z-cal	2.336**	
P(Z<=z) one-tail	0.0097	
Z-Critical one-tail	1.645	
P(Z<=z) two-tail	0.0195	
Z-Critical two-tail	1.960	

Note: **Significant at 5%

4.6 Constraints Encountered by Root and Tuber Crop Farmers

Root and tuber crop farmersare faced with some constraints in their attempt to produce root and tuber crops in the study area. These are presented in Table 4.26.

High input cost: About 86 % of the respondents in the study area complained of high cost of input in root and tuber crop production. This they opined is the major cause of low profit in agricultural production.

Limited finances: About 77% of the respondents had limited access to credit. The reasons for limited access to credits may include high interest rates charged by commercial banks, absence of agricultural financial institutions in the rural areas, and lack of collateral to secure loans from commercial banks. Even from the cooperative societies they belong, funds is often not sufficient to go round as at when demanded, particularly during the farming season.

Bad roads: About 76% of the respondents reported that roads in the study area were bad. An efficient transport system is critically important for efficient agricultural marketing. If transport services are of poor quality or expensive, then farmers will be at a disadvantage when they sell their crops. An expensive service will naturally lead to low farm gate prices (the net price the farmer receives from selling his produce). In Nigeria, trips from crop producing areas to the buying urban markets are made over rough roads. This result in lower prices, crop losses due to spoilage and higher cost of farm inputs (Sieber, 1999).

Low produce prices: Low prices were listed by 39% of the farmers. Low prices offered for the commodity relates to the imperfect nature of the rural markets in the study area. These rural markets are separated by long distances connected by bad roads and few vehicles. The proportion of produce price captured by smallholders, and the wages paid to labourers on the farms, have a critical bearing on poverty including the ability of rural households to meet health and education costs.A report by the World Bank (1986) state that an insufficient price incentive for agricultural producers is an important factor behind the disappointing growth of African agriculture. According to Takane (2000), provision of incentives to farmers is usually considered essential for agricultural development in Africa.

Inadequate equipment/facilities: Equipment and facilities such as milling machines, drying platforms, knapsack sprayers and wheel barrows. About 35% of the respondents said they do not have these equipments and those that have complained of high cost of purchase because of the rural locality.

Poor marketing: In the study area, about 30% of root and tuber crops farmersreported that marketing of root and tuber products was difficult. The adverse market conditions faced by small producers are the result of chronic world oversupply of root and tuber crops and high price volatility fuelled by speculation on commodity exchanges. Marketing problems also arise due to lack of competition along the root and tuber crops supply chain. Badly designed agricultural commodity market structures reforms in the country also undermined the ability of poor producers to participate in root and tuber markets on more equitable terms.

High cost of labour: About 29% of the respondents mentioned high cost of labour as a constraint. Tasks in root and tuber crops production such as weed control, harvesting, processing, product drying, and transportation all require labour. Most farmers during this period rely on hired labour.

Poor storage: About 22% of the farmers mentioned that they the planting materials on the floor. Poorly stored planting materials turn mouldy and lose its viability and quality.

Shortage of fertilizer: Fertilizer is an important input in crop production in that it replenishes the fertility of the soil. However, it is not extensively used in the study area. About 14% of root and tuber crop farmers indicated that they would have used the input if it were available at an affordable price.

Table 4.26: Constraints faced by root and tuber crop farmers

Problem	Frequency	Percentage (%)
High costs of input	155	86
Limited finances	139	77
Bad roads	136	76
Low produce prices	71	39
Inadequate fixed inputs	63	35
Poor marketing practices	54	30
High cost of labour	53	29
Poor storage facilities	39	22
Non-availability of water	31	17
Shortage of fertilizers	25	14

