IMPACT OF ROOT AND TUBER EXPANSION PROGRAMME TECHNOLOGY ADOPTION ON POVERTY AND FOOD SECURITY STATUS OF CASSAVA-FARMING HOUSEHOLDS IN SOUTHWESTERN NIGERIA

By

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A THESIS IN THE DEPARTMENT OF AGRICULTURAL ECONOMICS SUBMITTED TO THE FACULTY OF AGRICULTURE AND FORESTRY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY UNIVERSITY OF IBADAN

ABSTRACT

Adoption of yield increasing technologies among farming households is one way of reducing poverty and food insecurity. In Nigeria, Root and Tuber Expansion Programme (RTEP) was implemented to develop improved technology of root and tuber crops. However, the impact of RTEP technology on poverty and food security has not been fully established. Therefore, the effect of RTEP technology on poverty and food security status of cassava-farming households in southwestern Nigeria was investigated.

Ondo and Ogun states were randomly selected from the six states in southwestern Nigeria. Two RTEP participating and two Non-RTEP participating Local Government Areas (LGAs) were randomly chosen from each state. Three communities were randomly selected from each of the LGAs. In each RTEP community, 30 households were randomly selected (beneficiaries and non-beneficiaries) while 15 households were randomly selected from each Non-RTEP community making 540 respondents. Data were collected on age, gender, Household Size (HS), Land Area Cultivated (LAC), technology adoption, Credit Accessibility (CA), Educational Level (EL), Off-farm Activities Participation (OAP), Cassava Yield (CY), Distance to Input Market (DIM) and Household Consumption Expenditure (HCE) using structured questionnaire. The HCE was used to estimate Poverty Incidence (PI) and Food Insecurity Incidence (FII) while other variables were hypothesized to influence Adoption Level (AL) of RTEP technology. Data were analyzed using propensity score matching, descriptive statistics, Foster-Greer-Thorbecke and Tobit regression model at $p = 0.05$.

There were 387 RTEP and Non-RTEP households with similar characteristics. Age (44.3 ± 10.1 years), HS (6.0 ± 2.0) and LAC (1.0 ± 0.4 hectares) of the beneficiaries were not significantly different from those of the non-beneficiaries. The AL of RTEP technology was 76.01%. Cassava yield of RTEP Beneficiaries (RTEPB) was 14.56 ± 1.27 tons/ha. Gender, OAP, CA and EL significantly increased AL by 13.8%, 15.8%, 4.7% and 17.6% respectively while DIM decreased AL by 1.8%. At poverty and food insecurity lines of ₦34,473.00 and ₦20,132.20 respectively per annum, 55.0% RTEPB were poor while 51.3% were food insecure. The RTEP technology adoption reduced PI of RTEPB by 11.2%. The PI of the male beneficiaries reduced by 12.6% compared with 5.6% for female. The PI of RTEPB with CA reduced by 11.8% compared with 5.2% for those without CA. The PI decreased by 14.1% for RTEPB with OAP while the reduction was 8.2% for those without off-farm activity. The FII decreased by 16.3%

with male RTEPB having higher reduction of 17.8% compared with female of 8.0%. The FII of the beneficiaries with CA decreased by 20.9% while the reduction was 9.8% for those without CA. The decrease in FII was 17.45% for RTEPB with OAP compared to 9.4% for those not participating.

Root and Tuber Expansion Programme technology alleviated both poverty and food insecurity status of beneficiaries especially among males, those with credit accessibility and off-farm activity participation in southwestern Nigeria.

Keywords: Cassava-farming households, Root and Tuber Expansion Programme, Yield increasing technology.

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DEDICATION

This thesis is dedicated to the Almighty God; my Alpha and Omega; The Lifter up of my head; The Author of wisdom. God's name alone be praised for the privilege He has given me to go through this programme.

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CERTIFICATION

I certify that this work was carried out by Mrs. Adekemi Adebisola Obisesan under my supervision in the Department of Agricultural Economics, University of Ibadan.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ADP	Agricultural Development Programme
ANRTEPB	All Non-RTEP Benefiaries
ATE	Average Treatment Effect
ATT	Average of the Treatment on the Treated
ATU	Average Treatment Effect on the Untreated
CDD	Community Driven Development
CMP	Cassava Multiplication Programme
CPRP	Community-based Poverty Reduction Programme
CSDP	Community and Social Development Projects
DFRRI	Directorate of Food, Roads and Rural Infrastructure
FAO	Food and Agriculture Organization
FEAP	Family Economic Advancement Programme
FGT	Foster-Greer-Thorbecke
FSP	Family Support Programme
GHI	Global Hunger Index
HDI	Human Development Index
IFAD	International Fund for Agricultural Development
LEEMP	Local Empowerment and Environmental Management Programme
LGA	Local Government Area
MDGs	Millennium Development Goals
NAFPP	National Accelerated Food Production Project
NALDA	National Land Agricultural Development Agency

NAPEP	National Poverty Eradication Programme
NDE	National Directorate of Employment
NEEDS	National Economic Empowerment and Development Strategy
NGOs	Non-Governmental Organizations
NRTEPBO	Non-RTEP Beneficiaries Outside RTEP LGA
NRTEPBW	Non-RTEP Beneficiaries Within RTEP LGA
OFN	Operation Feed the Nation
PS	Propensity Score
PSM	Propensity Score Matching
RTEP	Root and Tuber Expansion Programme
RTEPB	Root and Tuber Expansion Programme Beneficiaries
SAP	Structural Adjustment Programme

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Eradicating extreme poverty and hunger is the first target of the Millennium Development Goals (MDGs), and this has made poverty reduction and food security the undisputed overriding goals of development (Deaton, 2004; United Nations Millennium Project, 2005). Despite this declaration, the world still faces a serious food crisis which is perilous and life threatening for millions of poor people. Although, there is a variation in the estimate of the food-insecure people all over the world, available statistics shows that more than 800 million people still remain food- insecure while about 1.4 billion people live on less than US$1.25 a day (Weibe, 2003; FAO, 2005; IFAD, 2011).

Poverty in Africa has been described as a rural phenomenon **(**World Bank, 2000; IFAD, 2001). This has also been attested to by the World Development Report (WDR, 2008) which stated that more than half of the population in the countries in this region live in rural areas where poverty is most extreme (World Bank, 2007). By this, it is acknowledged that rural communities are the worst hit by poverty. In Africa, the share of rural areas in overall poverty is around 90.0% in many countries. Rural poverty results from lack of assets, limited economic opportunities, poor education and capabilities, as well as disadvantages rooted in social and political inequalities (IFAD, 2011).

In Sub-Saharan Africa (SSA), poverty rates and food insecurity remains high while other developing regions of the world are making significant progress in achieving the first MDG. Though the global hunger index (GHI) score fell by 18.0% compared with the 1990 score, the 2011 GHI score of 20.5 indicates an alarming situation in the region. In the same vein, Sub-Saharan Africa's rural poverty decline is also slow, where more than 60.0% of the rural population lives on less than US$1.25 a day, and almost 90.0% lives on less than US$2/day (IFAD, 2011). Many reasons have been attributed to the rise in absolute numbers of poor people and the proportion of people living in extreme hunger in sub-Saharan Africa. These reasons range from inequality due to the trends of globalization, violent civil conflict, governance

failures and institutional gaps. However, since the majority of the people living on less than US$1 a day in SSA live in rural areas where agriculture is their predominant source of livelihood, the prominent explanatory factor attributed to the rise in regional poverty and food insecurity rates is the reduction in absolute value of aid volumes and government expenditures to agriculture and rural infrastructure (Lipton, 2000; IFAD, 2001; Booth and Mosley, 2003; IFPRI, 2006).

Moreover, it is now generally believed that investment in agricultural technology must be prioritised in sub-Saharan Africa in order to achieve the core MDG of halving the proportion of people living in extreme poverty and hunger by 2015. This is because the massive investments in agricultural technology in some of the Asian economies in the past five decades have been successful in achieving food self-sufficiency, poverty reduction, agricultural and rural development as well as boosting employment generation (Saleth, 2002; IFPRI, 2006).

Paradoxically, despite Nigeria's rich endowment of resources and human capacity, the country has not yet managed to resolve its rural food insecurity and poverty problems. The level of poverty has increased since the implementation of the Structural Adjustment Programme in the 1980s (World Bank, 1999). Statistics on poverty profile in Nigeria indicates that poverty increased from affecting 17.1 million people in 1980 to 34.7, 39.2, 67.1 and 68.7 million people in 1985, 1992, 1996, and 2004 respectively. At present, 112.5 million people are classified poor in the country (NBS, 2010).

Furthermore, the proportion of the core poor increased from 6.2% in 1980 to 29.3% in 1996, came down to 22.0% in 2004, and rose to 38.7% in 2010. For the moderately poor, the picture was quite different as the proportion recorded an increase between 1980 and 1985 from 21.0 to 34.2% but went down between 1996 and 2010, from 36.3 to 30.3%. On the other hand, the proportion of non-poor was much higher in the country in 1980 (72.8%) compared to 1992 (57.3%) and 1996 (34.4 %). Although, it rose to 43.3% in 2004, it dropped to 31% in 2010 (NBS, 2010). In 2010, across the different geopolitical zones in the country, the North West was the poorest with 77.7% poverty incidence. This was closely followed by the North East (76.3%); North Central (67.5%); South East (67%); South South (63.8%) and South West (59.1%). The

poverty situation in the South West geopolitical zone is as follows: Ogun state (69%), Oyo (60.7%), Lagos (59.2%), Ekiti (59.1%), Ondo (57%), and Osun (47.5%) (NBS, 2010).

Moreover, national food poverty incidence increased from 33.6% in 2004 to 41% in 2010, while the urban and rural food poverty incidence stood at 26.7% and 48.3% respectively. North West had the highest food poverty incidence (51.8%) followed by North East (51.5%), South East (41%), North Central (38.6%), South South (35.5%) and South West (25.4%). Across the six states in the South West geopolitical zone, Ogun state had the highest food poverty incidence of 41.8% followed by Ondo (36.1%), Ekiti (35.8%), Oyo (24.6%), Osun (19.5%) and Lagos (14.6%) (NBS, 2010).

However, Nigeria focuses on sustainable agriculture and rural development as a means of reducing rural food insecurity and poverty. Some of the policies and programmes that have been designed at one time or another to reach the poor and food-insecured include: the establishment of the National Accelerated Food Production Project (NAFPP), Operation Feed the Nation (OFN), Green Revolution, Agricultural Development Programme (ADP), National Directorate of Employment (NDE), People's Bank, Community Bank and Small-scale Industries Credit Scheme, the Family Support Programme (FSP), the strategic grain reserve programs, the liberalization of different agricultural input delivery systems, introduction of measures to involve the private sector in the agricultural sector, NFDP (flood plain development) Programme. Others include: Presidential Initiatives on cocoa, cassava, rice, livestock, fisheries and vegetables, the National Agricultural Land Development Agency (NALDA), National Special Programme on Food Security (NSPSF), Directorate of Food, Roads, and Rural Infrastructure (DFRRI), Family Economic Advancement Programme (FEAP), National Poverty Eradication Programme (NAPEP), National Economic Empowerment and Development Scheme (NEEDS), Cassava Multiplication Programme (CMP), Root and Tuber Expansion Programme (RTEP) (Nuhu, 2007; Federal Ministry of Agriculture and Water Resources , 2008).

Root and Tuber Expansion Programme (RTEP) was designed to consolidate the gains made under the Cassava Multiplication Programme (CMP) and to address the problem arising from its implementation. Consequently, earlier coverage by the Cassava Multiplication Programme (CMP) of the nine States of Akwa Ibom, Anambra, Benue, Delta, Ebonyi, Edo,

Enugu, Imo and Ogun was extended by the RTEP to include almost the entire central and southern parts of the country, bringing the total number of states covered to 26, of which most are in the south (IFAD, 2009). The implementation of RTEP commenced in July, 2001. The main goal of RTEP was to increase income, alleviate poverty and improve food security status of the small holder farming households with less than 2 hectares of land categorised as the poorest of the poor, growing and processing cassava, yam, cocoyam, Irish and sweet potato in the project areas.

In order to facilitate the attainment of the objectives of the programme, three components were identified namely: improved production technology, processing and marketing, monitoring and evaluation. Based on the initial design of RTEP, the implementation of activities during the first tri-term (2001-2004) was largely state-wide, thinly spread and supply-driven, thus naturally limiting the possibilities of innovations, successes and sustainability. However, following the first tri-term implementation review in 2004/05, the use of Community Driven Development (CDD) approach was adopted to enhance stronger programme ownership and beneficiary empowerment.

CDD approach has been successfully adopted in some countries such as : India, Pakistan, Argentina and Kenya (World Bank, 2003). Since targeting the poor has been one of the challenges of development and emergency response programmes (Farrington and Salter, 2006), it is argued that using CDD could improve targeting because CDD programmes use better local knowledge to define and identify the targeted groups (Mansuri and Rao, 2004).

Community-Driven Development recognises that poor people are prime actors in the development process, not targets of externally designed poverty reduction efforts. In CDD, control of decisions and resources rests with community groups, who may often work in partnership with demand-responsive support organisations and service providers, including elected local governments, the private sector, Non-Governmental Organisations (NGOs), and central government agencies. Experience has shown that, given clear rules of the game, access to information, and appropriate support, poor men and women can effectively organise to provide goods and services that meet their immediate priorities. Not only do poor communities have greater capacity than generally recognised, they also have the most to gain from making good

use of resources targeted at poverty reduction (Alkire *et al*, 2001). The CDD's potential is increasingly recognised as individual studies have shown that CDD can increase the effectiveness, efficiency, and sustainability of projects or programmes, making them more pro-poor and responsive to local priorities. Other objectives include developing capacity, building social and human capital, facilitating community and individual empowerment, deepening democracy, improving governance, and strengthening human rights (Mansuri and Rao 2004).

Therefore, considering the fact that eradicating poverty and hunger is the first target of the MDGs, and were widely viewed as a relevant measure to evaluating the progress of a country in terms of wellbeing (Vasco, 2006), this study assesses the impact of RTEP technology adoption on poverty and food security status of cassava-farming households in Southwest Nigeria.

1.2 Cassava in Nigerian Economy

Cassava is a major source of calories for roughly two out of every five Africans. It serves as an important food source for an estimated 200 million people or about one-third of the population of sub-Saharan Africa (IITA *et al*, 2003). Cassava has the potential to increase farm income, reduce rural and urban poverty, as well as help close the food gap between the rural and urban communities. It is a low-risk crop for poor farmers, available to low-income rural households in the form of simple food products (for example, dried roots and leaves) which are significantly cheaper than grains such as rice, maize and wheat. Similarly, urban households in many parts of West Africa consume cassava in the form of gari (Nweke et al., 2001). Its drought tolerance makes it the most suitable food crop during periods of drought and famine (Nweke et al., 2001).

Nigeria is known to be the leading producer of cassava globally with a production of about 52 million tonnes in 2011 which was 20% higher than its production in 2004. The increase in production came about as a result of the interventions of the Nigerian Government and some developmental agencies. The Nigerian Government facilitated the development of new disease-resistant cassava varieties by the joint efforts of IITA, National Root Crops Research Institute (NRCRI), RTEP, and the Federal Ministry of Agriculture, in conjunction with Agricultural Development Programmes and cassava farmers. In 2002, cassava suddenly gained prominence

following the pronouncement of a presidential initiative on the crop which was aimed at using cassava production as an engine of economic growth in Nigeria.

Cassava is mainly produced by small holder farmers, cultivating less than two hectares of land, and plays a dominant role in the rural economy of the southern agro-ecological zones though it is increasingly gaining importance in other parts of Nigeria. The southern states account for 64% of the cassava produced in Nigeria with the Southwest contributing about 20% of the total production. It provides the livelihood for over 30 million farmers, countless processors and traders (FMARD, 2002*).* Cassava is important not only as a food crop but also as a major source of cash income for producing households. As a cash crop, it generates cash income for the largest number of households, contributing positively to poverty alleviation. As a food crop, cassava fits well into the farming systems of the small-holder farmers in Nigeria because it is available all year round, thus providing household food security. Cassava performs five main roles namely: famine reserve crop, rural food staple, cash crop for urban consumption, industrial raw material, and earner of foreign exchange (Nweke *et al*, 2002).

In Nigeria, cassava is primarily produced for food, especially in the form of *gari*, *lafun* and *fufu* with little or no use in the agribusiness sector as an industrial raw material. However, the crop can be processed into several secondary products of industrial market value. These products include chips, pellets, flour, adhesives, alcohol, and starch, which are vital raw materials in the livestock feed, alcohol/ethanol, textile, confectionery, wood, food and beverage industries (Ezedinma *et al*, 2002). According to Nweke *et al* (2002), Nigeria is the most advanced of the African countries poised to diversify the use of cassava as a primary industrial raw material and livestock feed. Two factors put Nigeria to this comparative advantage in Africa: one is the rapid adoption of improved cassava varieties, and the second is the development of small scale processing technologies including the cassava grater. Also, among the crops widely cultivated in southern Nigeria, research efforts have made the greatest impact on cassava (Nweke *et al*, 2002).

Furthermore, in 2002, the President of Nigeria announced an initiative to use cassava as an export commodity to generate five billion Naira annually in export revenues. To achieve this goal, there was a need to develop the domestic market, diversify the use of cassava, and create

national policies that will leverage cassava development in the country (Ezedinma *et al*, 2002). Recently, cassava was listed as one of the six crops to receive increased attention under the recently launched Agricultural Transformation Agenda (ATA) with the objective of the Federal Government's cassava initiative as to increase commercial cassava production, prevent or eradicate the problem of cassava glut through marketing, and use the crop which the country is known for to boost industrial development (David, 2012).

Moreover, the Nigerian government has recently announced plans to cut wheat imports by revisiting policy compelling the inclusion of 10% cassava flour into wheat flour. This policy was first attempted in 2002 but was not sustained due to inadequate domestic capacity to process industry grade cassava flour. However, with the present government, the inclusion rate is expected to increase steadily to 40% by 2015. As part of the plan, the government will implement a 65% levy on wheat flour importation to bring the effective duty to 100% while wheat grain will attract a 15% levy which will bring the effective duty to 20%. Bakeries that attain 40% blending will benefit from a corporate tax incentive of 12% rebate. In addition, all equipment for processing high quality cassava flour will enjoy a free duty regime as an incentive for bakers for composite flour utilization. This policy direction could greatly reduce wheat exports to Nigeria (USDA, 2012). Therefore, the development of the cassava subsector is emerging a key component of strong and diversified economy, able to generate employment, contribute to food security, alleviate poverty, and sustain inome for the Nigerian populace.

1.3 Problem Statement

Poverty and food insecurity are among the topmost challenges facing developing countries (Deaton, 2004). However, despite massive progress in reducing poverty and food insecurity in some parts of the world over the past couple of decades, there are still about 1.4 billion people living on less than US$1.25 a day, and close to 1 billion people suffering from hunger (IFAD, 2011). Poverty remains a massive and predominantly rural phenomenon with at least 70% of the world's very poor being rural. Sub-Saharan Africa (SSA) is the region worst affected by poverty and hunger. In SSA, poverty is increasing and food security situation is

deteriorating (Hazell and Haddad, 2001), over 50% of the population in this region live on less than $1.25 a day with 239 million suffering from hunger (FAO, 2011).

In Nigeria, projects, programmes and policies targeted at reducing the problem of food insecurity and poverty notwithstanding, the country ranked 156 out of 187 countries and territories on the Human Development Index (HDI) and 40th on the Global Hunger Index (GHI) of 81countries with a GHI score of 15.5 indicating a serious hunger situation (IFPRI, 2011; UNDP, 2011). In 2004, Nigeria's poverty incidence stood at 54.4%, implying that approximately 69 million Nigerians lived in poverty but increased to 69% (or 112.5 million Nigerians) in 2010 (NBS, 2012). Also, poverty in the south-western geopolitical zone increased to 59.1% in 2010 from 43% which translates to about 16.5 million people living in poverty. It therefore remains a paradox, however, that despite the fact that the Nigerian economy is growing, the proportion of Nigerians living in poverty increases every year, although it declined between 1985 and 1992 from 46.3% to 42.7%, and between 1996 and 2004 from 66.6% to 54.4% (NBS, 2012). In the same vein, the level of food insecurity continued to rise steadily since the 1980's. It rose from 18.0% in 1986 to 41.0% in 2004 and stood at 65.0% in 2009 (Sanusi *et al*, 2006; Davies, 2009).

Poverty is endemic to rural areas where the main occupation is farming (Fields, 2000; World Bank, 2008). According to the Nigerian Living Standard Survey (NLSS) Report (2012), 73.2% of the rural population are poor compared to 61.8% in the urban area. The predominance of rural poverty over urban has been consistent between 1996 and 2010. Incidentally, the rural sector is the predominant sector in the nation's economy as it plays some fundamental roles such as serving as a base for food and fibre production; the major source of capital formation for the country; a principal market for domestic manufacturers; job creation at relatively low unit costs and in general, engages in primary activities that form the foundation of any economic development, and thus, remains the most important growth priority of the country (Stewart, 2000).

Furthermore, farming population comprises primarily of resource-poor peasants, cultivating tiny plots of land with low and declining productivity (IFAD, 2007). There are evidences that the farming households are poorer among the rural poor. For instance, NBS (2004) revealed that the incidence of poverty was 72.3 and 64.4% in 1996 and 2004, respectively

for Nigerian farming households while it was 58.0 and 59.2% for their non-farming counterparts, respectively. Moreover, escaping poverty traps in many developing countries depends on the growth and development of the agricultural sector (World Bank, 2008). Agricultural growth and development is not possible without yield-enhancing technological options because merely expanding the area under cultivation, except in a few places, to meet the increasing food needs of growing populations is no longer sufficient. Research and adoption of technological improvement are thus crucial to increasing agricultural productivity, alleviating poverty and food insecurity.

Agricultural productivity, particularly in poor countries, is the key to global food security and fight against poverty (Braun *et al*, 2008). Low agricultural productivity resulting from soil fertility depletion, heavy reliance on basic indigenous technology including the use of unimproved and low yielding planting materials, lack of good crop protection methods among others have been alleged to be the critical factors accounting for rural poverty (Uganda,1998; Omonona *et al*, 2005), pointing to the fact that agriculture plays a unique role in reducing poverty. Therefore, the resulting gains in poverty eradication and greater food security will depend in part on an integrated set of research outputs which include high yielding and pest resistant varieties, improved crop management, processing equipment and procedures, as well as improved policies that facilitate the development and adoption of these innovations (Nweke, 1992).

Furthermore, the introduction of, access to and use of improved agricultural technologies are tools needed to improve agricultural productivity. This serves as the key to global food security and fight against poverty. But it remains a challenge for agricultural researchers to understand the extent to which these technologies are used and with what impacts (McCalla, 2001; Braun *et al*, 2008). To this end, it then becomes imperative to study the adoption of improved technology and its impact on food security and poverty reduction.

It is interesting to note that many of the developing world's poorest and most food insecure households depend on root and tuber crops as a contributing if not the principal sources of food, nutrition and income (Alexandratos, 1995). Moreover, the importance of roots and tubers in Africa notwithstanding, African food policy over the last half a century has focused on

achieving growth and self-sufficiency in cereals such as wheat, rice and maize, with growth rates in roots and tubers over this period largely driven by area expansion as opposed to yields (resulting from technological innovations such as improved varieties and production techniques) (Scott *et al*, 2000; Nweke, 2004; Hartmann, 2007). However, the degree of impact these crops will have on problems of food insecurity, poverty and development will depend, among other factors, on research innovations scientists make, the use of these innovations by farmers and resource allocation decisions by governments and International donors on these crops.

Among such resource allocation decisions was the Root and Tuber Expansion Programme (RTEP) whose improved production technology adoption was assessed in this study. RTEP improved production technology which is one of the components of the programme comprised of improved varieties, recommended spacing, timely maintenance, fertilizer, herbicide and pesticide application. For the periods of implementation of the RTEP, very little was known about the adoption level of its production technology package and its impact on the poverty and food security status of the farming households in Nigeria. Therefore, the following research questions were answered by this study:

(1) What is the adoption level of the RTEP production technology among cassava-farming households in Southwest Nigeria?

(2) What are the determinants of their adoption level in the study area?

(3) What is the level of income, food security and poverty status of the RTEP and the Non-RTEP cassava-farming households?

(4) What is the impact of the RTEP technology adoption on the income, food security and poverty status of cassava-farming households in the study area?

1.4 Objectives of the Study

The main objective of the study is to evaluate the impact of the Root and Tuber Expansion Programme (RTEP) technology adoption on poverty and food security status of cassava-farming households in Southwest, Nigeria. The specific objectives are to:

1. Determine the adoption level of the RTEP production technology among cassava-farming households in Southwest Nigeria.

2. Examine factors influencing the adoption level of the RTEP production technology by cassava-farming households in the study area.
3. Compare the level of income of the RTEP and the Non-RTEP cassava-farming households in the study area.
4. Evaluate the impact of the RTEP technology adoption on cassava-farming households' poverty and food security status in the study area.

1.5 Justification of the Study

The estimates of adoption level of the RTEP production technology and the influencing factors will inform the federal government and other stakeholders on the extent to which the whole package have been adopted, where to devote the available resources in order to remove constraints and increase research efficiency as well as designing policy, programmes and institutional reforms to enhance technology adoption. It is imperative to provide good and reliable estimates of the RTEP technology adoption level and impact in order to reveal the suitability of the technology in terms of increased income, food security and poverty reduction of the targeted population. This study is further justified in that its findings will provide relevant information concerning the level of achievement of the RTEP as well as the gaps noticed in the achievement capacity of the programme which will be helpful in reorganising the project to enhance performance in the second phase.

Moreover, this study will contribute to the scanty and flawed literature that exists on the impact of the RTEP in Nigeria. The few studies on the RTEP (Ater *et al*, 2006; Ibrahim and Onuk, 2010; Tijani and Thomas, 2010 Olujide and Leoto, 2010) were on the impact of the programme on productivity except Ater *et al* (2006) that was on poverty. However, these studies have assessed the outcomes of the programme using only data from participants, and by employing descriptive and inferential statistics which prevented them from getting the counterfactual outcomes, that is, the outcomes of the participant if he had not participated in the project. This study used propensity score matching (PSM) to address the evaluation problem and employed the counterfactual outcome framework to show the impact of the outcome defined in the modern policy evaluation literature as the average effect of the treatment on the treated

(ATT) which helps to reduce biased estimates. It pursues a targeted evaluation of whether adopting the RTEP improved technology causes resource-poor farmers to improve their income and decrease the propensity to fall below the food insecurity and poverty line (Mendola, 2007).

Furthermore, this study is significant in that it informs on the adoption of improved technology and the impact on food security and poverty alleviation; it helps to know the level of income among cassava farmers in the south west zone, as this will be useful in formulating policy in line with improving rural income and also assist in understanding the food security and poverty change caused by the RTEP in the zone which are important for effective targeting of the programme in the states where this type of project will be extended to. Finally, this study will be helpful in the implementation of the second phase of the programme and serves as a guide to policy makers, donor agencies and Non-Governmental Organisations on how to enhance adoption of new agricultural technology and alleviate poverty in Nigeria. It also adds to the existing literature in the field, which is recently receiving utmost attention from the academia, administrators and the general public.

1.6 Plan of the Report

The rest of the report comprises of four chapters. Chapter two entails the theoretical, conceptual framework and literature review. This addresses the theoretical perspectives of technology adoption, concepts of poverty and food security, general approaches to poverty reduction, past efforts on food security and poverty alleviation in Nigeria, and conceptual framework for the study. Analytical/methodological framework comprises the impact assessment, counterfactual framework, measurement of poverty and food security. In the sub-section on literature review, studies on poverty and agricultural technology adoption as well as studies on RTEP are discussed. In chapter three, the focus is on the methodology adopted for the study. This chapter comprises of areas of study, nature of data and data analysis. Chapter four is devoted to the presentation and discussion of the analysis. Chapter four addresses distribution of socio-economic characteristics of respondents, adoption level and the determinants, level of income and poverty status of respondents and the impact of RTEP. The last chapter contains the summary, conclusions and policy recommendations emanating from this study.

CHAPTER TWO

THEORETICAL /CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Theoretical and Conceptual Framework

2.1.1 Theoretical Foundations and Basic Concepts of Agricultural Technology Adoption

Technology plays an important role in economic development. A technology is any idea, object or practice that is perceived as new by the members of a social system (Mahayan and Peterson, 1985). Rogers (1995) used the words technology and innovation synonymously and defines technology as the design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome. Innovations are classified into process and product innovations. A process innovation is an input to a production process while product innovation is an end product for consumption. The agricultural technology considered in this study falls in the first category. Adoption and diffusion of technology are two interrelated

concepts, describing the decision to use or not to use and the spread of a given technology among economic units over a period of time. Adoption of any innovation is not a one step process as it takes time to complete. First time adopters may continue or cease to use the new technology. The duration of adoption of a technology vary among economic units, regions and attributes of the technology itself. Therefore, adequate understanding of the process of technology adoption is necessary for designing effective agricultural research programmes.

Adoption commonly refers to the decision to use a new technology or practice by economic units on a regular basis. Rogers (1983) defined the adoption process as the mental process an individual passes from first hearing about an innovation to final decision to use or not. Based on this, five stages are identified in the adoption process. These are: awareness or the initial knowledge of the innovation; interest and persuasion toward the innovation; evaluation or the decision whether or not to adopt the innovation; trial and confirmation sought about the decision made; and lastly, adoption. These stages imply a time lag between awareness and adoption. Hence adoption is not a random behaviour but is the result of sequence of events passing these adoption stages.

However, for rigorous theoretical and empirical analysis, a precise quantitative definition of adoption is needed. Such a definition must distinguish between individual (farm level) adoption and aggregate adoption. Final adoption at the individual farmer's level is defined as the degree of use of a new technology in long-run equilibrium when the farmer has full information about the new technology and its potential while aggregate adoption is defined as the process of spread of a new technology within a region. This definition implies that aggregate adoption is measured by the aggregate level of use of a specific new technology within a given geographical area. The adoption decision also involves the choice of how much resource, that is, land to be allocated to the new and old technologies if the technology is not divisible (mechanisation and irrigation). However, if the technology is divisible (for example, improved seed, fertilizer and herbicide), the decision process involves area allocation as well as level of use or rate of application (Feder et al, 1985). Thus, the process of adoption decision includes the simultaneous choice of whether to adopt a technology or not and the intensity of its use. In most cases, agricultural technologies are introduced in packages that include several components, for

example, high-yielding varieties (HYV), fertilizer, and corresponding land preparation practices. While the components of a package may complement each other, some of them can be adopted independently. Thus, farmers may face several distinct technological options. They may adopt the complete package of innovations introduced in the region or subsets of the package that can be adopted individually.

The definition of adoption above refers to the degree of use of a new technology as a quantitative measure of the extent of adoption. A distinction needs to be drawn, however, between new technologies which are divisible (such as HYV or new variable inputs) and those which apply to the whole farm and are not divisible, at least at a practical level (for example, harvesters) with regard to the measurement of intensity of adoption. The intensity of adoption of divisible technologies can be measured at the individual farm level in a given time period by the share of farm area utilising the technology or quantity of input used per hectare in relation to the research recommendations. This measure can also be applied to the aggregate level of adoption in a region. On the other hand, the extent of adoption of non-divisible agricultural technologies at the farm level in a given period is dichotomous (use or no use) and the aggregate measure becomes continuous. In the latter case, aggregate adoption of a lumpy technology can be measured by calculating the percentage of farmers using the new technology within a given area.

2.1.1.1 Speed of Technology Adoption

There is a great variation in the speed of technology adoption. It has been argued that potential adopters' perceptions of the attributes of the new technology affect the speed with which that technology is adopted. A study by Rogers (1983) identified five characteristics of innovations that have an impact on the speed of adoption. These characteristics include: relative advantage, compatibility, complexity, divisibility and observability. Supe (1983) added two more attributes that affect the rate of adoption which are variation in the cost of adoption and group action requirements of the technology. For example, technologies such as drainage and watershed management require group actions for adoption compared to technologies that are taken up on an entirely individual basis such as improved seed and fertilizer. The latter group of

technologies is adopted faster than those technologies that require group actions, as all farmers may not be equally interested in these technologies.

Among the technological characteristics mentioned above, relative advantage is regarded as the one with the strongest effect on the rate of adoption. The relative advantage can be subdivided into economic and non-economic categories. The economic categories are related to the profitability of the technology while the non-economic features are a function of variables including saving of time (leisure) and increase in comfort (Rartz, 1995). The higher the relative advantages, the higher the rates of adoption. The compatibility of a technology indicates the degree to which that technology is consistent with the existing social values, cultural norms, experiences and needs of the potential adopters. This attribute also plays a key role in influencing the speed of adoption. Profitability and riskiness of a given technology are a function of agro-climatic and socio-economic environments such as rainfall and prices. In other words, rainfall and prices indirectly influence the rate of adoption. The benefits of using improved seed (hybrid) for instance, are enhanced by fertilizer application, especially under favourable environmental condition (Hassan et al, 1998). The rate and speed of improved technology adoption also depends on its availability which involve the generation and dissemination of these technologies to users (farmers). The other important reason for the length of time needed for technology generation, dissemination and adoption is how fast results are achieved as an indicator of the greater potential economic returns.

2.1.1.2 Mode and Sequence of Agricultural Technology Adoption

Much attention has also been given to explaining the mode (approach) and sequence of agricultural technology adoption. Two approaches are common in the agricultural technology adoption literature. The first approach emphasises the adoption of the whole package while the second one stresses step-wise or sequential adoption of components of a package. Technical scientists often recommend the former approach while field practitioners specifically farming system and participatory research groups advance the latter. There is a great tendency in agricultural extension programmes of developing countries to promote technologies as a package and farmers are expected to adopt the whole package.

Opponents of the whole package approach strongly argue that farmers do not adopt technologies as a package but rather adopt a single component or a few suitable technologies (Byerlee and Hesse de Polanco, 1986). Farmers choose to adopt inputs sequentially, initially, adopting only one component of the package and subsequently adding components over time, one at a time. The major reasons often given for sequential adoption of a technology package are profitability, riskiness, uncertainty, lumpiness of investment and institutional constraints (Byerlee and Hesse de Polanco, 1986; Leather and Smale, 1991). A farmer first selects the technology that best exhibits these attributes. Farmers might view each part of the technology package as a less risky activity than the complete package in terms of what the farmer could lose if crop failure occurs in that season. Sequential adoption of the components of technology package is therefore a rational choice for farmers with limited cash. As cash is accumulated from previous adoption of a component of the package, farmers will add another component based on the relative advantage and its compatibility under their condition. This process will continue until the whole package is fully adopted.

2.1.1.3 Adoption Determinants Models

Generally, it is assumed that farmers' decisions in a given period of time and space are derived from maximisation of expected utility or profit subject to resources constraints. Therefore, adoption depends on farmers' discrete choice of a new technology from a mix including the traditional technology and a set of components of the new technology (Feder et al, 1985). To answer the question of what determines whether a particular technology is adopted or not and the intensity of adoption, most of the adoption of agricultural innovations studies used static, rather than dynamic models.

A static model refers to farmers decisions to adopt an improved technology at a specific place and a specific period of time. This model attempts to answer the question of what determines whether a particular technology is adopted or not and what determines the pattern of adoption at a particular point in time (Ghadim and Pannell, 1999). Static adoption models include logit, probit, tobit, double hurdle, and double-limit hurdle models. One limitation of the static model is that it does not account for time in the adoption process nor for the farmers'

ability to learn to improve their technical efficiency in growing and marketing the crop. These weaknesses are addressed in dynamic adoption model.

Dynamic adoption models allow for changes in farmers' adoption decisions as farmers gain skills in growing the improved seed from year to year. In a dynamic model, at the beginning of each period, the actual yields, revenues and profits/ losses realized, information and the experiences accumulated during the period by the farmer and information from other farmers are used to update decision making in the next period (Ghadim and Pannell, 1999).

2.1.2 Technology and its Contribution to Pro-poor Agricultural Development

Agricultural technology can affect small-holder income, labour opportunities for the poor, food prices, environmental sustainability and linkages with the rest of the rural economy. Agricultural technology has been a primary factor contributing to increases in farm productivity in developing countries over the past half-century. Although, there is still widespread food insecurity, the situation without technology development would have been unimaginable. Agricultural technology can provide additional rural employment, but there are always countervailing pressures to reduce labour input and lower its costs. Food prices are demonstrably lower because of technology, but the distribution of benefits between consumers and producers depends on the nature of the local economy and trade patterns (De Janvry and Sadoulet, 2002; Thirtle *et al*, 2003).

The adoption of technology requires adequate incentives for producers. Investments in labour or cash will not be made unless there are adequate returns. One of the most important supporting factors is the adequacy of markets for outputs and inputs. Although, there is much academic debate regarding the nature and impact of technological change, the important issues for development assistance agencies are related to other uncertainties. These include: identifying the most effective planning procedures for directing agricultural technology to poverty reduction; establishing the role of agriculture in national development strategies; deciding the degree to which agricultural investments are appropriate for marginal areas; identifying the correct mix of public, private, and civil society support to agricultural technology generation; and identifying the types of technology that warrant support (Byerlee, 2000).

The rhetoric of technological revolutions should be eschewed in favour of consistent attention to building technological capacity in response to changes in the rural economy. Private sector technology generation (and technology delivery) is of growing relevance to poverty reduction strategies, but it is probably unreasonable to place high expectations on vastly expanded formal public-private partnerships. Support to NGOs in agricultural technology generation should focus on their role in building local institutions and capacities; a strong rural civil society is essential for articulating technology demand (Timmer, 1988; Thirtle *et al*, 2003).

Among the most important policy challenges related to support for agricultural technology are: the identification of an effective investment portfolio of technologies; structuring interchange among producers, consumers, public institutes (national and international), civil society and the private sector to elicit effective pro-poor demand; structuring assistance to recognise the long-term, incremental nature of technology generation; locating technology policies in a wider policy arena; setting and articulating clear policy goals that relate technology generation to food price, labour, trade, and regional development. There are a number of implications for the way that donor assistance to agricultural technology is structured. The agencies need to develop an in-house capacity to monitor the processes and outcomes of agricultural technology generation. Policies in support of agricultural technology generation should place strong emphasis on local institution building and should see that agriculture is addressed in a coherent fashion in poverty planning. An understanding of the multiple impacts and second-order effects of technology should inform the policy process. Finally, donor agencies need to increase their collaboration and co-ordination in support of technology generation (Timmer, 1988).

2.1.2.1 Technology's Role in Poverty Reduction

For millions of poor people, particularly in Asia, the technological advances of the Green Revolution (complemented by a massive increase in irrigation) provided a route out of poverty through: directly increasing producer incomes and wages; lowering the price of food; and generating new livelihood opportunities as success in agriculture provided the basis for economic diversification. Asian industrialisation was in essence agriculturally led (Timmer, 1988). Despite

decades of investment in new agricultural technology, hunger and poverty continue to plague large areas of the developing world. The problem is, particularly, acute in areas of the world dependent upon rain-fed agriculture, in particular sub-Saharan Africa, where the impact of new technologies has been less apparent and agricultural productivity has at best stagnated.

Achieving the Millennium Development Goal of halving the proportion of people living in absolute poverty by 2015 will require agriculture to play a major role. Increasing agricultural productivity remains perhaps the single most important determinant of economic growth and poverty reduction, hence provides the key to achieving the MDGs (Lipton, 2001). This fact is not lost on developing countries and their development agency partners, who are seeking ways to stimulate agricultural development, in particular, to increase productivity as a corner stone of their growth and poverty reduction process. But questions remain about technology's role in agricultural development and debate continues in a number of areas, specifically: can technological development be pro-poor? How can the poor benefit from the rapid improvements in knowledge and technology being achieved in the private sector? Is sufficient amount spent on bio-technology and in the right places? A better understanding of the impact of new agricultural technology on the lives and livelihoods of the poor will help in finding out, at least, some of the answers to these questions.

Improvements in agricultural productivity through technology adoption have a powerful knock-on effect to the rest of the economy by creating jobs in neighbouring sectors such as food processing and input supply as well as directly in farming; increasing the supply of affordable food, stimulating and supporting wider economic growth and development. Thus, no other sector than agriculture offers the same possibilities to create employment and lift people out of poverty (Lipton, 2001).