Total	**766***	**425***

*Multiple responses allowed

CHAPTER FIVE

SUMMARY, CONCLUSION, CONTRIBUTION TO KNOWLEDGE AND RECOMMENDATIONS

5.1 Summary

The broad objective of this study was to evaluate the impact of Fadama III programme on productivity, food security and poverty status among root and tuber crop farmers in the north central Nigeria. In other to achieve this objective, multistage sampling technique was employed to select the respondents. In the first stage, three states namely; Benue, Kogi and Plateau States under the Fadama III root and tuber crop programme was purposively selected from the states in the north central zone based on the targeted root and tuber crops adopted for the National Fadama Development Project. In the second stage, four local government areas were purposively selected from Benue state, three local government areas from Kogi stateand one local government area was selected from Plateau state based on the levels of root and tuber crops production in these local government areas and involvement in Fadama III programme. In the third stage, six districts and seventeen villages were randomly selected in the four local government areas in Benue state. Three LGAs, five districts and eight villages were randomly selected from Kogi state. One LGA, two districtsand four villages were randomly selected from Plateau state respectively. In the fourth stage, from the sample frame, a total of four hundred and twenty seven participants (10%) and five hundred and seven non-participants (10%) were randomly selected for this study. A total number of twenty three villages were selected.The selection of the farmers was done randomly from the list of farmers participants from the National Fadama office in Abuja. A total of nine hundred and thirty four structured questionnaires were administered on both the Fadama III participants and non-participants in the study area. Data for analysis was

based on before and after Fadama III programme experience of the respondents. The result was anaysed through the use of descriptive statistics, net farm income analysis, production function, double difference method, paired z-statistics, propensity score match and chow test statistics.

The results of the study shows that minimum age of the farmers cultivating root and tuber crops in the study is made up of 22 years and 30 years, maximinum age is 70 years and 78 years and the mean age are 22 years and 34 years for participants and non-participants respectively. The minimum faming experience in root and tuber production of participants and non-participants are 2 years each, maximum farming experience is 50 years each for participants and non-participants, the mean experience is 23 years and 22 years for the participants and non-participants respectively. The analysis shows that the minimum years spent on education is 6 years each for both programme participants and non-participants , maximum years spent on education is 16 years each for both fadama III participants and non-participants. The minimum years of cooperative involvement is 1 year each for both programme participants and non-participants of Fadama III root and tuber farmers, maximum years in cooperative is 25 years and 26 years for participants and non-participants of Fadama III root and tuber farmers while the mean years of involvement in cooperative is 7 years and 6 years for participants and non-participants respectively. The minimum hecterage cultivated by the Fadama III root and tuber crops participants and non-participants is 1 hectare and 1.5 hectares respectively, the maximum hecterage cultivated is 10 hectares each for both programme particioants and non-participants, while the mean farm size cultivated is 2.6 hectares and 1.5 hectares for programme participants and non-participants respectively. The distribution according to farm size indicates that Fadama III Root and tuber farmers

were made up of small, medium and large-scale farmers. About 10% and 8% participants and non-participants of the Fadama III root and tuber cropfarmers were singles, 61% and 68% of the participants and non-participants were married, 0% and 11% of participants and non-participants were divorced, and 29% and 11% were widowed. The minimum household size of the participants and non-participants is 5 persons and 2 persons; the maximum household size is 68 persons each for the participants and non-participants respectively, while the mean hosehold size is 10 persons each for the fadama III root and tuber crop participants and non-participants respectively. The average number of contacts for the Fadama III root and tuber crop participants was approximately 2 with a standard deviation of 0.76; while that for the non-participants was approximately 1 time with a standard deviation is 0.18.

The net farm income (NFI) for Fadama III root and tuber crop participants and non participants was before the programme is ₦268,195.04 /Ha and ₦287,768.09 /Ha respectively,while the net farm income after the programme is ₦639,584.75 and ₦511,515.40 for participants and non-participants respectively. The result indicates that root and tuber crop production is profitable in the study area. This is in agreement with the work of Ajayi, (2014) titled 'comparative economic study of mixed and sole cassava cropping systems in Nigeria. The change in net farm income (NFI) is 57.67% and 43.74% for participants and non-participants respectively. The double difference, that is, the difference between the two output differences ₦1032827.711 – ₦ 734047.8485] is ₦.298779.8629.It indicates that the double difference estimates of the net farm income of participants and non-participants of Fadama III root and tuber crop scheme had a positive value. The implication is that Fadama III root and tuber crop scheme had positive impact on the participants' net farm income.

The frequency distribution of the technical efficiency estimates for root and tuber crop farmers in the study area as obtained participants in the study area. This result is consistent with the findings of Ezeh (2004) and Nkonya *et al* (2008). The study revealed that 19% of the root and tuber crop farmers had technical efficiency (TE) of 0.61 and above while 81% of the farmers operate at less than 0.61 efficiency level. The root and tuber crop farmers with the best and least practices had technical efficiencies of 0.90 and 0.087 respectively.