2.1.2.2 The Adoption of New Technology by Farmers

A range of factors appears to have been critical in determining the rate at which farmers have used new ideas, and so, been able to raise productivity for the benefit of growth and the pace of poverty reduction. These are as follows:

i) Secured Output Markets

Farmers will innovate to increase subsistence production, but as innovation generally implies some type of investment (in cash, labour or learning), the chances of farmers investing and innovating are greatly enhanced by the existence of secure markets. As the evidence shows, it is difficult to overestimate the importance of reliable output markets as an incentive to new technology adoption. Unreliable markets lock many farmers into inefficiently producing as much of their own needs as possible, rather than innovating with new crops in which they may well have a comparative advantage (Orr and Orr, 2002).

ii) Effective Input Supply Systems Including Credit

Effective input supply systems are essential, particularly when technological change depends on purchased inputs. Inadequate formal seed supply systems have been shown to dampen, or even preclude the diffusion of new crop varieties (Tripp, 2001). Establishing the systems to provide those inputs is, however, one of the major challenges for many technologies.

iii) Supporting Infrastructure

The presence of supporting infrastructure is fundamental to effective innovation of new technology. Roads are critical to supporting input and output marketing but the expansion of irrigation, probably, constituted the most important element of supportive investment. The expansion of irrigation in developing countries has been greatest where attaining increasing agricultural output through land expansion has been difficult, and so, gains are made by intensification (Dorward *et al*, 2004).

iv) Risk and Vulnerability

The relationship between risk and technology use is a perennial theme. It can work in two directions. First, the adoption of agricultural technology can make a limited contribution to reducing the vulnerability of the poorest. Examples include the adoption of drought resistant varieties that reduce the risk of crop failure because of drought. The use of irrigation can enable double cropping and lengthen the growing season thereby smoothing production and consumption as well as mitigating against the impact of price volatility. Secondly, there can be tradeoffs between growth through agricultural technologies and risk since taking up new agricultural technology is in itself risky. Whilst improved productivity through agricultural technology can lead to increased incomes, adoption is associated with capital and transactions

costs that poor people may not be able to afford. Furthermore, poor farmers struggle to control production uncertainties. Whilst there are some instances of very poor people investing in quite risky technology (e.g. cotton farming in much of South India), on the whole, because poor people are risk averse, they tend to benefit less than others from agricultural technologies and stick with low risk and low return activities.

2.1.2.3 Benefits of agricultural technology to the poor

A number of factors influence the extent to which the poor benefit from changes in agricultural productivity through the adoption of new technology. These are discussed below:

i) The impact on employment

Employment on the farms of others is of critical importance to the livelihoods of the poor. It is also an important way for many farmers to supplement their incomes. The impact of new technology on labour markets, specifically, its impact on the demand for labour and wage rates, is of great importance to the poor. Most evidence on this issue comes from the Asian Green Revolution experience while often technology-specific, a number of general principles emerge with respect to the impact of new technology on the demand for labour and wage rates. In terms of the impact on the demand for labour, the adoption of high yielding varieties generally increased demand for labour due to the higher harvesting and threshing requirements associated with their greater yields. The majority of additional labour used was hired rather than family labour (Lipton and Longhurst, 1989). This is particularly important for the poorest. Increased labour demand was greatest when new varieties were introduced into high potential areas and often associated with an increase in cropping intensity, while the impact was less pronounced when in low potential areas (Lipton and Longhurst, 1989; David and Otsuka, 1994).

The impact on wage rates is more difficult to determine because there are numerous causal and on occasion counteracting factors. Some conclusions can be drawn though, including that: generally, wages appear to have increased (IFPRI, 2002); labour saving technology has, probably, dampened the rate of wage increases, although this does not mean that wages have fallen because of the adoption of new technology. Lipton and Longhurst (1989) show that while a doubling of yields increased wages by 40% early in the Green Revolution, a similar yield-

increase 20 years later resulted in only a 10-15% increase in wages due to mechanisation. Bautista (1997) describes disappointing increases in the demand for agricultural labour in the Philippines, explained in part by subsidised farm mechanisation. In some cases, for example, herbicide adoption in rice systems (Naylor, 1994), the introduction of labour-saving technology has been a response to rising rural wage rates caused by growth in non-farm wage rates. Even where wage increases have been modest, the adoption of new technology has frequently increased the number of employment days and on occasion, facilitated the introduction of contracts for casual labourers (Leaf, 1983).

ii) Food prices

For the poor, the price of food is critically important, given the relatively larger proportion of their income generally spent on it. A relative lowering of food prices particularly of staples allows the poor to eat more and possibly better which has a positive impact on nutrition, health and food security. However, cheaper food also releases income which can be spent on other goods and services with immediate positive benefits to the poor such as improved shelter or access to key services such as health and education. This release of income also creates demand for goods and services which can have a powerful multiplier effect on the wider economy. In many developing countries and for the developing world as a whole, increases in the production of staple foods have comfortably outstripped population growth since the mid-1960s when the Green Revolution began to be adopted widely. Only in Sub-Saharan Africa have food supplies grown slower than population during the last thirty years.

Given this significant increase in per capita supply and the relatively low elasticity of demand for basic foods, the real world market prices of the major traded grains have steadily fallen since the early 1950s. At the individual country level, increased production of food grains can have a dramatic effect on prices. This is of great benefit to the poor, both in urban and rural areas where many people buy as well as grow their own food (De Janvry and Sadoulet, 2002). However, increasing production can also be a double-edged sword if it reduces prices to the extent that producer incomes fall. In cases where productivity increases due to technology match or even outpaces the corresponding fall in prices, both net consumers and net producers can benefit.

iii) Nutrition and food utilisation

There are numerous examples of how agricultural technology has benefited the nutritional status of poor households. These include: improved varieties with increased vitamin content that contribute to the reduction of human disease; post-harvest fortification of crops to reduce vitamin deficiencies; longer cropping seasons to regulate food supply and reduce the number of months that households go hungry; improved storage and processing to extend the shelf-life of food and reduce waste.

iv) Access to land and other resources

The extent to which agricultural technology can benefit poor people clearly relates to existing inequalities in land and access to other resources. There are various explanations of why poor people stay poor that are couched in terms of the allocation of land and other resources. There is the concern that technologies may exasperate inequality in access to productive resources. One major criticism of the early Green Revolution was the fact that early adopters tended to be richer farmers (Gulati & Narayanan, 2003). These farmers were able to take greater risks and gain economies of scale from applying new technologies to larger land holdings. Evidence suggests that subsequently, smaller farmers caught up and in some cases, took better advantage of the new technology (Lanjouw and Stern, 1998). Nevertheless, it is widely accepted that, initially at least, technology is an unlikely way to overcome major inequalities in access to basic resources, especially land.

v) Gender issues

Gender-related effects of technology change are often important in determining the impact of adoption on poverty. Technology generation has tended to favour crops traditionally grown by men, who frequently have greater access to labour, markets, credit and other inputs than women to a degree that may impact negatively on the intra-household distribution of income and consumption (Doss, 2001). Addressing these challenges goes well beyond technology design, as male dominated societal rules and norms. Also, a complex household environment of joint decisions, multiple objectives and mutual dependence make it difficult to target or predict the gender-related outcomes of technology development (Bonnard and Scherr, 1994).

2.1.3 Concepts of Food Security and Poverty

The degree of food security is essentially a proxy for poverty. The use of food security indicators provides a convenient way of measuring changes in poverty. A focus on food security ensures that the needs of the poorest are not neglected in policy formulation. Food security refers to the condition in which all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996). There are four major elements of food security: food availability, access, utilisation and stability.

Food security at household level is a subset of the national level and it requires that all individuals and households have access to sufficient food either by producing it themselves or by generating sufficient income to demand for it. At the household level, food security implies an adequate access to food over time. This is possible when there is adequate food availability to the household, and an adequate income capacity for the purchase of the available food. For farm households in rural areas, food availability means ensuring that sufficient food is available for them through their own production or purchase from markets. However, due to lack of adequate storage facilities and pressing needs, they mostly end up selling excess produce during the harvesting period, and sometimes, rely on market purchases during the hungry season, thereby creating a situation of food insecurity for most rural farm producers and households. Not only does food insecurity in itself have deleterious effects on households and individuals, but efforts at achieving food security may also exert a heavy toll on households if they must spend most of their income on obtaining food.

Food availability is a function of the combination of domestic food stocks, commercial food imports, food aid, and domestic food production, as well as the underlying determinants of each of these factors. Food availability refers to sufficient quantities of appropriate, necessary types of food from domestic production, commercial imports, and other sources, that are consistently available to individuals or are in reasonable proximity to them. In this context, availability refers to the physical existence of food, from own production or in the markets. National level food availability is a combination of domestic food production, commercial food

imports, food aid, and domestic food stocks, as well as the underlying determinants of all of these factors (Gross et al. 2000).

Food access is influenced by the aggregate availability of food through its impact on supplies in the market, and therefore, on market prices. Food access has three components: physical, economic, and sustainable access to food. Physical access implies food availability or food supply to the household, as there might be food available at the national level which, however, may not trickle down to the household level. Access is further determined by the ability of households to obtain food from their own production and stocks, from the market and from other sources. These factors are in turn determined by the resource endowment of the household, which defines the set of productive activities they can pursue in meeting their income and food security objectives. Furthermore, access to food is defined by an individual's capacity (that is income or other resources) to purchase or barter to obtain levels of appropriate foods needed to maintain consumption of an adequate diet and nutritional level. Food access is also a function of the physical, social, and policy environment which determine how effectively households are able to use their resources to meet their food security objectives. Access is, therefore, ensured when all households and all individuals within those households have sufficient resources to obtain appropriate foods for a nutritious diet (Riely et al.1999). The level of resources (capital, labour, knowledge, and others) at the disposal of households and individuals, to a large extent, determines their economic access to required foods, in addition to the prevailing market prices of the food commodities.

Food utilisation entails the use of food through adequate diet, clean water, sanitation, and health care. This brings out the importance of non-food inputs in food security. It is not enough that someone is getting what appears to be an adequate quantity of food if that person is unable to make use of the food because he or she is always falling sick. Food utilisation, which is typically reflected in the nutritional status of an individual, is determined by the quantity and quality of dietary intake, general childcare and feeding practices, along with health status and its determinants. Poor infant care and feeding practices, inadequate access to, or the poor quality of, health services are also major determinants of poor health and nutrition. Improved food

utilisation also has feedback effects, through its impact on the health and nutrition of household members, hence, on labour productivity and income earning potential.

Stability of food implies that the food availability is not affected by any shocks or risks affecting food production at all times. It means that households should not risk losing access to food as a consequence of sudden shocks (climatic crisis) or cyclical events (e.g. seasonal food insecurity). Food stability at the household level is thus critical to food security.

Two broad groups of factors determine food security. These are supply-side factors and demand-side factors. The supply-side factors are those that determine food supply or food availability. In other words, they are determinants of physical access to food at national, household and intra-household levels. The demand-side factors, on the other hand, are factors that determine the degree of access of countries, households and individuals to available food. They are, in other words, determinants of economic access to food or entitlement to available food. Common to these two sets of factors, however, is another set of factors that affect the stability of both physical and economic access to food.

According to the World Bank (1986), there are two kinds of food insecurity, namely, chronic and transitory. Chronic food insecurity is a continuously inadequate diet caused by the inability to acquire food. This type of food insecurity affects households that persistently lack the ability either to buy enough food, or to produce their own food. This results from insufficient assets (including education and human capital), intra-household resource sharing, long-run relative prices and wages. Transitory food insecurity on the other hand, is a temporary decline in a household's access to enough food. This condition results from instability in food prices, food production or household incomes and health shocks. In its worst form, it produces famine.

There are three main approaches to conceptualising food security. These are the food first approach, livelihood approach, and actor-oriented approach (Maxwell, 2001). The food first approach was concerned mainly with access to food. Food was regarded as a primary need basic to all human's needs. The measuring and monitoring of a food security situation was based on present and past consumption. It was assumed that the coping strategies of people were designed to maximize immediate consumption. As time went on, these assumptions underlying the food first approach began to be questioned. It was noticed that people chose to go hungry to preserve

assets and future livelihoods. People were found to be quite prepared to put up with considerable degrees of hunger, in order to preserve seed for planting, cultivating their own fields, or avoid having to sell an animal (de Waal, 1991). These findings showed that poor people had other objectives other than immediate consumption. Maxwell (2001) points out that there is a broader issue of livelihood at stake, in which objectives other than nutritional adequacy are pursued. These thoughts led to a shift from the food first to a wider sustainable livelihood approach.

In the livelihood approach, the main objective is seen to secure and sustain livelihoods while coping strategies are designed to preserve these livelihoods. Actor-oriented approach was used to analyse how households searched for adequate food, and how they actually organised resources available to them. The actor-oriented approach pays attention to the experiences and practices of individual households in their quest to become food secure. It explains how food security is achieved, why some succeed while others fail to obtain adequate food. It also helps to classify the source of food security. The strength of this approach is that it demonstrates that households experience the search for food in different ways even though conditions may appear relatively homogeneous. On this basis, three kinds of households were identified: the enduring households, which maintain household food security on a continuous basis; the resilient households, which suffer shocks but recover quickly; and the fragile households, which become increasingly insecure in response to shocks. The sensitivity and resilience of a household to a shock provides a strong framework for the analysis of food insecurity over time. Food insecure households are characterised by high sensitivity and low resilience. Hence, livelihood security is a necessary and sufficient condition for food security.

Poverty is a form of deprivation. It exists when there is lack of the means to satisfy critical needs (Ogwumike, 1996). A family is poor, if it spends a very high percentage of its income on basic needs such as food, clothing, housing, health care and transport, with very little left for a rainy day (Ali, 1992). Poverty may be absolute or relative. The definition of absolute poverty focuses on the inability of an individual or household to consume a certain minimum of basic needs, while relative poverty compares the welfare of those with the lowest amount of resources with others in the society (Ogwumike, 1996). According to the World Bank (2001), poverty is defined as a state of long-term deprivation of well-being, a situation considered

inadequate for decent living. However, there are much debates on how well-being should be measured and what indicators should be used.

According to Ravallion (1994), there are two broad approaches to defining well-being. These are the 'welfarist' approach and the 'non-welfarist' approach. The 'welfarist' approach defines well-being in terms of the level of utility attained by an individual. The approach attaches great importance to the individual's perception of what is useful to him or her. It tends to concentrate in practice mainly on comparisons of "economic well-being", which is also called standard of living or "income". This approach is strongly anchored in classical micro-economics, where, in the language of economists, "welfare" or "utility" are generally key in accounting for the behaviour and well-being of individuals. Classical economics usually postulates that individuals are rational and that they can be presumed to be the best judges of the sort of life and activities which maximise their utility and happiness. It is widely used by economists in the operation research work of organisations such as the World Bank, the International Monetary Fund, and Ministries of Finance and Planning of developed and developing countries.

The 'non-welfarist' approach defines well-being independently of the individual's perception of it. The approach relies on what planners consider desirable from a social point of view. There are two major non-welfarist approach, the basic-needs approach and the capability approach. The first approach focuses on the need to attain some basic multi-dimensional outcomes that can be observed and monitored, relatively, easily. These outcomes are usually linked with the concept of functioning. Functionings approach is closely linked with well-known basic needs approach and the two are often difficult to distinguish in their practical application. Functionings are not synonymous with basic needs. Basic needs can be understood as the physical inputs that are usually required for individuals to achieve some functionings, hence, basic needs are usually defined in terms of means rather than outcomes. Unlike functionings which can be commonly defined for all individuals, the specification of basic needs depends on the characteristics of individuals and of the societies in which they live. The second approach, that is, capability approach is defined by the capacity to achieve functionings. In Sen's (1997) words the capability to function represents the various combinations of functionings that the person can achieve. Capability, is thus, a set of vectors of functionings, reflecting the person's

freedom to live one type of life or another. What matters for the capability approach is the ability of an individual to function well in society; it is not the functionings actually attained by the person, hence, having the capability to achieve basic functionings is the source of freedom to live well and is thereby sufficient in the capability approach for one not to be poor or deprived.

The difference between the capability and functioning or basic needs is that in the basic needs and functionings approach, deprivation comes from a lack of direct consumption or functionings experience while in the capability approach, poverty arises from the lack of incomes and capabilities, which are imperfectly related to the actual functioning achieved. Non-welfarist (capability and basic needs) approaches to poverty measurement suffer from some comparability problems because they typically generate multi-dimensional qualitative poverty criteria: their fulfilment takes a simple dichotomic yes/no form. They also translate into greater implementation difficulties than for the usual proxy indicators of the welfarist approach. Welfarist approach will not impose multi-dimensional thresholds. For instance, the welfarist approach will usually not require, for one not to be poor, that both food and non-food expenditure be larger than their respective food and non-food poverty lines. This simplifies the identification of the poor and the analysis of poverty.

Poverty can be regarded as the low profile status, objective or subjective, of an individual or a population. Poverty will have an objective definition once observable and measurable indicators exist that are used to approach the material or other aspects of the lives of individuals. This is sometimes referred to as the welfare approach. On the other hand, the subjective definition of poverty is when judgment (including value judgment) of individuals is taken into consideration in order to investigate their welfare (Boccanfuso, 2004). Poverty measurement has traditionally been dominated by the objective approach. Recently, international community are interested in measuring subjective poverty because of the limitations associated with objective indicators and the value of understanding the perspective of the poor in shaping policies and programmes. Consequently, participatory poverty assessment methodologies have been gaining ground.

2.1.4 Approaches to Poverty Alleviation and Food Security

Various strategies have been advocated in the literature to address poverty and food insecurity challenges. Prominent among these are economic growth strategy, basic needs approach, rural development approach, employment-oriented approach and targeting approach (Mansuri and Rao, 2004).

2.1.4.1 Economic Growth Approach: This approach goes back to the 1950s and 1960s. The development policy literature emphasises growth as central to any policy on poverty reduction. As already pointed out above, studies have found that growth accounts for income growth for the poor in a large number of countries. However, because of the reliance on the 'trickle down' effect and on the pace of growth, which may be driven by capital intensive production process, the traditional growth approach has been found to produce less progress in poverty reduction. This has, therefore, led to a shift in emphasis from the "pace of growth" to the "structure of growth" strategy.

2.1.4.2 Basic Needs Approach – This calls for the provision of basic needs such as food, shelter, water, sanitation, health care, basic education and transportation. This approach is concerned with improving first, the income earning opportunities of the poor, second, the public services that reach the poor, third, the flow of goods and services to meet the needs of all members of households and fourth, the participation of the poor in the ways in which their needs are met. Unless there is proper targeting, this approach may not directly impact on the poor because of their inherent disadvantage in terms of political power and the ability to influence the choice and location of government programmes and projects.

2.1.4.3 Rural Development Approach – This approach sees the rural sector as a unique sector in terms of poverty and food insecurity reduction. This is because majority of the poor and food insecure in developing countries live in this sector. In addition, the level of paid employment in this sector is very minimal, hence, traditional measures of alleviating poverty and food insecurity may not easily work in the rural sector without radical changes in the assets ownership structure, credit structure etc. Emphasis in this approach to development has focused on the integrated approach to rural development. This approach recognises that poverty is multi-dimensional and

therefore, requires a multi-pronged approach. The approach aims at the provision of basic necessities of life such as food, shelter, safe drinking water, education, health care, employment and income generating opportunities to the rural dwellers in general and the poor in particular. One basic problem with this approach to poverty reduction is that it is difficult to focus attention on the real poor given that poverty in the rural area is pervasive. In other words, it makes targeting of poverty reduction programmes very difficult.

2.1.4.4 The employment-oriented approach: This approach emphasises employment promotion as the principal means of spreading the benefits of economic development more evenly throughout the economy. The "pace of growth" objective was modified so as to maximize not only output but also the rate of labour absorption. This is to be complemented with credit facilities to integrate the trained unemployed persons into the labour market on a sustainable basis.

2.1.4.5 Target Approach – This approach favours the directing of poverty and food insecurity alleviation programme to specific groups within the country. This approach includes such programmes as Social Safety Nets, Micro Credits, and School Meal programme. This approach requires proper identification of the target group so as to minimize leakages.

Globally, in recent times, the concern over increasing food insecurity and poverty levels especially in the developing countries and the need for its alleviation as a means of improving the standard of living of the people has led to shifting from Supply Driven Approach to Demand Driven approach through the conceptualisation and implementation of various Community Driven Development (CDD) programmes.

2.1.4.5.1 Community Driven Development Approach: The CDD approach is broadly defined as giving control of decisions and resources to community groups. Community Driven Development approaches, by contrast, treat poor people and their institutions as initiators, as collaborators and as resources on which to build. World Bank (2003) defines CDD as an effective mechanism for poverty reduction, complementing market-and state- run activity by achieving immediate and lasting results at the grass roots level. Community Driven Development can enhance sustainability and make poverty/ food insecurity reduction effort more responsive to

demand. It has also been shown to increase the efficiency and effectiveness of efforts; it has the potential to occur simultaneously in a very large number of communities, thus achieving far-reaching impact.

The Community-Driven Development approach has become one of the key development strategies used by both government and development assistance programmes (Mansuri and Rao, 2004; Gillespie, 2004; Platteau, 2004). The CDD popularity has been propelled by its potential to develop projects and programmes that are sustainable, responsive to local priorities, empower local communities to manage and govern their own development programs, and are better targeted towards the poor and vulnerable groups (Dongier *et al*, 2001; Gillespie, 2004).

Khwaja (2001) observes that projects managed by communities are more sustainable than those managed by local governments because of better maintenance. However, Cleaver (1999), Kleimeer (2000) and Mosse (1997) find that CDD projects that lack external institutional, financial, and technical support are not sustainable. Targeting the poor has been one of the challenges of development and emergency response programmes (Farrington and Slater, 2006). One argument in favour of CDD asserts that it can improve targeting because CDD projects make better use of local knowledge to define and identify the targeted groups (Mansuri and Rao, 2004). However, there has been mixed empirical evidence concerning the effectiveness of targeting using the CDD approach. A review concluded that in heterogeneous communities with high social inequality, the performance of CDD projects in targeting has been worse than that of externally managed programmes (Conning and Kevane, 2002). However, the review also revealed that in egalitarian communities, with open and transparent systems of decision-making, targeting was better with CDD than with development approaches using external project management.

Alkire *et al* (2001) also define CDD as a demand driven approach which recognises that poor people are prime actors in the development process, not targets of externally designed poverty reduction efforts. In CDD, control of decisions and resources rests with community groups, who may often work in partnership with demand-responsive support organisations and service providers, including elected local governments, the private sector, NGOs, and central government agencies. Experience has shown that, given clear rules of the game, access to

information, and appropriate support, poor men and women can effectively organise to provide goods and services that meet their immediate priorities. Not only do poor communities have greater capacity than generally recognised, they also have the most to gain from making good use of resources targeted at poverty reduction (Alkire *et al*, 2001). Community Driven Development's potential is increasingly recognised. Individual studies have shown that CDD can increase the effectiveness, efficiency, and sustainability of projects or programmes, making them responsive to local priorities. Other objectives include developing capacity, building social and human capital, facilitating community and individual empowerment, deepening democracy, improving governance, and strengthening human rights (Mansuri and Rao, 2004).

2.1.5 Poverty Alleviation / Food Security Programmes and Strategies in Nigeria

In Nigeria, the poverty alleviation and food security measures implemented so far have focused more on economic growth, basic needs, rural development approaches and employment generation. It is important to note that Nigeria focuses on agriculture and rural development as a means of reducing food insecurity and poverty. This is because food insecurity and poverty in Nigeria is largely a rural phenomenon with agriculture accounting for the highest incidence over the years. Besides, food security and poverty reduction depend to a large extent on the agricultural sector because the sector, not only provides food for consumption as well as raw materials for manufacturing activities, it is the main employer of labour, especially in the rural areas (Ogwumike, 2003). There are three periods that can be identified: Pre SAP era, SAP era and Democratic era.

2.1.5.1 Pre-SAP Era

Poverty reduction was never the direct focus of development planning and management during Pre- SAP era, Government only showed concern for poverty reduction indirectly. During this era, Nigeria had prepared and executed four national development plans as follows; First National Development Plan (1962 – 68), Second National Development Plan (1970 – 74), Third National development Plan (1975 – 80), and the Fourth National Development Plan (1981 – 85). During this era, many of the programmes which were put in place in Nigeria by the government

(either wholly or in association with international agencies) had positive effects on poverty reduction, although the target population for some of the programmes was not specified explicitly as poor people or communities. Some of these programmes are farm production enhancement programmes which tend to facilitate and support farmers in their production.

One of the first such programmes was the Farm Settlement Scheme (FSS) of the old Western Region of Nigeria established in 1959. The FSS was intended to put more lands under farming by engaging young school leavers in farming communities where they were expected to live together sharing facilities and responsibilities. Also, after the civil war in 1970, the Federal Military Government of Nigeria became more involved in initiating these programmes. Some of these programmes were fully funded by Nigerian Government while some were supported by the World Bank. These programmes include: the National Accelerated Food Production Programme (NAFPP); the Operation Feed the Nation (OFN), and the Green Revolution Programme (GRP). These were intended to improve the food situation in the country after the debilitating civil war. National Accelerated Food Production Project was a general-purpose food production programme, which was intended to make more resources available to farmers on their turfs through mobilisation of extension workers. Operation Feed the Nation was an awareness programme intended to educate people generally to engage in food production around their homes, schools and on any available piece of land. Green Revolution Programme (GRP) was initiated as a comprehensive development programme designed to revolutionise, not only food production, but also export tree crops production. Several instruments were considered in implementing GRP, but the most significant in terms of scope and financial commitment was harnessing of the water of Nigeria's river basin for food production (Anthonio and Akinyosoye, 1986). This led to Nigeria's River Basin Development Authorities (RBDAs) in 1977. In addition to the activities of RBDAs, the Agricultural Development Project (ADPs) became a major initiative for supporting the agricultural sector and rural economy of the nation in the 1980s. ADPs were to provide extension services, technical input support and rural infrastructure services. They also provide temporary role in providing advisory services.

The most serious intervention in developing a modern agricultural marketing system in Nigeria was the establishment of the marketing boards for the major crops of the country

between 1947 and 1986 to serve as buyer of last resort, at fixed prices, and hold strategic or buffer stock. The marketing boards functioned as para-public sector organisations, otherwise known as parastatals. They enjoyed a certain level of administrative autonomy but were still under close Government supervision. Marketing boards in Nigeria were characterised by many ills generally associated with government business concerns. They suffered from bureaucratic nuisances, a very large staff size, most of them were not qualified for the positions they held, and were poorly-paid. Excessive intervention in their management, relative insecurity of tenure and high operating costs contributed to the low level of efficiency in the boards. Other programmes during this era include the Agricultural Credit Guarantee Scheme (ACGS), the Rural Electrification Scheme (RES), the Rural Banking Scheme (RBS), Free and Compulsory Primary Education (FCPE) which were also set up in 1977, Green Revolution established in 1979, and Low Cost Housing Scheme. Most of these programmes were designed to take care of such objectives as employment generation, enhancing agricultural output and income, and stemming the tide of rural-urban migration. These programmes made some laudable impact; they enhanced the quality of life of many Nigerians. Despite this, they could not be sustained due to lack of political will and commitment, policy instability and insufficient involvement of the beneficiaries in these programmes (Ogwumike, 1998; CBN, 1998; Akinyosoye, 2005).

2.1.5.2 SAP Era

Conscious policy efforts by the government towards poverty alleviation and food security began in Nigeria during the era of the Structural Adjustment Programme (SAP). The severe economic crisis in Nigeria in the early 1980s worsened the quality of life of most Nigerians. The government made determined efforts to check the crisis through the adoption of SAP. However, the implementation of the SAP further worsened the living conditions of many Nigerians, especially the poor who were the most vulnerable group. This made the government to design and implement many poverty alleviation and food security programmes between 1986 and 1993. Also, under the guided economy deregulation that spanned the period 1993 to 1998, more poverty/ food insecurity reduction programmes were put in place by government. Some of the programmes under this era were Directorate of Food, Roads and Rural Infrastructure

(DFRRI), National Directorate of Employment (NDE), Better Life Programme (BLP), People's Bank of Nigeria (PBN), Community Banks (CB), Family Support Programme (FSP), Family Economic Advancement Programme (FEAP), National Agricultural Land Development Authority (NALDA), the Agricultural Development Programmes (ADP), and the Strategic Grains Reserves Programmes (SGRP), the Primary Health Care Scheme (PHCS), and the Guinea Worm Eradication Programme.

The Directorate of Food, Roads and Rural Infrastructures (DFRRI) was the first rural infrastructural development initiative in the country which was created in 1986 to act as catalyst for rural development by providing rural areas with various items of infrastructural services from the construction, rehabilitation and maintenance of rural feeder roads, rural market places, rural electricity installations and rural potable water installations for rain water catchments and ground water exploitation. The Directorate of Food, Roads and Rural Infrastructures programme only touched the lives of very few rural dwellers and people saw it as largely political as they did not internalise the ideas of self-development embedded into this seemingly revolutionary concept in rural transformation. In the early 1990s, the National Agricultural Land Development Authority (NALDA) was initiated with the mandate to expand land under cultivation by creating large farm communities similar, in concept to the old Western Region FSS. Other programmes that were initiated in the 1990s included the Agricultural Land Resource Management Programme. The objectives of the programme are the selection of suitable lands for the production of specific crops through soil surveys and land evaluation; monitoring and improvement of their qualities through soil fertility management; and ensuring the conservation of the fertility of the lands through rehabilitation. The project was not implemented due to limited financial resources and lack of technical personnel. The Rural Water Supply and Sanitation Programme (RUWASSAN) took off in 1995; the aim was to assist states to attain, at least, 50 percent national coverage for rural water supply by 2000. The problem with the RUWASSAN is similar to that of other rural programmes that are executed without regard to existing organisations. The Rural Water Supply and Sanitation Programme provided services that the State Water Supply Agencies and Health institutions were established to perform.

During the SAP era, some rural household empowerment programmes were also implemented. One of such programmes was the Better Life for Rural Women Programme (BLP) which was established to alleviate poverty and eliminate ignorance among rural people, particularly women. The programme metamorphosed into the Family Support Programme (FSP) in 1994 under a military Government. By 1997, another variant of the BLP and FSP had been designed by the Federal Government and called the Family Economic Advancement Programme (FEAP). This is an empowerment programme designed, specially, for locally based producers of goods and services and potential entrepreneurs in the cottage industries. The programme is aimed at improving the standard of living of the low-income groups by stimulating appropriate economic activities in the various wards of each local government area in the country. By 1999, all these previously established programmes were consolidated into the Poverty Alleviation Programmes (PAPs). All these old and new programmes follow the same approach of micro credit and promotion of rural-based Small-Scale Enterprises (SSEs). The programmes were not well thought out and the various programme activities not planned for. They were long on propaganda (if not noise-making), but short on substance. Sustainability was not built into their planning; hence programme names changed anytime a new Government came on board. Institutions created to manage the programme only benefited the managers of the programme. The programmes were more deceptive rather than empowering rural households to develop self-sustaining enterprise. They thrust on them a dependency syndrome with a "beggar" mentality that did not prepare the rural people to have the needed market and political power to demand for and get their entitlements from Government (Akinyosoye, 2005).

2.1.5.3 Democratic Era

During the democratic era, governments also designed and implemented various programmes and strategies to alleviate poverty and food insecurity. In 1999, the Poverty Alleviation Programme (PAP) that was established, with the objective of creating 200,000 jobs annually, failed to have any appreciable impact on poverty reduction in the country, due to "state capture" and leakages, among other reasons. It was replaced in 2003 by the National Poverty Eradication Programme (NAPEP), with five main programme areas. It is estimated that since

inception, the NAPEP has been able to train 130,000 youths, and has engaged 216, 000 persons who are attached to various establishments. However, like the PAP, beneficiaries are largely non-poor (Olaniyan *et al*, 2005; Aigbokhan, 1999). Similarly, the National Economic Empowerment and Development Strategy (NEEDS) and the Seven Point Agenda were the strategies initiated during this era.

The National Economic Empowerment and Development Strategy (NEEDS) was Nigeria's home-grown poverty reduction strategy (PRSP). The NEEDS was a medium term strategy (2003- 07) but which derives from the country's long-term goals of poverty reduction, wealth creation, employment generation and value re-orientation. NEEDS was a nationally coordinated framework of action in close collaboration with the State and Local governments (with their State Economic Empowerment and Development Strategy, SEEDS) and other stakeholders to consolidate on the achievements of the 1999- 2003 democratic dispensation. NEEDS has four key strategies: reforming the way government works and its institutions; growing the private sector; implementing a social charter for the people; and re-orientation of the people with an enduring African value system.

Reforming Government and Institutions: The goal is to restructure, right-size, re-professionalise and strengthen government and public institutions to deliver effective services to the people. It also aims at eliminating waste and inefficiency, and free up resources for investment in infrastructure and social services by Government. Growing the Private Sector: NEEDS is a development strategy anchored on the private sector as the engine of growth for wealth creation, employment generation and poverty reduction. The government is the enabler, the facilitator, and the regulator. The private sector is the executor, the direct investor and manager of businesses. The key elements of this strategy include the renewed privatisation, de-regulation and liberalisation programme. Implementing a Social Charter: NEEDS was about people: it was about their welfare, their health, education, employment, poverty-reduction, empowerment, security and participation. This is the overarching goal of NEEDS.

The National Economic Empowerment and Development Strategy (NEEDS), the economic development blueprint, developed by Obasanjo regime, influenced the creation of President Umaru Musa Yar'Adua's 7-Point Agenda; an articulation of Policy Priorities to strengthen the

reforms and build the economy, so that the gains of the reforms are felt widely by citizens across the country. The Seven Points Agenda are the following:

1. Power and Energy – The infrastructural reforms in this critical sector, through the development of sufficient and adequate power supply, will be to ensure Nigeria's ability to develop as a modern economy and an industrial nation by the year 2015.
2. Food Security – This reform is primarily agrarian based. The emphasis on the development of modern technology, research, financial injection into research, production and development of agricultural inputs will revolutionalise the agricultural sector, leading to a 5 – 10 fold increase in yield and production. This will result in massive domestic and commercial outputs and technological knowledge transfer to farmers.
3. Wealth Creation – By virtue of its reliance on revenue from non-renewal oil, Nigeria is yet to develop industrially. This reform is focused on wealth creation through diversified production, especially in the agricultural and solid mineral sector. This requires Nigerians to choose to work, as hard work by all is required to achieve this reform.
4. Transport Sector – The transportation sector in Nigeria with its poor road networks is an inefficient means of mass transit of people and goods. With a goal of a modernised industrialised Nigeria, it is mandatory that Nigeria develops its transport sector. However, the reforms might take some time to take effect; it is a need that must be addressed.
5. Land Reforms – While hundreds of billions of dollars have been lost through unused government-owned landed asset, changes in the land laws and the emergence of land reforms will optimise Nigeria's growth through the release of lands for commercialised farming and other large scale businesses by the private sector. The final result will ensure improvement and a boost to the production and wealth creation initiatives.
6. Security – An unfriendly security climate precludes both external and internal investment into the nation. Thus, security will be seen as not only a constitutional requirement but also as a necessary infrastructure for the development of a modern Nigerian economy. With its particular needs, the Niger Delta security issue will be the primary focus,

marshaled not with physical policing or military security, but through honest and accurate dialogue between the people and the Federal Government.

7. Education – The two-fold reforms in the educational sector will ensure firstly the minimum acceptable international standards of education for all. With that achieved, a strategic educational development plan which will ensure excellence in both the tutoring and learning of skills in science and technology by students who will be seen as the future innovators and industrialists of Nigeria will also be achieved.

All of these agenda just appeared on the pages of newspapers; however, they were not fully realised**.**

The Home-Grown School Feeding and Health Programme was adopted worldwide and initiated in September 2005 by Nigeria's federal government to reduce child malnutrition and poverty; empower school-aged children and to mitigate risk factors for underdevelopment. The programme ensures a free meal for a child each school day that is adequate in quality and quantity. It also aims to provide preventive health services for all Nigerian school children to reduce hunger and improve nutrition, increase school enrolment, enhance learning, and improve health. The programme also strives to enrol a sizeable number of girls to correct a gender imbalance. A total of 15 states, including two non-pilot states, covering the six geopolitical zones, are implementing the program now with a target of 2.5 million children. The strategies the program employs to deliver its services include using a home-grown, school-based, community-driven, multi-sectoral and multi-stakeholder approach. The programme has three components, namely, programme management, school feeding, and health.

The National Special Programme for Food Security (NSPFS) is an initiative of the Federal Government of Nigeria in conjunction with the Food and Agricultural Organisation for poverty reduction in line with the thrust of the National Economic Empowerment Strategy. It focuses on the transfer and application of low-cost technologies to improve agricultural productivity and sustain agricultural systems. The programme's broad objective is to contribute to sustainable improvements in national food security through a rapid increase in productivity; to foster food production on an economically and environmentally sustainable basis; to reduce yearly variability in agricultural production; and to improve the people's access to food. Its specific

objectives are to: assist farmers to achieve their potential for increasing output, productivity, and incomes; strengthen the effectiveness of research and extension services by bringing technology and new farming practices developed by research institutes to farmers; concentrate initial efforts in pilot areas for maximum effect and ease of replicability and educate farmers in the effective use of available land, water, and other resources and facilities to produce food and create employment.

Failures of Some Poverty and Food Security Programmes

The major reasons for the failure of poverty and food insecurity reduction related programmes in Nigeria include programme inconsistency, poor implementation, corruption of government officials and public servants, political instability and interference, poor targeting mechanisms, ineffectiveness of the policies, and nature of growth and strategies (Supply Driven Approach), failure to focus directly on the poor, unintended beneficiaries benefiting more than the intended ones (Kankwenda *et al*, 2000; Ogwumike, 1998; Egware, 1997; and Maduagwu, 2009). Some of these programmes with their weaknesses are summarised in the Table 1.

Table 1: Agricultural Development Initiatives Implemented by Past Government, 1935 –2007

No	Programme/ Program	Year established	Nature of intervention	Weaknesses
1	Cooperatives	1935 to date	To regulate cooperative activities in the country.	Policy inconsistency and administrative dislocations of the federal department in charge of cooperatives.
2	Commodity Boards	1947 to 1986	Served as buyers of last resort, at fixed prices and held strategic or buffer stock.	Inability to pay farmers the subsisting market prices at that time. Scrapped in 1986 under Structural Adjustment Programme.
3	Agricultural Research Institutes	1964 to date	To conduct research in various crops, livestock and fisheries.	Instability of the research institutes as a result of constant movement of the agricultural research institutes from one Ministry to another. There was also a major problem with funding of these institutes.
4	National Accelerated Food Production Project (NAFPP)	1970s	To increase the yields of seed varieties and enhanced fertilizers use and promoted extension and credit services as well as adaptive research and staff training.	Started very well but the wheat programme was affected by a basic withdrawal of political support and lifting of the ban on wheat import.
5	Agricultural Development Projects (ADPs)	1975 to date	To provide extension services, technical input support and rural infrastructure services. Also to provide temporary role in providing advisory services.	The decline in oil prices that started in 1982 had a substantial fiscal effect in Nigeria and led to shortages of counterpart funds for these projects.
6	River Basin Development Authorities (RBDAs)	1977 to date	To develop and take advantage of available water bodies in the country for agriculture, fishing and other purposes.	Unnecessary political interference and managerial problems. Lack of qualified manpower to provide effective leadership at the departmental levels.
7	Operation Feed the Nation (OFN).	1976 to 1979	A reaction to the first real food crisis in the country. Improve agricultural production and general performance of the agricultural sector.	The lack of continuity and shift in approach by successive governments were the reasons for the failure of the programmes.
8	Green Revolution	1979 to 1983	Improve agricultural production and general performance of the agricultural sector.	The lack of continuity and shift in approach by successive governments were the reasons for the failure of the programmes.
9	Directorate for Food, Roads and Rural Infrastructures (DFRRI)	1986 to 1993	Feeder Roads, rural water supply and rural electrification.	The lack of funds and commitment limited the extent of rural areas. The government rural infrastructural programmes were embarked upon without effective programme of action and appropriate institutional arrangements for their execution.
10	National Agricultural Land Development Authority (NALDA)	1991 to 1999	Providing strategic public support for land development, promoting and supporting optimum utilization of Nigeria's rural land resources, providing gainful employment opportunities for rural people as well as raising incomes and improving general living standard in rural areas.	The NALDA approach increased rather than reduce the direct public provision of goods and services, which could be produced by the private sector instead.
11	Presidential Initiatives on Cocoa, Cassava, Rice, Livestock, Fisheries and Vegetables	1999 to 2007	To improve Nigeria's food production in line.	Poor funding and lack of institutional arrangements for implementation.