The result also revealed that 35% of the root and tuber crop farmers had allocative efficiency (AE) of 61% and above while 65% of the root and tuber crop farmers had allocative efficiency (AE) below 61%. This implies that the greater proportion of root and tuber crop farmers were not allocative efficient as 35% of them attained efficiency level in the region of 0.61 and above.

Also, the result of technical efficiency (T.E), allocative efficiency (A.E) and economic efficiency (E.E) shows that the predicted farm specific technical, allocative and economic efficiencies for root and tuber crop farmers ranges between 8.7% - 90% with a mean of 58.5%, 19.3% - 99.8% with a mean of 69.8%, 5.6% - 89.8% with a mean of 41.1%. The result also revealed that 1% of the root and tuber crop farmers had economic efficiency (EE) of 0.61% and above while 99% of the root and tuber crop farmers had economic efficiency (EE) below 61%. The mean economic efficiency of the root and tuber crop farmers in the study areas was 0.41. This implies that on the average, there was a fall in the root and tuber crop output level by 59% from the maximum feasible level due to economic inefficiency. The root and tuber farmer with the best and least practice had economic efficiencies of 0.89 and 0.056 respectively.

In the same vein, the study also revealed that for the average root and tuber crop farmer in the study area to achieve economic efficiency of his most efficient counterpart, he will have to realise about 54% [1-(0.41/0.89)*100] cost savings while on the other hand, the least economic efficient cowpea farmers will have to realise about 94% [1-(0.056/0.89)*100] cost savings to become the most economic efficient root and tuber crop farmer. However, the result indicates that the highest number of root and tuber crop farmers have economic efficiencies between 0.41-0.60, representing about 99% of the 934 root and tuber crop farmers. This is an indication that the root and tuber crop farmers were not economically efficient in producing root and tuber crops at a minimum cost for a given level of technology.

The frequency distribution of the economic efficiency estimates of root and tuber crop farmers in the study area. Frequency distribution of technical efficiency (T.E), allocative efficiency (A.E) and economic efficiency (EE) shows that the predicted farm specific technical, allocative and economic efficiencies for root and tuber crop farmers ranges between 8.7% - 90% with a mean of 58.5%, 19.3% - 99.8% with a mean of 69.8%, 5.6% - 89.8% with a mean of 41.1%. The result also revealed that 1% of the root and tuber crop farmers had economic efficiency (EE) of 0.61% and above while 99% of the root and tuber crop farmers had economic efficiency (EE) below 61%. The mean economic efficiency of the root and tuber crop farmers in the study areas was 0.41. This implies that on the average, there was a fall in the root and tuber crop output level by 59% from the maximum feasible level due to economic inefficiency. The root and tuber farmer with the best and least practice had economic efficiencies of 0.89 and 0.056 respectively.

The test of the ascersion that the improved root and tuber crop Participants' productivity obtained was as a result of their participation in Fadama III programme was carried out using the Chow test analysis.The F-chow calculated value is 3.729 while thae F-tabulated value is 1.95 at 5 percent level of probability for eight degree of freedom and the population (N) was 934. The analysis shows that F* - chow calculated is greater than F-tabulated. This implies that Fadama III had impact on Root and tuber crop productivity of programme participants.

The result of food security status shows that 61% and 63% of participants and non-participants were food secure respectively. Conversely, the participants had more food insecure households (39%) than non-participants (37%). The Food Security Index was 1.83 and 2.15 for paticipants and non-participants respectivelty.The average household daily calorie consumption for food secure households was 2841.632 kcal for participants and 2978.809 kcal for non-participants respectively. Based on the recommended daily calorie intake of 2260 kcal, the average household had 581.632 and 718.809 kcal in excess of the recommended intake for the participants and non-participants respectively. In assessing the impact of Fadama III programme on Root and Tuber crop scheme on food security status of participants using Propensity Score Match (PSM), the annual crop production was used as a proxy for food security. Since the average impact of treatment on the treated is positive (61.86215), this means that the Fadama III root and tuber crop scheme in the study area had significant impact on the programme participants.

Crop output was used as proxy for poverty status. The result of Z-statistics shows that Z- calculated is greater than Z-critical and is significant at 5% level of probability, thus

implying that there was impact of Fadama III root and tuber crop scheme on the alleviation of the participants from poverty.