Source: Federal Ministry of Agriculture and Water Resources, 2008.

2.1.6 Community-Driven Development Programmes in Nigeria

During the democratic era, several CDD projects have been implemented and some are still on or about to be implemented. These include Local Empowerment and Environmental Management Project (LEEMP), Community based Poverty Reduction Project (CPRP), Community and Social Development Project (CSDP), Community Based Agricultural and Rural Development Project, Community Based Natural Resources Management Project, Fadama projects and RTEP.

2.1.6.1 Local Empowerment and Environmental Management Project (LEEMP)

The Local Empowerment and Environmental Management Project (LEEMP), a Community Driven Development Project that became effective in 2004 was implemented for five years in nine states. The participating states were Adamawa, Bauchi, Bayelsa, Benue, Enugu, Imo, Katsina, Niger and Oyo. The LEEMP was designed to establish an institutional mechanism for transferring investment resource to communities, so that they can finance their own investment priorities. In addition, it emphasised the management of the environment as a prerequisite to sustainable livelihoods and development. It was financed by the International Development Association (IDA), state governments and participating beneficiary communities. It sought to reduce poverty, stimulate growth and empower people using a Community Driven Development (CDD) approach, which emphasises social, natural resources and environmental management. The Local Empowerment and Environmental Management Project engenders social inclusion through gender equality and people's participation. It creates job opportunities and wealth through the provision of support for various income-generating activities. It provides support for policy and legislative reforms in the environmental sector, and for communities to engage in sustainable agricultural practices, improve access to market, and mainstreaming the environment (NISER, 2007).

2.1.6.2 Community –Based Poverty Reduction Project (CPRP)

The Community-Based Poverty Reduction Project was initiated in 2001 with financial aid from the International Development Association (IDA). Twelve states benefited from the project; eight of these states were funded by the World Bank and the remaining four states funded by AfDB. The CPRP used community driven development approach to support the financing of social infrastructure and environmental management practices and engaging communities and local level governments in tackling poverty. The development objectives of

this project are: the improvement of access of the poor to social and economic infrastructure, to increase the availability and management of development resources at the community level. The output of the project was to have improved services and infrastructure in poor beneficiary communities; increased capacity of Federal government to support, monitor and evaluate poverty reduction activities; increased capacity at State level for implementing community-driven projects (Federal Ministry of Finance, 2008).

2.1.6.3 Community and Social Development Project (CSDP)

This is a Community Driven Development project that was initiated in July, 2008 to end in December, 2013. The CSDP is a five-year Sector Investment Loan (SIL) to allow (i) the scaling up of the CDD approach from the CPRP and LEEMP states, to other states in Nigeria, (ii) the institutionalisation of the CDD approach in the planning approaches adopted by the three levels of government, (iii) response to the challenge of human development at the grassroots level in a sustainable and participatory manner, and (iv) improved sustainable natural resource management. The project aims at sustainably increasing the access of poor people to social and natural resource infrastructure services through supporting (i) the empowerment of communities to develop, implement and monitor micro social infrastructure projects (public and common pool goods), including natural resource management interventions and, (ii) strengthening the skills and capacity of local government authorities and sectoral public agencies to support communities and build a partnership between them.

Possible micro-projects that may be contained in eligible CSDPs are rehabilitation, extension or construction of primary schools, health centres, rural electrification, water points, water reservoirs; rehabilitation or construction of feeder road, small bridges, culverts, drifts and stock routes, boreholes and other basic transport infrastructures. Small socio-economic infrastructure for community use (public goods) are markets and storage; vocational training centres (skill development centres); and natural resource management facilities such as community reforestation, woodlots or community-managed measures for firewood utilisation or planting of windbreaks, physical and biological measures for lowering soil erosion and environmental degradation, community sanitation, including treatment of human and livestock waste, agro-forestry, water catchments systems, drainage systems or local management of solid wastes; and community energy efficiency, including promotion of equitable access to energy-efficient stoves or biogas pits (Federal Project Supporting Uint, 2008).

2.1.6.4 National Fadama Development Project (NFDP)

Fadama refers to a seasonally flooded area used for farming during the dry season. It is defined as alluvial, lowland formed by erosional and depositional actions of the rivers and streams (Qureshi, 1989). The desire to realise the full potential of *Fadama* resources in Nigeria led to the design of the National *Fadama* Development Project, mainly funded by the World Bank, with counterpart funding by the Federal and benefiting state governments. *Fadama*-I Project was implemented during the 1993-99 period. *Fadama*-I focused mainly on crop production and largely neglected downstream activities such as processing, preservation, and marketing. The emphasis of *Fadama*-I was on provision of wash bores to crop farmers through simple credit arrangements aimed at boosting aggregate crop output (NFDO, 2005).

The Second National *Fadama* Development Project (NFDP-II) is a follow-up on the first phase. The main objective of NFDP-II is to sustainably increase the incomes of *Fadama* users through expansion of farm and non-farm activities with high value added output. It covered eighteen states including the Federal Capital Territory (FCT). *Fadama*-II was operated for six years (2004–2010) with a goal of contributing to poverty reduction in Nigeria. The direct beneficiaries are the 2 million rural families living in the participating states who are now pursuing their livelihoods in the *Fadama* lands. These are not only farmers, as a significant aim of the project design was to ensure that the various *Fadama* User Groups (FUGs) learn to accept each other's rights to a common resource pool which they share as well as take individual decisions. Thus, keeping in mind the impact such actions may have on others and on the *Fadama* environment at large. In order to achieve its objectives, the project had five components namely: Capacity Building, Rural Infrastructure Investment, Pilot Productive Asset, Demand-Responsive Advisory Services, Project Management, Monitoring and Evaluation (NFDO, 2005). The success of *Fadama*-II has led to the extension of the project to other states of the country in 2010 called *Fadama*-III. The aim is to reduce poverty among the beneficiaries in the entire 36 states and the Federal Capital Territory of Nigeria.

2.1.6.5 Root and Tuber Expansion Programme (RTEP)

The Root and Tuber Expansion Programme (RTEP) assisted by the International Fund for Agricultural Development (IFAD), was designed to consolidate the gains made under the Cassava Multiplication Programme (1987-97) and to address the problem arising from its implementation. The implementation of the project commenced in July, 2001. Earlier

coverage by the Cassava Multiplication Programme (CMP) of the nine southern States was extended by the RTEP to include almost the middle-belt and southern states of the country, bringing the total number of states covered to twenty-six including the Federal Capital Territory. The states are: Abia, Akwa-Ibom, Anambra, Bayelsa, Benue, Cross River, Delta, Ebonyi, Edo, Ekiti, Enugu, Kaduna, Kogi, Kwara, Imo, Lagos, Nasarawa, Niger, Ondo, Oyo, Ogun, Osun, Plateau, Rivers and Taraba.

The main goal of the RTEP is to increase income, alleviate poverty and improve food security status of the small-holder households in the programme states with less than 2 hectares of land, growing and processing cassava, yam, cocoyam, Irish and sweet potato. This is done through the transformation of cassava and other major root and tuber crops into commercial commodities. The beneficiaries of the RTEP included 18,750 families that produced or received improved planting materials and 285,000 farmers who were trained on new production technologies. In order to facilitate the attainment of the objectives of the programme, three components were identified namely: Development of improved production technology including multiplication of improved varieties as well as improved adaptive research and extension; support to processing and marketing involving diversification of cassava processing technologies/methods, community-based processing and marketing, as well as capacity-building and institution development; programme management and evaluation.

Based on the initial design of the RTEP, the implementation of activities during the first tri-term (2001-2004) was largely state-wide, thinly spread and supply-driven, thus, naturally limiting the possibilities of innovations, successes and sustainability. The programme was initially implemented as a supply-driven project but redesigned in 2006 to adopt community-driven development approach to enhance stronger programme ownership and beneficiary empowerment. Although the RTEP started out as a purely single commodity, agricultural production intervention, it has been transformed to a degree towards the community-based approach that is a key feature of the other programmes. The effectiveness of the RTEP is being affected by the changes in programme design since the Tri-term Review. The original programme design was premised on lessons learned from the CMP review, namely that: (i) it was confined to cassava and only to production; (ii) its resources were spread too thinly; (iii) processing and marketing were largely missing; and (iv) demonstration, training and promotion were the best tools for root and tuber promotion, therefore, further assistance to groups should be provided on a grant basis.

Programme Strategy and Approaches

The strategies and approaches generally adopted in the implementation of the RTEP activities following the tri-term review are considered apt, very appropriate and most effective. First, the community-based, beneficiary-driven, participatory approach invariably endowed ownership and enhanced the sustainability of selected/chosen root and tuber crops production, processing and marketing enterprises. Second, the shift in focus in favour of five Local Government Areas (LGAs) per state and five selected communities per LGAs, resulted in better and more efficient deployment of programme resources. Such targeted approach enhanced the effectiveness of the management, service provision and monitoring of enterprise activities, thus, improving the possibility of meaningful programme outcome and impact. Finally, the introduction of a contributory stakeholder support grant fund (90% RTEP and 10% beneficiary/community group) clearly served as a positive incentive in the promotion and diversification of production, processing and marketing enterprises chosen and managed by programme beneficiaries.

Assessment of Relevance of RTEP

The choice of cassava, yam, cocoyam, sweet and irish potato as target crops for expanded production, small to medium- scale processing and marketing enterprises and activities, under the RTEP very much remains pertinent to present-day Nigeria. Issues of inadequate commercialisation of the country's agricultural sector, poverty, food insecurity and high food prices have indeed increasingly assumed more and greater developmental concern and relevance. Agriculture in the roots and tubers belt of Nigeria, especially covering the southern and middle-belts states is dominated by small-holder farmers/producers, post-harvest processor/handlers and marketers/traders. Moreso, these crops, particularly cassava, have considerable potential for development, value addition, poverty alleviation and food security.

2.2 Methodological Review

2.2.1 Impact Assessment

Impact assessment is the process of identifying the consequences of an intervention. It is a means of measuring the effectiveness of organisational activities and judging the significance of changes brought about by those activities. It is used to ensure that projects, programmes and policies are economically viable, socially equitable and environmentally sustainable. Impact is seen as the contribution of the intervention to the overall goal. Impact assessment can be classified into ex-ante and ex-post. Ex-ante impact assessment is undertaken before a programme or policy is implemented as an aid in priority setting. It involves quantitative techniques that try to predict the various effects of policies, while ex-post assessment is carried out after the programme or policy has been in place. It is done to observe and precisely identify the direct and indirect effect of a policy to see whether the actual effects were those expected (Bourguignon and Pereira Da Silva, 2003; Todd, 2006). Expost evaluation generates information that is useful for the selection, planning and management of future research programme.

Impact evaluation can also explore unintended consequences, whether positive or negative on beneficiaries. Of a particular interest is the extent to which project benefits reach the poor and the impact that these benefits have on their welfare. Some of the questions addressed in impact evaluation include the following: how did the programme affect the beneficiaries?, were any improvement a direct result of programme or would they have improved anyway?, could programme design be modified to improve impact?. However, these questions cannot be simply measured by the outcome of a project. There may be other factors or events that are correlated with the outcome but are not caused by the project.

Therefore, to ensure methodological rigour, measuring programme impact on beneficiaries requires a strategy to estimate the counterfactual state of participants, which is by definition, unobservable, or what would have happened had the intervention not taken place. Due to the fact that the counterfactual is not observable, impact evaluations must include some form of appropriate comparison or control group (Baker, 2000). To determine the counterfactual, it is necessary to net out the effect of the intervention from other factors, a somewhat complex task. This can be solved using the experimental and non-experimental (Quasi-experimental) approaches.

Ideal social experiments identify programme impacts by balancing many features of the data at the same time such as (1) Participants and controls have the same distributions of

unobserved personal attributes; (2) They have the same distribution of observed personal characteristics; (3) The same questionnaire is administered to both groups, so outcomes and personal characteristics are measured in the same way for both groups; and (4) Participants and controls are placed in a common economic environment. Features (2) and (4) can also be achieved by a non-experimental evaluation method. Matching methods essentially use resampling methods to mimic feature (2) of an experiment in non-experimental data. Matching methods also substantially reduce bias when the data is also characterized by features (3) and (4) (Heckman *et al*, 1997; Todd, 2006).

Challenges in Evaluating Agricultural Projects

There are three interrelated challenges that impact assessment studies face: establishing a viable counterfactual (the predicted outcome in the absence of the intervention, that is, what would have happened to the beneficiaries had they not participated in the project); attributing the impact to an intervention; and coping with long and unpredictable time lag (Alston and Pardey, 2001; Salter and Martin, 2001). To truly understand the impact of a project on a given indicator, information would ideally be available on project beneficiaries with the project and without the project. The indicator could then be compared between these two states to see if the project had an impact. Of course, beneficiary farmers cannot be simultaneously in the project and out of the project, that is, the same person is not observed in both states (hypothetical and counterfactual). This is called the problem of causal inference by some statisticians (Holland, 1986). Therefore, it is necessary to find a substitute group of farmers to act as the counterfactual. To be a legitimate counterfactual, this counterfactual or control group would need to be exactly like the project beneficiaries or treatment group except they would have not received the treatment. Thus, any differences in the indicator could be attributed to the project. Creating a counterfactual through identifying a reasonable control group and ensuring that an identified impact can be attributed to a project is always a challenge (Winters *et al*, 2010).

One common issue with evaluating agricultural projects is that they often involve self selection of participants implying that not all farmers may choose to participate in a given project. If an evaluation attempts to determine the impact of a project by comparing those that chose to be in the project to those that did not, difference in the indicator of interest may reflect not only the impact of the project, but also any innate differences between participants and non-participants. Suppose the better farmers in a region decide to participate in an

agricultural extension project, that is, farmers that are innovative and like to experiment with their production to see what works best. Such farmers are likely to have higher yields even without the project. A comparison of yields between these innovative, treated farmers and non-participant, control farmers is likely to show higher yields for the treated farmers due to the project but also due to the fact the farmers are innovative. The problem is that it is hard to know how much of the yield difference is due to the project and how much to the differences in farmers' type. This makes any estimate of project impact biased since the estimate cannot be solely attributed to the project. Clearly, selection is also an issue if farmers with certain attributes are chosen by the project to participate. If a project focuses on farmers with limited land access, those with larger landholding are unlikely to be a good comparison. However, these attributes tend to be observable since the project must observe them to identify who will participate. With careful evaluation design, particularly if done in combination with project design prior to project implementation, it is possible to create a reasonable counterfactual and avoid biased estimates of impact (Winters *et al*, 2010).

Incorporating Spill over Effects

Spill-over effect occurs when the intervention has an impact on units not in the treatment group. There are a number of reasons to expect that agricultural projects will have spill over effects at least within local communities, and possibly, beyond that. This, not only has the potential to cause problems for identifying the direct project impacts, since it can lead to the potential contamination of a control group, but can lead to underestimates of project impact if not incorporated in the evaluation. If spill over effects are expected, the evaluation design should make efforts to incorporate them into the impact evaluation.

The first step in incorporating spill-over effects into an evaluation is to consider the theoretical reasons why spill-over effects are expected. The two primary reasons for spill-over effects are the existence of externalities, and of general equilibrium effects. It is critical to understand why spill-over effects occur since it identifies the group of non-participants that may be indirectly affected by the project. For example, in a technology transfer project, the primary group that is likely to indirectly benefit from a project is non-participants in communities where the project is transferring new technologies. Although not participating in the project, they may learn about the technology or even receive the technology from participants and decide to adopt the technology themselves. If such effects are expected to be substantial, they should be measured (Winters *et al*, 2010).

Considering the Methodological Options

The methodological approach depends both on the characteristics of the project as well as the data that is available or can be collected. When possible, a common practice among evaluators is to employ multiple methods or different specifications to identify the impact of a project. The project characteristics and the data available, of course, limit options, but, when possible, this is considered a good practice since it helps to ensure that the estimated impact is correctly identified. The expectation is that any valid evaluation approach should bring about similar results and reflect the true impact of the project. By using multiple methods or difference specifications, the robustness of the estimate of impact can be checked. In designing an evaluation strategy as part of the project design, it is often advantageous to consider not just what individual approach might be best, but what alternatives might be needed or desirable to verify the accuracy of impact estimates (Winters *et al*, 2010). Broadly, the approaches to impact evaluation are experimental and non-experimental approaches.

2.2.1.1 Experimental Approach

Experimental approaches attempt to randomly assign treatment and control groups prior to project implementation Random assignment (or 'experiments') is generally viewed as the most robust evaluation approach (Burtless, 1995). Random assignment operates by creating a control group of individuals who are randomly denied access to a programme. Properly carried out random assignment creates a control group comprising individuals with identical distributions of observable and unobservable characteristics to those in the treatment group (within sampling variation). Hence, the selection problem is overcome because participation is randomly determined. The mean outcome for those participating in the programme, relative to that for those in the control group, provides an estimate of the Treatment on the Treated (TT). While this is the parameter most commonly examined using random assignment, it is possible to design experiments in such a way as to derive estimates of Average Treatment Effect (ATE) (White and Lakey, 1992). Newman *et al* (1994) emphasise that "whenever a project is of sufficient interest to policymakers to warrant an impact evaluation, programme designers ought to consider randomised control design because this methodology yields the most robust results." Randomisation protects internal validity by ensuring that participation is completely exogenous, and thus, uncorrelated with other pertinent variables or the error term in a regression (Bryson *et al*, 2002).

At the practical level, experiments are often costly and require close monitoring to ensure that they are effectively administered. They may also require informing potential participants of the possibility of being denied treatment. The potential for denying treatment can pose ethical questions that are politically sensitive. These may reduce the chances of an experiment being considered as a means of evaluating a programme and may increase the chances of those responsible for delivery of the programme being reluctant to cooperate. There are also practical problems that can bias the estimates. It may be that the implementation of the experiment itself alters the framework within which the programme operates. This is known as 'randomisation bias' and can arise for a number of reasons (Heckman and Smith, 1995). For instance, if random exclusion from a programme demotivates those who have been randomised out, they may perform more poorly than they might otherwise have done, thus, artificially boosting the apparent advantages of participation. Furthermore, those receiving treatment may drop out of the programme. In this case, random assignment does not identify treatment on the treated, but instead, identifies the mean effect of 'intent to treat'. This may or may not be of direct policy interest. Conversely, those denied treatment may choose to participate in programmes that are effective substitutes for the programme under evaluation. With both programme dropout and comparison group substitution, non-experimental methods can be used to retrieve the desired parameters (Bryson *et al*, 2002).

2.2.1.2 Non-Experimental/Quasi–Experimental Approach

There is no general approach to estimating treatment effects. A number of different methods have been used in impact evaluation theory to address the fundamental question of missing counterfactual. Each of these methods has its own assumptions about the nature of potential selection bias in programme targeting and participation; and the assumptions are crucial to developing the appropriate model to determine programme impacts. These methods include the "before and after" (reflexive) approach, "with and without" analysis, Difference in Difference estimators, Instrumental Variables (IV) approach, Regression Discontinuity approach and Propensity Score Matching (PSM). These are discussed as follows:

(i) Before-and-after or reflexive approach: The evaluation problem can be viewed as a missing data problem, and is being addressed by using pre-programme data to impute the missing counterfactual outcomes for programme participants (Todd, 2006). This approach to evaluation compares indicators of impact for beneficiary farmers from before the project is

implemented to after the project is in place and view the difference as the estimate of Treatment on the Treated (TT). An advantage of before-after estimator relative to other classes of estimators is that it can be implemented even when data are available only on programme participant at a minimum; two cross-sections of data, one pre-program and post-programme are required to implement the estimator.

Although these types of comparisons are often used in ex-post evaluations, they remain problematic. Note that, the evaluation problem requires a counterfactual that represents beneficiary farmers in the absence of the project. In the case of a reflexive comparison, the counterfactual is the beneficiary farmers themselves but before the project. This may seem like a reasonable approach since clearly beneficiaries at one point in time are similar to themselves at a later point in time. The problem, however, comes precisely because of this time dimension. Comparing beneficiaries before and after a project assumes that no other changes have occurred over time other than the initiation of the project and, therefore, that all changes in impact indicators can be attributed to the project. Any ex post evaluation, using this approach is likely to be biased, and it is impossible to separate general time trends from actual project impact (Winters *et al*, 2010).

(ii) "The with and without" comparison: In this approach, the outcome of beneficiaries are compared with that of non-beneficiaries, and the difference constitutes the impact. However, this can only be true if there is no problem of selection bias. That is, if the two populations (beneficiaries and non-beneficiaries) are homogeneous, except that one is treated and the other is not. However, a proper comparison group that is a close counterfactual of beneficiaries is needed. This implies that the "with and without" approach may lead to under or overestimation of the impact of a programme or project.

(iii) Difference in Difference Estimator (DID) or Double Difference (DD): It is commonly used in evaluation work. It measures the impact of the programme intervention by the difference in the before-after change in outcomes between participants and non-participants, which requires pre- and post-programme data on programme participants and non-participants. Alternatively, the DID estimator is often implemented using a regression. This operates by comparing a before-after estimate for participants with a before-after estimate for non-participants and regarding the difference as TT. The advantage of the DID estimator is that it also removes the trend effects, that is, nets out the effects of any factors (whether

observable or unobservable) that have fixed (time-invariant) and additive impacts on the outcome indicator (Ravallion, 2005). In principle, this approach can be used to assess programme impact without using PSM, and will produce unbiased estimates of impact as long as these assumptions hold. However, if the program has differential impacts on people having different wealth or other observable characteristics, the simple DD estimator will produce biased estimates if participant and non-participant households differ in these characteristics (Heckman *et al*, 1998). DID require pre and post-programme data on programme participants and non-participants. It could be Longitudinal or repeated cross section data.

(iv) Instrumental Variables: The IV method is possible when a variable can be identified that is related to participation but not outcomes. This variable is known as the 'instrument' and it introduces an element of randomness into the assignment which approximates the effect of an experiment. Where it exists, estimation of the treatment effect can proceed using a standard instrumental variables approach. Where variation in the impact of treatment across people is not correlated with the instrument, the IV approach recovers an estimate of impact of Treatment on the Treated (TT). However, if the variation in gains is related to the instrument, the parameter estimated is Local Average Treatment Effect (LATE) (Imbens and Angrist, 1994). If the policy under consideration is a marginal increase or decrease in the costs of participation, then LATE is the parameter of interest. The main drawback to the IV approach is that it will often be difficult to find a suitable instrument because, to identify the treatment effect, one needs at least one regressor which determines programme participation but is not itself determined by the factors which affect outcomes (Blundell and Costa Dias, 2000; Heckman, 1995).

(v) Regression Discontinuity (RD): In a non-experimental setting, programme eligibility rules can sometimes be used as instruments for exogenously identifying participants and non-participants. To establish comparability, one can use participants and nonparticipants within a certain neighbourhood of the eligibility threshold as the relevant sample for estimating the treatment impact. This method allows observed as well as unobserved heterogeneity to be accounted for. The main idea behind regression discontinuity is that at the margin of the threshold, the assignment to treatment and control is close to be random. In other words, farmers who are in the neighbourhood of the cut-off (below or above) are very similar, and,

therefore, represent a good counterfactual for the treatment group. Although, the cut-off or eligibility threshold can be defined non-parametrically, the cut-off has in practice traditionally been defined through an instrument.

There are two types of regression discontinuity: sharp and fuzzy. The sharp discontinuity refers to the type of targeting in which the threshold clearly determines participants and non-participants. Fuzzy discontinuity differs to sharp discontinuity in that the variable *x* does not perfectly determine treatment and control but influences the probability of treatment. Therefore, the variable *x* can be used as an instrumental variable to predict treatment and the model can be estimated. Regression discontinuity design has not been widely implemented to evaluate agricultural projects despite the fact that many projects define a clear threshold to determine participation such as by land size or income. Other agricultural projects define their interventions geographically which could also facilitate the use of this methodology. This methodology is rather powerful as it can be comparable to an experiment in the neighbourhood close to the threshold. Concerns with the regression discontinuity approach include the possibility that eligibility rules will not be adhered to consistently, as well as the potential for eligibility rules to change over time. Furthermore, it requires a good number of observations next to the discontinuity in order to draw meaningful conclusions. Besides, as in the case of IV, this methodology can only estimate a local treatment effect, which means that the results are valid only for those participants who are close to the threshold but it might be difficult to extrapolate those findings to other units located far away from it (Winters *et al*, 2010).

(vi) Propensity Score Matching (PSM): When a treatment cannot be randomised, the next best thing to do is to try to mimic randomisation that is, try to have an observational analogue of a randomised experiment. The idea behind matching is simply to select a group of non-beneficiaries in order to make them resemble the beneficiaries in everything. If such resemblance is satisfactory, the outcome observed for the matched group approximates the counterfactual, and the effect of the intervention is estimated as the difference between the average outcomes of the two groups. The fundamental assumption for the validity of matching is that, when observable characteristics are balanced between the two groups, the two groups are balanced with respect to all the characteristics, relevant to the outcome. If one assumes that differences in participation are based solely on differences in observed characteristics, and enough non-participants are available to match with participants, the

corresponding treatment effect can be measured even if treatment is not random. The problem is to credibly identify groups that look alike. Identification is a problem because even if households are matched along a vector, *X*, of different characteristics, one would rarely find two households that are exactly similar to each other in terms of many characteristics. Due to the fact that many possible characteristics exist, a common way of matching households is propensity score matching.

In propensity score matching, each participant is matched to a non-participant on the basis of a single propensity score, reflecting the probability of participating conditional on their different observed characteristics X (Rosenbaum and Rubin, 1983). The average treatment effect of the programme is then calculated as the mean difference in outcomes across these two groups. This reduces the matching from a multi-dimensional problem (where the number of dimensions depends on the number of available variables) to a one-dimensional problem. Intuitively, each beneficiary is matched to the non-beneficiary who is most similar in terms of probability of being a beneficiary, where this probability is calculated on the basis of individual characteristics. PSM, therefore, avoids the "curse of dimensionality" associated with trying to match participants and nonparticipants on every possible characteristic when *X* is very large. The PSM approach tries to capture the effects of different observed covariates *X* on participation in a single propensity score. Then, outcomes of participating and non-participating households with similar propensity scores are compared to obtain the programme effect. Households for which no match is found are dropped because no basis exists for comparison. The existence of a substantial overlap between the characteristics of beneficiaries and non-beneficiaries (common support) is another requirement for the applicability of this method (cavatassi *et al*, 2010).

This method of matching has an intuitive appeal because, by constructing a control group and using difference in means, it mimics random assignment. The crucial difference with respect to an experiment is that, in the latter, the similarity between the two groups covers all characteristics, both observable and unobservable, while even the most sophisticated matching technique must rely on observable characteristics only. Once the two groups are formed, the treatment effect is estimated for each outcome by simply computing the difference in means between the two groups. Another advantage of propensity score matching is that it does not necessarily require a baseline or panel survey (Evenson and Rosegrant, 2003). It also has some advantages over econometric regression methods since it

compares only the comparables, it does not rely on parametric assumptions to identify the impact of projects.

However, PSM is subject to the problem of "selection on unobservables", meaning that the beneficiary and comparison groups may differ in unobservable characteristics, even though they are matched in terms of observable characteristics. However, it has been put forward that selection on unobservable is empirically less important in accounting for evaluation bias (Baker, 2000). Also, in a situation where the same questionnaire is administered to both groups (so that outcomes and personal characteristics are measured in the same way for both groups) and the participants and controls are placed in a common economic environment matching substantially reduce bias (Heckman *et al*, 1996).

Policy Relevant Treatment Effect Parameters

There are a number of treatment effect parameters in impact assessment namely: Average Treatment Effect (ATE) is the population average treatment effect which is the difference of the expected outcomes after participation and non-participation. This measure answers the question which would be the effect if farmers in the population were randomly assigned to treatment. Average Treatment effect on the Untreated (ATU) is the effect of an intervention on the subgroup not receiving treatment, that is the untreated. However, they do not always answer the economically interesting questions and might not be of importance to policy makers because they include the effect for whom support was not intended. The Average Treatment Effect on the Treated (ATT) is the most important evaluation parameter which concentrates solely on the effects on those for whom the programme is actually introduced. This parameter focuses directly on those farmers who participated. ATT is the parameter needed in determining whether or not a given programme should be shut down or retained. It is informative on the question of whether the participants of a programme benefit from it in gross terms, that is, it determines the realised gross impact from a programme (Heckman *et al*, 1997; Heckman and Vytlacil, 2003).

2.2.2 Counterfactual Framework

In a counterfactual framework, the quantity of interest is the average treatment effect defined by Rosenbaum and Rubin (1983). If a project's outcome indicator is household income, the average impact of a project on the beneficiaries (referred to in the impact assessment literature as the average effect of the treatment on treated (ATT)) is defined as the

difference between the expected income earned by project beneficiaries while participating in the project and the expected income they would have received if they had not participated in the project as:

$$ATT = E(Y_1|p = 1) - E(Y_0|p = 0) \text{ ----------(1)}$$

Where,

ATT = average impact of treatment on the treated; p = participation in the project (p = 1 for participation in the project and p = 0 for non-participation in the project)

Y_1 = outcome (household income in this example) of the project beneficiary after participation in the project; and Y_0 = outcome (income) of the same beneficiary if he/she had not participated in the project.

Unfortunately, the counterfactual income of the beneficiaries had they not participated in the project cannot be observed ($E(Y_0|p=1)$. Simply comparing incomes of households that are participating in the project and those that are not can result in serious biases, since these two groups may be quite different, and hence, likely to have different incomes regardless of their participation in the project. For example, adding and subtracting $E(Y_0|p=0)$ on the right hand side of equation (1), it gives:

$$ATT = [E(Y_1|p = 1) - (E(Y_0|p = 0)] - [E(Y_0|p = 1) - (E(Y_0|p = 0)] \text{----------(2)}$$

The first expression (in the first squared bracket) is observable since it is the difference of income of the beneficiaries and non-beneficiaries. The second expression (which is unobservable because $E(Y_0|p = 1)$ is unobservable) represents the bias resulting from estimating ATT as the first expression. This bias results because the income that non-beneficiaries receive without the programme may not be equal to the income that beneficiaries would have received without the programme (that is, $E(Y_0|p = 1)$ is not equal to $(E(Y_0|p = 0))$.

Two common sources of bias are programme placement or targeting bias, in which the location or target population of the programme is not random (for example, the RTEP was targeted at the poor and vulnerable so that the wealthier groups do not have an equal chance of participating); and self-selection bias, in which households choose whether or not to

participate, and thus, may be different in their experiences, endowments and abilities. The most accepted method to address these problems is to use an experimental approach to construct an estimate of the counterfactual situation by randomly assigning households to treatment (beneficiary) and control (non-beneficiary) groups which is described in sub section 2.2.1.1 above. Such an approach is not feasible in the present study, since programme placement and participation decisions were already made prior to design of this study, and are unlikely to have been random. The notion of random assignment also conflicts with the nature of this CDD programme, in which communities and households make their own decisions about whether to participate and what activities they will pursue; thus, limiting the ability to use this approach even from the onset.

One of the most commonly used quasi-experimental methods is propensity score matching (PSM), which selects project beneficiaries and non-beneficiaries who are as similar as possible in terms of observable characteristics expected to affect program participation as well as outcomes. The difference in outcomes between the two matched groups can be interpreted as the impact of the project on the beneficiaries (Smith and Todd, 2005). This method was used to estimate the ATT for impact of the RTEP on household food security and poverty. It pursues a targeted evaluation of whether adopting the RTEP improved technology causes resource-poor farmers to improve their income and decrease the propensity to fall below the food insecurity and poverty line (Mendola, 2007)

Though PSM is subject to the problem of "selection on unobservables", meaning that the beneficiary and comparison groups may differ in unobservable characteristics, even if they are matched in terms of observable characteristics (Heckman *et al*, 1998). However, it has been put forward that selection on unobservable is empirically less important in accounting for evaluation bias (Baker, 2000). Also, in a situation where the same questionnaire is administered to both groups (so that outcomes and personal characteristics are measured in the same way for both groups), and the participants and controls are placed in a common economic environment (such as the case in this study), matching substantially reduces bias (Heckman *et al*, 1996).

There still could be a bias due to heterogeneous or time varying impact of the unobservable differences between participants and non-participants. Such shortcomings are unfortunately inherent in all non-experimental methods of impact assessment. It should be noted that there is no perfect solution to these potential problems, we cannot totally remove

bias, it could only be reduced and it is believed that the method used addressed these issues as well as possible in this case (Heckman *et al*, 1996).

2.2.4 Measurement of Poverty

The poverty measure is a statistical function that translates the comparison of the indicator of household well-being and the chosen poverty line into one aggregate number for the population as a whole or a population subgroup (Coudouel *et al*, 2002). A lot of models have been designed to measure poverty. These are: the Sen Index (Sen 1976), Foster, Greer and Thorbecke-FGT weighted poverty measure (Foster *et al*, 1984), Human Development Index (HDI) UNDP, 1990), the Food Security Index (FSI), Integrated Poverty Index (IPI), Basic Needs Index (BNI), and Relative Welfare Index (IFAD, 1993). The most prominently used poverty measure is the Foster, Greer and Thorbecke (1984) class of poverty measures, including the Headcount Index or Incidence of poverty (P_0), the Poverty Gap Index (P_1), and the severity of Poverty Index (P_2). The Foster-Greer-Thorbecke index is a weighted sum of the poverty gap ratios of the poor. In contrast with Sen index, the weights do not depend on the "ordering rank" of the poor but on the poverty gap ratios themselves. In other words, the contribution of an individual to the poverty measure depends only on the distance between his income and the poverty line and not on the number of individuals that lie between him and the poverty line. The Foster-Greer-Thorbecke index satisfies the monotonicity axiom (that is, a reduction in a poor person's income, holding other incomes constant, increases the poverty index), and the transfer axiom, that is, the index increases whenever a pure transfer is made from a poor person to someone with more income (Aguirregabiria, undated). The three FGT indices can be expressed into one general form and distinguished by the different weights attributed to the distance between income of the poor and the poverty line. They are described below:

(a) Headcount Index (P_0)**:** This is the share of the population whose income or consumption is below the poverty line, that is, the share of the population that cannot afford to buy a basic basket of goods.

(b) The Poverty Gap Index (P_1): This provides information regarding how far off households are from the poverty line. This measure captures the mean aggregate income or consumption shortfall relative to the poverty line across the whole population. It is obtained by adding up all the shortfalls of the poor (assuming that the non-poor have a shortfall of zero) and dividing the total by the population. In other words, it estimates the total resources needed to

bring all the poor to the level of the poverty line (divided by the number of individuals in the population). Poverty gap can also be used as a measure of the minimum amount of resources necessary to eradicate poverty, that is, the amount that one would have to transfer to the poor under perfect targeting (that is, each poor person getting exactly the amount he/she needs to be lifted out of poverty) to bring them all out of poverty.

(c) Poverty Severity (P_2): This takes into account not only the distance separating the poor from the poverty line (the poverty gap), but also the inequality among the poor. That is, a higher weight is placed on those households further away from the poverty line. The measure of depth and severity are important compliments of the incidence of poverty. The poverty depth and severity are particularly important for programme evaluation (Coudouel *et al*, 2002; Verme, 2003).

2.2.5 Measurement of Food Security

At the household level, food security is measured in terms of diet quantity, quality and economic vulnerability.

Diet quantity indicators: These are closely related to the notion of access to food by people, a fundamental component of the definition of food security. Energy from food is arguably the most important nutrient for survival, physical activity, and health. Households are the units through which people generally access food. The indicators pertain to the amount and sufficiency of energy in the food that is immediately available to households for consumption, which is a clear indication of their ability to access sufficient food. The indicators of diet quantity are: Daily food energy consumption per capita and the percentage of households or people that are food energy- deficient.

The daily food energy consumption per capita is measured at the household level as the household daily food energy availability per capita. The total amount of energy in the food acquired by the household over the survey reference period divided by the number of household members and the number of days in the period.

The percentage of households that are food energy deficient, that is, the percentage of households in a population group who do not consume sufficient dietary energy. It is measured by determining whether a household acquires sufficient food over the reference period to meet the dietary energy requirements of all of its members for basal metabolic function and light activity. If the estimated total energy in the food that the household

acquires daily is lower than the sum of its members' daily requirements, the household is classified as food energy deficient.

Diet quality indicators: It is increasingly recognised that inadequate diet quality rather than insufficient energy consumption is becoming the main dietary constraint facing the population of the poor populations across the globe (Ruel et al. 2003; Graham, Welch, and Bouis 2004). For these reasons, it is critically important that indicators of the nutritional quality of the food people eat be included in any analysis of food security. The diet quality indicators are: diet diversity, percentage of food energy acquired from staples and the quantity of individual foods consumed daily per capita.

Diet diversity is measured simply as the number of foods or nutritionally significant food groups from which food is acquired over the survey reference period. Diet diversity indicators based on food groups predict nutrient adequacy better than those based on individual foods (Ruel 2002). Examples of nutritionally significant food groups are cereals, roots, tubers, pulses, legumes, nuts, vegetables, fruits, seafood, milk and dairy products, eggs, oils and fats, beverages and miscellaneous foods. The quantity of individual foods consumed daily per capita is measured as the quantity of specific foods acquired over the reference period divided by the number of household members and the number of days in the period. Information on specific foods is often of interest to policymakers, aiming to improve food security in a particular population or region. For instance, knowledge of the amounts consumed of individual foods rich in particular nutrients may serve as the basis for policies aimed at reducing nutrient deficiencies. Similarly, in countries where many households are not consuming sufficient dietary energy, policymakers may be interested in the consumption of energy-dense staple foods. Alternatively, policymakers, hoping to stem chronic disease, may be interested in the consumption of foods containing particular types of fats.

The current economic access: The indicator of current economic access is the percentage of total household expenditures on food. Households are profiled into food secure and food insecure groups based on their per capita food expenditure. A food secure household is, therefore, that whose per capita food expenditure falls above or is equal to two-thirds of the mean per capita food expenditure. On the other hand, a food insecure household is that whose per capita food expenditure falls below two-thirds of the mean monthly per capita food expenditure.

2.3 LITERATURE REVIEW

2.3.1 Empirical Review on Determinants of Adoption of Improved Production Technology

Njine (2010) investigated the factors influencing low adoption rate of improved cassava varieties by small-scale farmers in Kiganjo, Nyeri Municipality Division, Kenya. Primary data were collected from 80 farmers in January, 2010, with the aid of structured questionnaire through random sampling technique. Two regions, Kirichu and Gachika, were chosen at random from the four regions in Kiganjo. Respondent farmers were selected at random from villages in the study area, including both member and non-member farmers of extension groups used for training during implementation of the Central Kenya dry area project (CKDAP). The data were analysed using descriptive statistics and mean difference. The results revealed that the cassava adoption rate was higher for farmers with larger farms than for those with smaller farms. The adoption rate was closely related to farmer's income. The adoption rate of improved cassava varieties was higher among farmers with income from cash crops and livestock than for farmers without such income. Farmers who were members of extension groups cultivated cassava improved varieties at higher rates than farmers who were not members. Farmer's perception and attitude, livestock income, access to improved varieties and available market significantly influenced the rate of adoption of cassava improved varieties. The study recommended that there is need for more effective ways of reaching farmers with limited income and land resources because they are most vulnerable to food insecurity. Extension group members should accept the social responsibility of sharing planting materials with non-members to help them break the cycle of poverty.