About 86 % of the respondents in the study area complained of high cost of high cost of input in root and tuber crop production. Also, about 77% of the respondents had limited access to credit. The reasons for limited access to credits may include high interest rates charged by commercial banks, absence of agricultural financial institutions in the rural areas, and lack of collateral to secure loans from commercial banks. About 76% of the respondents reported that roads in the study area were bad.Low prices were listed by 39% of the farmers. Low prices offered for the commodity relates to the imperfect nature of the rural markets in the study area. These rural markets are separated by long distances connected by bad roads and few vehicles. The proportion of produce price captured by smallholders, and the wages paid to labourers on the farms, have a critical bearing on poverty including the ability of rural households to meet health and education costs. About 35% of the respondents said they do not have these equipments and those that have complained of high cost of purchase because of the rural local. In the study area, about 30% of root and tuber crops farmers reported that marketing of root and tuber products was difficult. The adverse market conditions faced by small producers are the result of chronic world oversupply of root and tuber crops and high price volatility fuelled by speculation on commodity exchanges. About 29% of the respondents mentioned high cost of labour as a constraint. Tasks in root and tuber crops production such as weed control, harvesting, processing, product drying, and transportation all require labour. Most farmers during this period rely on hired labour. About 22% of the farmers mentioned that they the planting materials on the floor. Poorly stored planting materials turn mouldy and lose its viability and quality. About

14% of root and tuber crop farmers indicated that they would have used the input if it were available at an affordable price.

5.2 Conclusion

From the findings of the study, it has been to establish the fact that Fadama III root and tuber crop scheme has impact on the participants' productivity through their netfarm income and efficiency. This was evidenced in the net farm income of the participants which was significantly different from that of the non-participants after the Fadama III programme than before the programme. Hence, the null hypothesis with regards to no impact of Fadama III of participants' productivity is rejected.

Fadama III programme has significantly improved the food security status of the participoants from the non-participants. This is as shown by the calorie consumption of both the Fadama III programme participants and non-participants and the propensity score match which shows a positive indicator. Hence, the null hypothesis with regards to no impact of Fadama III of participants' food security is rejected.

Similarly, Fadama III programme had significant impact on the participants' poverty status based on these three indicators namely; poverty prevalence, depth and severity which lower for the participants than the non-participants. The result of impact also of the Z-statistics shows that the Z-calculated was greater than Z-tabulated. Hence, the null

hypothesis with regards to no impact of Fadama III of participants' poverty status is rejected.

5.3 Recommendations

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

i. Farmers should be advised through the Agricutural Development Programme of Benue, Kogi and Plateau States and other agricultural based capacity development organizations that have the mandate of training should train the farmers on resource utilization and farm management skills to further boost their income and increase their efficiencies through the adoption of the best technologies or techniques in root and tuber crop production.

ii. The various states that make up the central state in Nigeria should encourage the teeming youths in the region to take up root and tuber production as a business through the various State Agricultural Development Agency and other relevant agricultural development organizations that have the mandate of establishing micro, small and medium enterprises to provide the enabling environment for the growth of this sub-sector.

iii. There is is the need for the government at the federal, state and local government levels to invest more in modern and easy to maintain agricultural equipment in order that food production may increase at a rate higher than the population growth.

iv. Farmers should encouraged to form cooperative societies to enhance bulk purchse of input which will reduce input cost and ensure timely supply of same.

v. There is the need for policy makers to pursue opportunities for regional cooperation in international input procurement and to facilitate privatization and competition in input distribution. This will make the input more readily available at a reasonable cost.

5.4 Contribution to Knowledge

1. The Fadama III root and tuber crop scheme participants' income increased by 50.34% compared to non-participants' income increased by 39.07%, NFI of participants increased by 55.69% while that of the non-participants increased by 49.21%.
2. The mean pooled TE, AE, and EE of the root and tuber crop farmers in the study area is 58.5%, 69.8% and 41.1% respectively, while the impact of Fadama III root and tuber crop scheme scheme on the participants was positive with F-Cal (3.729) higher than F-Tab (1.95).
3. Fadama III root and tuber crop scheme had impact on the Participants' food security. The study also revealed that the food security index of Fadama III root and tuber crop scheme participants is higher (2.25) than that of the non-participants' (1.95), with 63.53% of the participants being food secure while 62.53% of the non-participants were food secure.
4. The study also revealed that Fadma III root and tuber crop scheme had impact on thee participants' poverty alleviation, with 72% of the participants lifted out of poverty compared with the non-participants' 57%

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Appendix: Farmers Questionnaire

QUESTIONNAIRE FOR NON-PARTICIPANTS OF FADAMA III PROGRAMME

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY,
AHMADU BELLO UNIVERSITY, ZARIA.