Owusu and Donkor (2012) examined the adoption of cassava improved varieties among small-holder farmers in Sekyere South district of Ghana. Primary data was collected with the aid of structured questionnaire through random sampling technique from 350 cassava farmers in the study area. Tobit model was employed to analyse the effect of the determinants of adoption extent. The empirical results indicated that education, household size, membership of farmers' based organisation and access to credit had positive influence on the extent of adoption while the age of the farmer and location-level specific effects were negatively related to extent of adoption of the cassava improved varieties. The study recommended that policy makers should create enabling environment for the farmers to join farmer-based organisation and farmers should be provided frequent education and training on technology adoption.

Kavia *et al* (2007) analysed factors influencing the incidence and intensity of adoption of improved cassava varieties in Lake Zone regions of Tanzania. Semi-structured questionnaires were administered to 400 farmers selected by multi-stage sampling procedure. Logit and Tobit models were used to test factors affecting the incidence and intensity of adoption. These levels of explanatory power and study findings are consistent with other cross-section studies, using censored data to explain technology adoption. Major adoption limitations include the lack of information on technology package, susceptibility of improved cassava varieties to cassava mosaic diseases and low starch contents. The results of the Tobit regression indicated that age, formal education level, farmer's experience in farming and acreage of land owned, significantly, influenced intensity of adoption of improved cassava varieties. The importance of extension services and cassava surplus sold in influencing adoption was underscored. Emphasis was put on the role of cassava producers' information on cassava agronomic management hence, the need for more investment on information dissemination to cassava producers.

Udensi *et al* (2011) examined various factors influencing the adoption of selected improved cassava varieties by small-holder farmers in Abia State, Nigeria. A multi-stage random sampling procedure was used to select 510 cassava farmers from 17 Local Government Areas of Abia State. The data were analysed using descriptive statistics and probit model. Results of the study showed that 56.5% of the respondents were females. Most (78.8%) of the respondents were married, 83% attended formal schools while 75% had a household size of more than 5 persons. All the respondents were basically small-holder farmers with 47% full time, 50% of the respondents had secured tenurial arrangements; 93% had more than 6 years of farming experience. Results indicated that 74% of the respondents adopted improved cassava varieties. Marital status, household size, farm size, cassava maturity period and tenurial status were negatively, but significantly related to adoption while cassava yield and average income had a positive relationship with the adoption of the improved varieties. Implicit in these results is that policies should be aimed at introduction and prompt release of high yielding, early maturing cassava varieties and converting tenurial arrangements of land to more secure forms.

Imoh and Essien (2006) investigated the adoption of improved cassava varieties in Ikot Ekpene agricultural zone of Akwa Ibom State, Nigeria. The multi- stage cluster sampling technique was employed in the collection of data. A total of 100 farmers were randomly selected from 10 villages in five cycles within two blocks. Data were analysed using

descriptive statistics and multiple regression analysis. Results revealed that 68% of cassava farmers were males while 66% had no formal education or only completed primary six level. About 66% were located closer to markets, 85% had 10 years of farming experience while 65% had below three hectares of land which implied that the farmers were small scaled. The results of the regression analysis revealed that farm size and level of formal education were positive and significant as the major determinants of adoption of the innovation.

Tokula *et al* (2009) examined the adoption of improved cassava varieties by farmers in Kogi state, Nigeria. The data for the study were collected with the aid of structured questionnaire through random selection of 60 farmers from two Local Government Areas (LGAs) randomly sampled from Ayangba and Alloma Agricultural Development Programme (ADP) zones of the state. Data collected included the demographic characteristics of the respondents, sources of farm labour, sources of agricultural information, awareness and use of improved cassava varieties, and value added products of cassava. Data was analysed using descriptive statistics and multiple regression analysis. Results showed that Extension Agents (EAs) were the major source of agricultural information (97%) in the area. Land for agricultural production was acquired mainly by inheritance (95%), with majority (70%) of the farmers cultivating cassava on about 5 ha of farmland mostly on scattered plots. TMS 92/0326 was the only predominantly cultivated improved variety of cassava by 90% of the farmers. Cassava flour and starch were the value added products mainly adopted and used by majority (100% and 70%) of the farmers, respectively. The multiple regression analysis results showed that age, household size, education and farming experience were positive and significantly related to adoption while marital status and membership of cooperative societies were negative but significantly related to adoption. Farmers were largely unaware of NRCRI cassava varieties and value added products. It was suggested that extension agents should organise regular field days to encourage diffusion through fellow farmers and collaborate with relevant research institutes to introduce other improved cassava production technologies to the farmers in the area.

Negash (2007) examined factors affecting adoption and intensity of adoption of improved haricot bean production package in Alaba special Woreda, South Ethiopia. Two stage sampling procedure was employed to select rural kebeles and households for the study. Four rural kebeles were selected purposively, and 160 household heads were selected randomly using probability proportional to size sampling. Structured interview schedule was developed, pre-tested and used for collecting the essential quantitative data for the study from

the sampled households. Focus group discussion was used to generate qualitative data. In addition, secondary data were collected from relevant sources such as woreda office of agriculture and rural development. Data were analysed using descriptive statistics and econometric model. The result of the study indicated that majority of the farmers in the study area preferred local variety over improved because of local market and consumption demand. Result of the econometric model indicated that household head's attitude towards haricot bean production technology package, participation in extension event (participation in training and field visit), knowledge level of household head on the package attributes, perceived relative disadvantage of technology attributes by a household and access to credit were important variables which had positively and significantly influenced adoption and intensity of adoption of improved haricot bean production package, while perceived relative disadvantage of technology attributes of the household head had negative relationship with adoption and intensity of adoption. Some farmers who previously adopted improved haricot bean varieties have discontinued planting the varieties mainly due to market problem. The overall finding of the study underlined the high importance of institutional support in the areas of extension; credit and market to enhance adoption of improved haricot bean production package. Therefore, policy and development interventions should give emphasis to improvement of such institutional support system so as to achieve wider adoption, increased productivity, and income to small scale farmers.

Alene *et al* (2000) examined factors influencing the adoption and intensity of utilisation of improved maize varieties in West Shoa Zone in the central highlands of Ethiopia. Secondary data collected during the 1998/99 cropping season from a random sample of 110 farmers from the Sasakawa Global 2000 project was used in the study. The data were analysed using Tobit model. The estimated results indicated that level of education, household labour, farm size, extension services, farm income, and timely availability of improved maize seeds significantly influenced the adoption and intensity of use of improved maize. The study suggested that creating more opportunities for off-farm employment and income will enhance the financial ability of small-holder farmers to acquire external inputs. The study recommended that policy makers need to focus on targeting resource poor farmers who represent the farming communities in many areas of the country. Furthermore, availability of improved seed proved to be a major constraint for adoption, therefore, there should be an improvement in improved seed delivery to effectively cope with the demands of small farmers.

Ayalew (2011) examined factors affecting adoption and intensity of adoption of improved haricot bean varieties and associated agronomic practices in Dale Woreda, Sidama zone of SNNPR. A total of 150 sample households were selected from 5 kebeles of Woreda and interviewed using structured interview schedule while qualitative data were collected using group discussion and field observation. Chi-square test, F-test Cramer's V, Pearson Correlation and Tobit econometrics model were employed in the data analysis. The results of the econometric model indicated that sex of household head, attending training on improved haricot bean production, attending field day programs, conducting demonstration, access to improved seed, credit and membership of seed multiplication group positively and significantly, influenced adoption and the intensity whereas market distance negatively influenced adoption and intensity of adoption of improved haricot bean varieties and associated agronomic practices. Farmers' evaluation and selection criteria of improved haricot bean varieties in the study area in order of importance were high-yielding, market demand, price advantage, time of maturity, grain colour, grain size, disease resistance and storability. Farmers' deviation from recommended package practices was found partly due to inadequate extension service, high cost of fertilizer, and also, lack of finance. The overall findings of the study underlined the high importance of extension service provision to improve farmers' access to information and extension advice to address the recommended agronomic practices practically, facilitating access to credit and improving market condition. The study recommended that attention has to be given to women headed households to participate in improved haricot bean production. Therefore, development interventions should give emphasis to improvement of such institutional support systems to increase adoption and productivity of the crop.

Mulugeta (2009) empirically examined the determinants of adoption intensity of old coffee stumping technology in Dale Woreda, Ethiopia. Multistage sampling procedure was employed to select rural kebeles and households for the study. One hundred and sixty coffee grower household heads were selected randomly using probability proportional to size sampling. Structured interview schedule was developed, pre-tested and used for collecting the essential quantitative data for the study from the sampled households. Focus group discussion was used to generate qualitative data. In addition, secondary data were collected from relevant sources such as Woreda office of Agriculture and others. The data were analysed using descriptive statistics and Tobit regression model. The Tobit model was employed to identify the determinants of the technology package adoption and analyse farmers' probability

of technology adoption and the intensity of adoption. Variance inflation factor for association among the metric explanatory variables and contingency coefficients for categorical variables were used as tests of multi-colinearity. Out of 23 explanatory variables included in the econometric model, only nine variables were found to significantly influence adoption and intensity of adoption of old coffee stumping technology. These include, education of household head, labour availability, having of old coffee, producing of coffee seedlings, getting coffee plants from common holding, participation in field day and frequency (number) of participation in field day, types of social participation, and coffee oldness problem perception. The overall findings of the study underlined the importance of institutional support in the area of extension, especially creating awareness on the problem of coffee oldness and decline of production. Therefore, policy and development interventions should give emphasis to improvement of such institutional support system so as to achieve wider adoption of old coffee stumping technology.

Ouma *et al* (2002) in their study on adoption of maize seed and fertilizer technology in Embu district, Kenya identified socioeconomic and technical factors affecting the adoption of improved maize seed and fertilizer use, and also determined the role of credit in adoption. Three maize growing divisions in the Embu District, Kenya, namely, Nembure, Runyenjes, and Kieni were purposively selected for the study. Embu District was selected because it is representative of maize growing areas in the region. The study covered both the long rains lasting from March through June, and short rains from October to December**.** One hundred and twenty-seven farmers were randomly selected and interviewed. Using structured questionnaire, data were collected on farmers and farm attributes and institutional structure. Logit and linear models were used to analyse factors affecting the adoption of improved maize seed and quantity of fertilizer, respectively. The results revealed that agro-ecological zones, gender, manure use, hiring of labour and extension were statistically significant in explaining the adoption of improved maize variety and the amounts of basal fertilizers farmers applied. Most adopters preferred the smaller 2kg seed package, because it was affordable and sufficient for their plots of maize. For most farmers, the high price of improved maize seed was the major constraint for the adoption. Other constraints mentioned were the low selling price of maize and lack of credit. The study suggested that a greater focus on farmer participatory breeding will help incorporate farmers' assessments of maize varieties in the research process. The packaging of maize seed in small and more affordable packages such as the 2kg bags will also help increase adoption of certified maize.

Olwande *et al* (2009) investigated the determinants of fertilizer adoption and use intensity by small-holder farmers in Kenya. The data for the study were obtained from a panel of 1,275 households surveyed in 1996/97, 1999/2000, 2003/04 and 2006/07 cropping years by Egerton University/Tegemeo Institute, with support from Michigan State University under Tegemeo Agricultural Monitoring and Policy Analysis Project. The data were analysed using double hurdle model. Results showed that the proportion of households using fertilizer dramatically rose in the last decade while fertilizer application rates increased marginally. Fertilizer use in the drier agro-ecological zones is still way below that in the higher agro ecologically potential zones, indicating higher risk involved in and lower profitability of using fertilizer in the drier areas. Econometric estimation results showed that age, education, credit, presence of a cash crop, distance to fertilizer market and agro-ecological potential are statistically significant in influencing the probability of adopting fertilizer. The strongest determinants of fertilizer use intensity are gender, dependency ratio, credit, presence of cash crop, distance to extension service and agro-ecological potential. The study suggested improving access to agricultural credit by especially low income farmers; concerted efforts to promote fertilizer use among farmers in the drier areas; government investment in rural infrastructure, efficient port facilities and standards of commerce to reduce the cost of distributing fertilizer, as some of the ways to promote fertilizer use.

Tiamiyu *et al* (2009) examined the levels, determinants and effects of complementary technology adoption on productivity of NERICA rice farming in savanna zone of Nigeria. Data for the study were obtained from sample survey of 227 NERICA rice farmers in the guinea savanna zone using multistage sampling technique. Data collected were analysed using descriptive statistics, Tobit regression model and Cobb-Douglas production function. Results showed that the average technology score was 52.1 percent. Fifty-five percent of the farmers who scored below the mean were categorised as low technology users. Tobit regression estimation showed that farmers' technology score was affected significantly by farmer's level of education, extension visit, farming experience, land ownership status, credit use and level of rice commercialization. Cobb-Douglas production estimation showed a neutrally outward shift in production function as the level of complementary technology increases, indicating increasing productivity. The study suggested that the promotion of complementary technology in NERICA rice production is a worthwhile effort and should continue to be funded. Improvement of those factors that significantly affect adoption of complementary technology is recommended.

The studies under review revealed the determinants of adoption of agricultural technology in different countries. They also showed common methodology used to examine the factors influencing technology adoption which is of major interest in this study.

2.3.2 Impact of Agricultural Technology Adoption on Poverty and Food Security

Diagne *et al* (2009) assessed the impact of agricultural technology adoption on poverty among the NERICA farmers in Benin. The study examined the relationship between agricultural technology adoption and poverty with a focus on New Rice varieties for Africa (NERICA). This study is based on data collected through a household survey conducted in 2005 from the Collines region of Benin by the Africa Rice Center in collaboration with Université d'Abomey-Calavi (UAC). The data collected were on the 2004 cropping season and were collected from 268 rice farmers in 24 villages selected through stratified random sampling. The counterfactual outcomes framework of modern evaluation theory was used to estimate the Local Average Treatment Effect (LATE) of NERICA adoption on household expenditure and calorie intake. The result of the study revealed that the adoption of NERICA varieties has a positive and significant impact on household expenditure and calorie intake. The adoption of NERICA varieties increases household daily expenditure by 147.51 CFA per adult equivalent and increases daily calorie intake by 35.8 kilo calories per adult equivalent. Furthermore, the impact is higher among female-headed households (161.75 FCFA/day) than male-headed households (128.34 FCFA/day). The study suggested that there is a scope for reducing poverty through the accelerated adoption of NERICA varieties by farmers.

Benedito (2009) analysed the use of improved agricultural technologies and the implications for food security and poverty reduction in rural Mozambique. The study utilised data from the National Agricultural Survey of 2005 commonly known as TIA05 covering the period from September 2004 to August 2005. A total of 6149 households were interviewed. Three econometric approaches namely: the doubly robust estimator, regression and matching; sub-classification and regression were used as a robustness check. The technologies examined in the study include: the use of animal traction, improved seeds (maize), tractor mechanisation and whether the household owns an improved granary. The results of the study revealed that the impact of improved technologies is positive on household income conditional on irrigation use. The use of improved granaries translated into higher household incomes, potentially, improved food entitlements, farmer's health and nutritional status. The result attests to the importance of increasing agricultural productivity in tandem with

improvements on farmers' ability to store food. The study suggested the need to sustain adoption of improved technologies over time by means of ensuring a positive and significant impact of improved technologies.

Alene *et al* (2009) analysed the economic and poverty impacts of maize research in West and Central Africa. The study assembled the results of three multi-country surveys on variety performance and adoption patterns to measure the impacts of maize research in West and Central Africa from 1981 to 2005, and used cost data since 1971 to compute social rates of return on public investments in maize research in the region. The economic surplus model and poverty reduction elasticity of agricultural productivity growth were employed in the data analysis. The results showed that adoption of modern varieties increased from less than 5% of the maize area in the 1970s to about 60% in 2005, yielding an aggregate rate of return on research and development (R&D) investment of 43%. Economic benefits from maize research were estimated for each country using yield gains as a proportion of maize variety (MV) yields: Cameroon (19%), Benin (18%), Ghana(17%), Burkina Faso (20%), Mali (25%), Senegal (15%), Coted'Ivoire (20%), Togo (15%), and Nigeria (27%). An average net yield gain of 23% was estimated as the weighted average (weighted by the maize area under MVs) of the individual country yield gains. The aggregate adoption rate of 60% over the period 1981–2005 and the experimental yield gain of 23% together suggested that maize research efforts have boosted average maize yields realised in West and Central Africa by 0.58% per year. Given the aggregate industry-level maize yield growth rate of 2% per year, this in turn suggested that improved maize germplasm accounted for about 30% of the overall yield growth with the rest being attributed to crop management. Poverty reduction expressed as a percentage of the poor ranges from less than 0.1% in 1981 to over 1.26% in 2004 with an average of 0.75% per year. In terms of the number of poor lifted out of poverty, the impact ranged from over 58,000 in 1981 to 1.4 million in 2004, with an average of 740,000 per year. Estimated impacts by country range from less than 0.2% of the poor per year in Cameroon to 0.6% in Benin, 0.75% in Ghana and 0.9% in Nigeria. The study concludes that more efficient extension, input supply systems and improved market infrastructure is needed to achieve greater impacts from maize research in West and Central Africa.

Johannes *et al* (2010) examined the adoption of cassava and maize production technologies and impact on poverty in forest savannah region of Cameroon. Data were collected from 367 households with the aid of structured questionnaire administered in 90 villages targeted for project intervention. The study used probit model and simple partial

equilibrium analytical model to assess factors affecting adoption and how exogenous change in agricultural technology adoption and productivity affect welfare and poverty. The empirical evidence strongly favours the support for improved agricultural production technology as an important part of any strategy to reduce the high poverty and food insecurity rates in the study area. The study found a robust and positive effect of agricultural technology adoption on farming households' wellbeing suggesting that there is a large scope for enhancing the role of agricultural technology in directly contributing to poverty alleviation.

Mendola (2007) assessed the potential impact of agricultural technology adoption on poverty alleviation in rural Bangladesh. The study empirically investigated the relationship between technological change of the Green Revolution type and wellbeing of small-holder farming households in two rural Bangladeshi regions. The data for the study were obtained from a household survey conducted in 1994/95 by the Institute of Development Studies in two clusters of four Bangladeshis villages. A total of 5,062 households were originally interviewed, but information on agricultural production was gathered from 3800 rural households. The study tackles a methodological issue in assessing the causal effect of technology on farm-household wellbeing through the non-parametric propensity-score matching analysis by pursuing a targeted evaluation of whether adopting a modern seed technology causes resource-poor farmers to improve their income and decrease the propensity to fall below the poverty line. The results revealed a robust and positive effect of agricultural technology adoption on farm household wellbeing suggesting that there is a large scope for enhancing the role of agricultural technology in directly contributing to poverty alleviation. The study concluded that there seems to be a large scope for boosting the role of agricultural technology in anti-poverty policies in rural areas. The study recommended the (direct) inclusion of a poverty dimension into the agricultural research priority-setting. Better targeting of agricultural research on resource-poor producers might be the main vehicle for maximizing direct poverty- alleviation effects.

Omilola (2009) assessed the impact of agricultural technology on poverty alleviation in rural Nigeria. The study argued that any change in poverty situation attributed to those who adopt new agricultural technology (treatment group) without a counterfactual comparison of carefully selected non-adopters (control group) are likely to be questionable. Primary data were collected with the aid of questionnaire between 2004 and 2005. Multistage random sampling approach was adopted in the selection of 200 adopters and 200 non-adopters of tube wells and pumps for the study. Foster, Greer and Thorbecke poverty indices were employed

in estimating the poverty levels of the respondents. To estimate the treatment effect of agricultural technology on poverty, the study utilised the difference-in-difference method by comparing changes in desired outcome indicators between a treatment group (adopters) and a comparison group or control group (non-adopters) over time before and after the introduction of new technology. The results showed that the coefficient of the unconditional treatment effect of the agricultural technology is negative and statistically insignificant, using the poverty headcount ratios. This indicated that the differences in poverty outcomes between the technology adopters and non-adopters are not significant. However, the gain in reduction of poverty incidence is disproportionately higher among the adopters than the non-adopters. Similarly, the reduction in income gap among the poor adopters is disproportionately more than the reduction in income gap among the poor non-adopters while the inequality of the poor tends to be lower among the adopters than the non-adopters. The study concluded that new agricultural technology would not expressly lead to poverty reduction in poor countries, the exact channels through which new agricultural technology impact poverty outcomes need to be further explored. An effort toward introducing new agricultural technologies in Africa should go hand in hand with increasing access of specific technology adopters to markets, education and land.