TOPIC: Analysis of the impact of Fadama III programme on root and tuber crop production on productivity, food security and poverty alleviation in North central, Nigeria.

Instruction: This questionnaire is for research purpose only, kindly tick (√) or fills in the blank spaces as appropriate

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

Date of administration…….

Name of respondent (optional) ……...

(A)Demographic Data

1. Sex: Male ( ) Female ( )
2. Age…….. (Years)
3. Marital status: Single ( ) Married ( ) Divorced ( ) Widow ( ) Widower ( )
4. Number of wives …….
5. Number of children……

Age of children (i) …… (ii) ……. (iii) ……. (iv) ……. (v)…….. (vi)……. (vii) …… (viii) …….. (ix) …….. (x) ……..

6. Number of other dependents ……..

6. How many years of experience do you have in root and tuber crop farming? ……..

7. Educational status of household head

i. No formal education ( ) iii. Primary education ( )

ii. Quoranic education ( ) iv Secondary education ( )

v. Tertiary education ( )

9. What is your primary occupation? i. Farming [ ] Trading [ ] Artisan [ ] iv. Civil service [ ] v. Others please specify……..

10. Are you engaged in any other occupation? YES [ ] NO [ ]

11. If YES, specify ……..

9. a. Are you a member of cooperative society? YES [ ] NO [ ]

b. If yes, for how years have you been a member? …….

(B)Information on Input Used in Root &Tuber Crops Production

10. Farm size (Ha)

LAND ACQUISITION

12. How many farms (locations) do you have? ……Indicate the size of each farm below

Location I …… (Ha) Location II …… (Ha) Location III …… (Ha)

11. How many hectares of land you cultivate to root and tuber crops? ……...

12. How did you acquire your land? Purchase ( ), rent ( ), lease ( ), community owned ( ), Gift ( ) inherited ( )? Tick as appropriate.

What does it cost to rent one hectare of land per season in your village? ₦.....

19. What type of root and tuber crop do you cultivate?

Cassava ( ), Yam ( ) Irish potato

20**. Labour used**

Hired Labour

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

22. Did you hire someone to spray chemical on your farm? YES [ ] NO [ ] If yes, how many loads?

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

24. Which of the following methods do you use in root and tuber crop production?

Manual ( ) Tractor ( ) Both Tractor and Manual ( )

25. If manual, what is the cost of the following operation?

26. How much does it cost to hire a labourer for one day in your village? ₦ ……

Please supply the following information before and after fadama III intervention

(Before)

Type of Operation	Number of Family labour /Ha	Cost per Manday	Number of Hired labour	Cost per manday
i.Land clearing ii.Ridge making iii.Planting iv.Weeding v.Harvesting				

vi.Earthen- up				

(After)

Type of Operation	Number of Family labour /Ha	Cost per Manday	Number of Hired labour	Cost per manday
i.Land clearing ii.Ridge making iii.Planting iv.Weeding v.Harvesting vi.Earthen- up				

27. What was the quantity and price per kilogramme of the following inputs per hectare you used in 2014 planting season?

(Before and After)

Type of Planting Material	Quantity(Kg)/Ha	Price (Kg)/Ha
i. Cassava cuttings ii. Seed Yam iii. Irish poato seeds		
TOTAL		
Type of Planting Material	Quantity(Kg)/Ha	Price (Kg)/Ha
iv. Cassava cuttings v. Seed Yam vi. Irish poato seeds		
TOTAL		

28. Did you use fertilizers in producing root and tuber crops? YES [ ] NO [ ]

29. If yes, what type, quantity the price of fertilizer did you use?

(Before)

Type of fertilizer	Quantity (Kg) per Hectare	Price / Hectare
i. ii. iii iv		

v		

(After)

Type of fertilizer	Quantity (Kg) per Hectare	Price / Hectare
i. ii. iii iv v		

30. What equipment did you now use in root and tuber crop farming? E.g. cutlass, hoes etc.

Type of equipment	Quantity	Price/unit	Year of purchase	Expected life span
i. ii. iii. iv. v. vi vii viii ix. x.				

31. Where did you buy your cassava cuttings/ seed yam?

a. ADP [ ] b. seed company [ ] c. Open market [ ] d. from previous season [ ] e. From other farmers

32. How many kilogrammes of root and tuber crops did you harvest from each of the farm location mentioned?

Cassava: Location I …… Kg/Ha, Location II ……. Kg/Ha, Location III……

Kg/Ha. Total Harvest ……

Yam: Location I ……. Kg/Ha, Location II ……. Kg/Ha, Location III……

Kg/Ha. Total Harvest ……

Irish potato: Location I …….Kg/Ha, Location II ……. Kg/Ha, Location

III…… Kg/Ha. Total Harvest ……

Sweet potato: Location I ……Kg/Ha, Location II ……..Kg/Ha, Location III…… Kg/Ha.

Total Harvest ……

33. What quantity of the following crop did you harvest before Fadama III programme

	Before	After
Cassava	……Kg/Ha	…….. Kg/Ha
Yam	……. Kg/Ha	……...Kg/Ha
Irish potato	…….. Kg/Ha	……...Kg/Ha

34. What was the prices of the following;

	Before	After
Cassava	₦……Tonne/Ha	₦…….. Tonne/Ha
Yam	₦……,, Tonne//Ha	₦……..Tonne/Ha
Irish potato	₦…… Tonne/Ha	₦ ……....Tonne/Ha

33. How much did you sell one tonne of Irish potato in 2014 farming season? ₦ ……

HOUSEHOLD EXPENDITURE

34. What quantities of the following food items do you consume on a weekly basis?

Food items	**Quantity (Mudu/Bunch/Number)**
Garri **Rice** **Beans** **Pap** **Yam (tuber)** **Yam flour** **Cocoyam** **Gote** **Tuwo** **Plantain** **Vegetable** **Bread (loaves)** **Sweet potatoes** **Irish potatoes** **Wheat** **Egg** **Meat (Kg)** **Fish (Kg)** **Fruits** **Vegetable oil** **Palm oil** **Milk** **Groundnut oil** **Melon seed** **Sugar** **Butter** **Beverages** **Other (specify)** **……** **…….** **……..**	

35. How much did you spend on the following?

1. Clothing/ Month …….. ₦……..
2. Foot wear/ Month……..₦……
3. Health & Medicare/ Month…… ₦……
4. Education of your children/ Term ……₦…….
5. Fuelling your car/Month ….……₦…….
6. Electricity/Month……..….₦…….
7. Transportation/Month…….…..₦……..
8. Remittances …….……₦……..
9. Rent/Year ……₦……
10. Kerosene/Month……...₦…….
11. Firewood/Week…….....₦……
12. Other expenses……₦……

13.. How much do you set aside for savings per month? ₦ ……..

14. How much do you spend on asset acquisition per month? ₦ ……

15. When faced with hard times, how do you cope or adjust? Use the options below to answer the questions.

a. When faced with hard times, how do you cope or adjust? Use the table below to answer the questions

36. How many of the following do you have and what are their value?

ITEM	QUANTITY	VALUE (₦)
1. Vehicle		
2. Motorbike		
3. Television set		
4. Radio		

5. Land (Ha)
6. Refrigerator
7. Landed property
8. Zinc-roofed house with cement
9. Zinc-roofed house with mud
10. Thatched-roof house with cement
11. Thatched-roof house with mud
12. Bicycle
13. Stove
14. Mobile phone
~~15.~~ Herds of cattle
16. Goats
17. Sheep
18. Donkeys
19. Chicken
20. Others (specify)

37. When faced with hard times, how do you cope or adjust? Use the table below to answer the questions

Survival mechanisms	Frequently used	Occasionally used	Rarely used	Not used
i. Crop diversification ii.Redused consumption iii.Sales and consumption of stored crops iv.Withdrawing from savings v.sales of asset e.g land, household items, house vi. Migration to urban centers vii.Engaged in paid job. viii.Fetching of firewood and dung ix. cutting down household expenditure x.borrowing from friends/ relatives xi. withdrawal of children from school				

38.. What are your reasons forNOTparticipating in Fadama III Programme?

i. ……

ii. …….

iii. …….

iv. …….

v……

39. Do extension officials visit you? Yes [ ] No [ ]

If tes, how often do they visit you?

Weekly [ ] Twice a month [] Monthly [ ] Bi-Monthly [ ] Once in six months [ ]

40. What are the problems facing you in the Root and Tuber cultivation?

i……..

ii……

iii …….

iv …….

v ……..

vi ……

vii …….

41. What are your suggested solutions to the problems identified above?

i……

ii ……..

iii ……....

iv ……....

v …….

vi ……

vii ……