Omonona *et al* (2006) examined the various factors influencing the adoption of improved cassava varieties and its impact on the welfare of rural farmers in Edo State, Nigeria. The study utilised cross-sectional data collected through personal interviews of 150 farmers from the three senatorial districts in Edo State. The personal interviews were conducted with the aid of a structured questionnaire using multistage random sampling technique. The Tobit regression model was used to determine the factors that affect adoption and poverty, while the Foster, Greer, and Thorbecke (FGT) class of measures was used to determine the incidence, depth, and severity of poverty among farming households who are adopters and non-adopters of improved cassava varieties. The results showed that sex, age, access to extension agents, access to inputs and crop yield were significant variables positively influencing adoption of improved cassava varieties. The incidence, depth, and severity of poverty were higher amongst households who were non-adopters of improved cassava varieties. The results of the determinants of household poverty revealed that age, household size, years of education, and extent of commercialisation were significant variables. Age, years of education, and extent of commercialisation influenced household poverty in the negative direction, implying that a unit increase in any of the variables will

lead to a decrease in household poverty. Household size, on the other hand, moved in a positive direction, implying that a unit increase in that factor will lead to an increase in household poverty. Implicit in these results is that, in order for poverty alleviation to be effective, human capital such as education should be emphasised. Extension services should also reach greater depths in which campaigns are staged to promote the relevance of new innovations, which are labour-saving and cost-effective.

Dontsop *et al* (2011) examined the impact of New Rice for Africa varieties (NERICAs) adoption on income and poverty among rice farming household in Nigeria. A cross-sectional data of 481farmers from the three major rice ecologies of Nigeria, namely, upland, lowland and irrigated were employed in the study. The study used instrumental variables (IV)-based estimator to estimate the Local Average Treatment Effect (LATE) of the adoption of NERICA on income and poverty reduction. The findings revealed a robust positive and significant impact of NERICA variety adoption on farm household income and welfare measured by per capita expenditure and poverty reduction. Specifically, the empirical results showed that adoption of NERICA varieties raised household per capita expenditure and income by an average of 4739.96 and 63771.94 Nigeria Naira per cropping season, respectively, thereby reducing their probability of falling below the poverty line. The study suggested that intensification of the investment on NERICA dissemination is a reasonable policy instrument to raise incomes and reduce poverty among rice farming household, although complementary measures are also needed.

The studies reviewed revealed the impact of agricultural technology adoption on poverty and food security in different countries. They also showed common impact assessment methodology which is pertinent to this study.

2.3.3 Empirical Review on Root and Tuber Expansion Programme

Few studies have been carried out on Root and Tuber Expansion Programme in Nigeria. These studies are discussed below:

Ibrahim and Onuk (2010) examined how the root and tuber expansion programme (RTEP) had impacted on root and tuber crops production in Nasarawa state, Nigeria. Purposive sampling was used to select 60 beneficiaries and 60 non-beneficiaries. Data were analysed using descriptive and inferential statistics. The results revealed that more than half of the beneficiaries of the RTEP (53%) were male while majority of the non-beneficiaries (80%)

were males. About 46.7% and 33.3% of the beneficiaries and non-beneficiaries of the RTEP respectively, do not have formal education. The major occupation of about 73.3% of the RTEP beneficiaries was farming while only 40% of the non-beneficiaries were into farming. The results further showed that 53.4% of the beneficiaries of RTEP were within the age range of 30-39 years, while only half of the non beneficiaries fall within this age range. The mean total factor productivity index for the beneficiaries was 2.4 while that for the non-beneficiaries was 2.45. The technical efficiency scores for the beneficiaries range from 0.3-1.0 with a mean of 0.84 while that for the non-beneficiaries range from 0.14 – 1.0 with a mean of 0.66. The study concluded that the RTEP had made some positive impact on its beneficiaries in Nasarawa state but a lot more could still be achieved. The study recommended that there is a need for the community facilitators and extension agents to mobilise the female root and tuber crops farmers in Nasarawa state to form cooperatives in order to benefit from the RTEP. Trainings on resource allocation and record keeping should be given to beneficiaries to increase their total factor productivity. The RTEP should be expanded to cover all the local government areas in the state.

Tijani and Thomas (2011) assessed the effectiveness of the Root and Tuber Expansion programme on cassava farmers' production in Remo Area of Ogun State, Nigeria. Random sampling technique was used to select 90 farmers from the list of registered participants with cassava farmers' association in Ikenne zone of Ogun State Agricultural Development Programme. Data were analysed using descriptive and inferential statistics. The study revealed that (40.0%) respondents were between ages of 31-40 years, married (90.0%) and went beyond secondary education (50.0%). The programme was beneficial to several age brackets, particularly farmers within the ages 31- 40 years. Percentage of farmers who cultivated between one and three hectares increased from 50.0% to 71.1%, while farmers with less than one hectare reduced from 38.9% to 28.9% before and after the intervention respectively. This implies that greater percentage of farmers in the study area took full advantage of the RTEP to increase their farm size. There was a significant difference in the extent of cassava farmers' commercialisation of the cassava production before and after expansion programme. The study recommended that adequate land should be made available to cassava farmers through a more modified land tenure system so that they will be able to increase their cassava production output to justify the objective of the Root and Tuber Expansion Programme. Furthermore, there should be greater cooperation between Federal,

State and Local governments in the area of disbursement of counterpart funding to enhance smooth implementation of this type of agricultural development programme in the future.

Ater *et al* (2006) in their study examined the comparative analysis of the impact of Root and Tuber Expansion Programme on poverty alleviation of peri-urban and rural communities in Benue state. Primary data were obtained from 208 respondents, using multistage random sampling. The data were analysed using descriptive statistics and discriminant function. The impact of poverty alleviation programme on root and tuber producers was conspicuous on valued output, sales income receipt, marketable surpluses, housing quality and quality of life in general. Six socio-economic variables accounted for 95% valued productivity. Using the fitted discriminant function, the typically rural and peri-urban producers were correctly identified up to 99% with the total discriminant score of 87%. The study found that even, though, peri-urban and typically rural were alleviated from poverty, there was a distinct dichotomy in the poverty alleviation index/score and valued marketable surpluses of the two distinct groups. The distinction was due mainly to: sales income from marketable surpluses, distance to nearest urban centre of best revenue receipts and distance to the nearest point of product evacuation for sale. These three variables all favoured the peri-urban producer more than the typically rural. Similarly, the three variables accounted for 55%, 15.2% and 10.5%, respectively, to variability in the function. The study suggested a re-focusing in the micro and macro-economic policy framework of developing economies to provide improved markets and marketing opportunities, improved road network and collection centres that check waste and deterioration in quality of agricultural products as these will enhance the ability of the typically rural to alleviate poverty, and thus, achieve the desired better quality of life in the shortest time.

Olujide and Leoto (2010) examined the effect of the Root and Tuber Expansion Programme (RTEP) on cassava and yam farmers' level of production in Oyo state. Multistage sampling technique was used to select respondents from two participating zones in the study area. Primary and secondary data were used in the study. Primary data were obtained through questionnaire administered to 120 respondents out of which 100 were used which gave a response rate of 83.3%. Secondary data were also collected from technical reports, and publications from the Federal headquarters, RTEP, Oyo State Agricultural Development Programme (OYSADEP), project coordinating unit (PCU) and other relevant establishments. Descriptive statistics and inferential statistics were employed in the analysis. The results revealed that majority of the respondents had formal education. Majority (84%) are married,

23% had farm size of 7.1-10 hectares which indicates that they have capacity for enlargement/increase. Also, majority (70%) have more than 15years of experience in farming and this will have influence on their indigenous practices in farming. The result of chi-square analysis showed that there is significant relationship between attitude and level of production of cassava and yam farmers. There is a significant relationship but inverse relationship between level of income and production. The analysis of variance showed that there is significant difference in the level of production of cassava and yam farmers before and during the programme. The study revealed the underlying problems in the implementation of agricultural programmes such as organisational principle, political influence, lack of the beneficiaries input in the design and implementation. The results showed that the RTEP has contributed to the level of production of cassava and yam famers as well as their income level through processing and marketing of various value added product from cassava and yam which is also extending to other root and tuber crops. The study recommended that effective extension system and a well coordinated agricultural development programme should be pursued to achieve greater agricultural production, increased household income and poverty reduction.

2.4 Conceptual Framework for the Study

As shown in figure 1, a framework representing the interactions between agricultural research, policy and livelihood is needed for a complete understanding of the impact of new agricultural technology on rural poverty alleviation and food security. This conceptual framework illustrates the important interactions among policies and programmes, agricultural technology, assets, and agricultural production which have implications for research on the adoption and impact of agricultural technologies.

The decisions of agricultural researchers on technology development are shapened by policies and programmes (such as the National policy on integrated rural development, new agricultural policy thrust and presidential initiative on cassava). Technologies are strongly linked to the rural households' asset base which includes: Natural, physical, financial, human and social capital; that is, there are certain assets that are required to adopt new technologies. For example, considerable policy emphasis has been given to expanding agricultural credit (financial capital) and road or transportation (physical assets) in order to permit technology adoption. Human capital (knowledge and skills) is often required to properly make use of new technologies, and it is now increasingly recognised that social capital can facilitate

adoption of technologies. Furthermore, agricultural technologies can shape the asset base as well, for example, new equipment becomes part of the physical capital, irrigation or soil fertility management practices improve the natural capital of land and water. Also, participatory or action research processes can strengthen human and social capital asset base when knowledge is acquired and groups are formed to work together on the technology.

As rural households' assets and agricultural technology (which is a product of agricultural research) are combined to pursue an agricultural production-based strategy, there is increased crop yield resulting to outcomes such as more income, increased consumption, reduced vulnerability, and ultimately, poverty reduction and food security. However, these outcomes are not necessarily the end point, as they feed back into the future asset base (Adato and Meinzen-Dick, 2002).

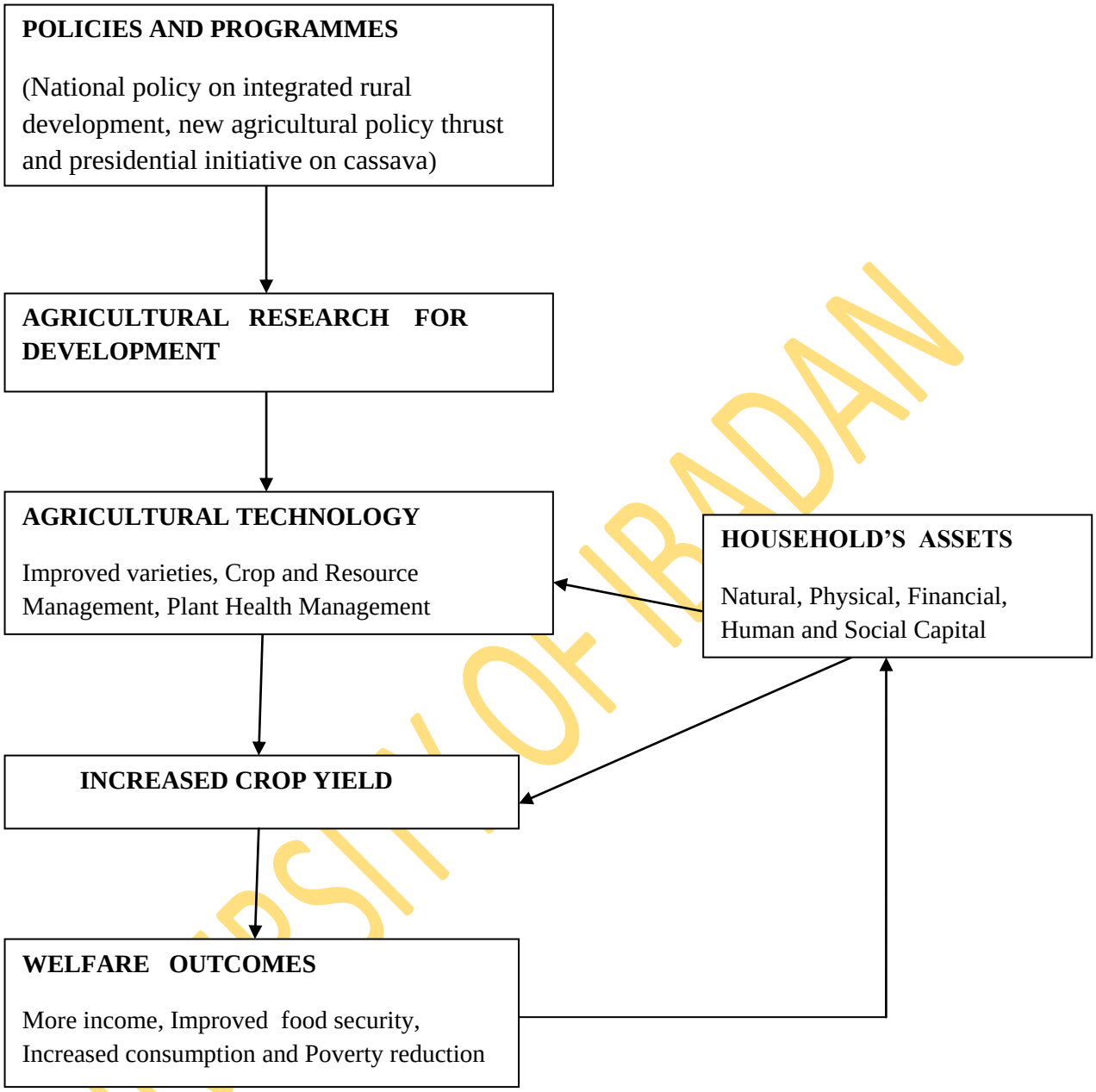

Figure 1: Conceptual Framework for Impact of Agricultural Technology

Source: **Adapted from Adato and Meinzen- Dick, 2002**

CHAPTER THREE

METHODOLOGY

This chapter presents the methodological framework adopted for the study. The sub-sections deal with area of study, sources of data, sampling procedure and analytical technique.

3.1 Area of Study

The study was carried out in South-Western, Nigeria. Southwest is one of the six geopolitical zones in Nigeria. It falls on latitude 6^0 to the North and latitude 4^0 to the South while it is marked by longitude 4^0 to the West and 6^0 to the East. It is bounded in the North by Kogi and Kwara States, in the East by Edo and Delta States, in the South by Atlantic Ocean and in the West by Republic of Benin. The climate is equatorial with distinct wet (rainy) and dry seasons with relatively high humidity. The dry season lasts from November to March, while the wet season starts from April and ends in October. The mean annual rainfall is 1480mm with a mean monthly temperature range of 18^0-24^0C, during the rainy season and 30^0-35^0C in the dry season. Southwest Nigeria covers approximately an area of 114,271 kilometre square, that is approximately 12 percent of Nigeria's total land mass and the vegetation is typically rainforest (Agboola, 1979). The total population was 27,581,992 as at 2006 and the people are predominantly farmers. The climate in the zone favours the cultivation of crops like maize, yam, cassava, millet, rice, plantain, cocoa, kola nut, coffee, palm produce, cashew etc (NPC,2006). The zone comprises of six states namely: Ekiti, Lagos, Ogun, Ondo, Osun and Oyo states.

3.2 Types and Sources of Data

Primary data were collected for the purpose of this study using structured questionnaire. Some of the data include: socio-economic and demographic characteristics, participation in the RTEP productive activities, cassava production, the RTEP cassava production technology, credit facilities and household expenditure details. The list of the RTEP participating LGAs and communities were collected from ADP and other relevant information were retrieved from the RTEP implementation manual.

3.3 Sampling Procedure

Multistage sampling technique was employed in this study. The first stage was the random selection of Ondo and Ogun states from the six participating states in Southwest, Nigeria. The second stage involved the random selection of two RTEP participating and two

Non-RTEP participating LGAs from each state, while in the third stage, three communities were randomly selected from each LGA. This resulted to 24 communities in the two states. The final stage involved a random selection of 30 households from each of the RTEP communities selected (comprising of participants and non-participants) and 15 households from each of the selected Non-RTEP communities resulting to a total of 540 respondents. However, a total of 482 were retrieved and completely filled from the field representing 89.3%. The distribution of the sampled communities is shown in Table 2.

Table 2: List of Sampled Communities

State	LGAs	Name of Communities	Number of Households	Number of questionnaire retrieved and completely filled
Ogun	Ijebu East (RTEP LGA)	Ijebu-Ife, Iresi and Odomefi	90	79
	Ijebu North East (Non-RTEP LGA)	Ogbogbo, Atan and Odosimadegun	45	37
	Obafemi Owode (RTEP LGA)	Jaguna, alapaako and Ajibayo	90	82
	Sagamu (Non-RTEP LGA)	Itasanmi-Ogijo, Okeate andEmuren	45	40
Ondo	Ile-Oluji/ Oke-Igbo (RTEP LGA)	Bamikemo, Oloruntele and Farm-settlement	90	78
	Ondo East (Non-RTEP LGA)	Laagba, Fagbo and Bolorunduro	45	39
	Akure South (RTEP LGA)	Ilekun, Adofunre and Amule	90	85
	Akure North (Non-RTEP LGA)	Imafu, Ilado and Owode	45	42
Total			540	482

Source: Field Survey, 2011

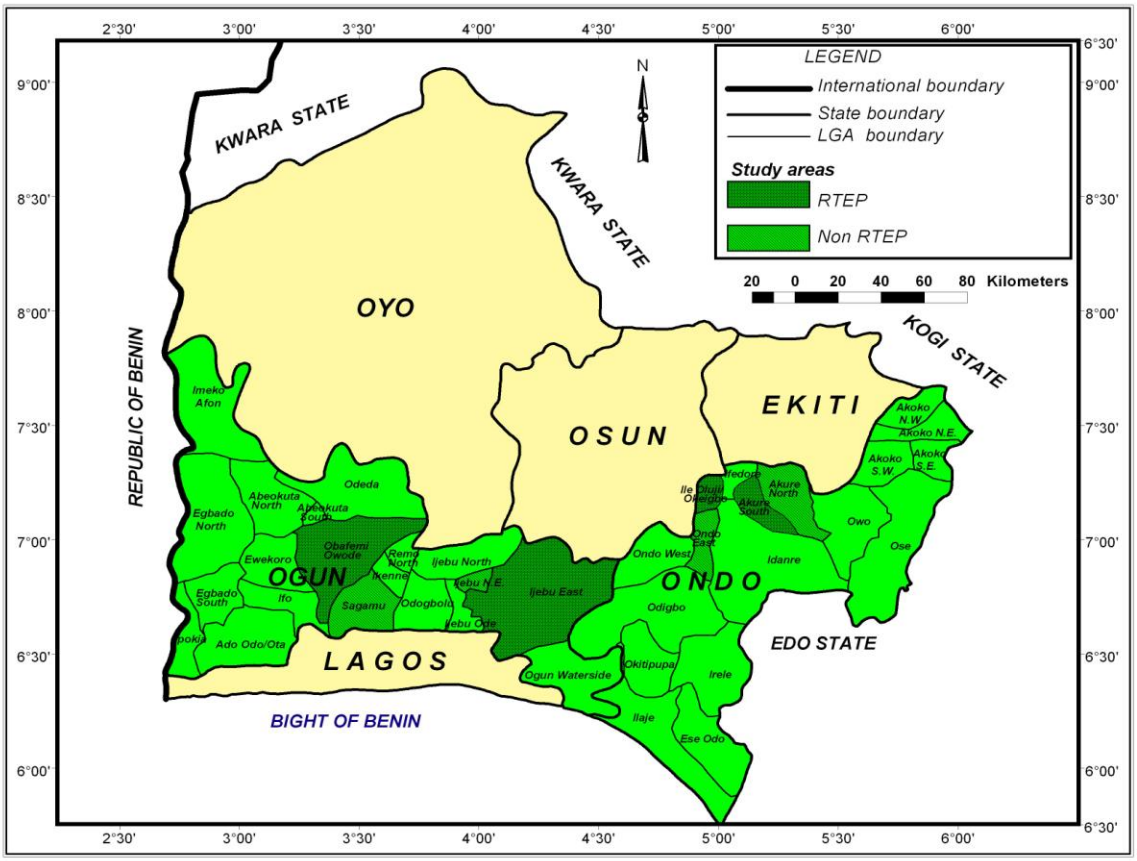

Figure 3.1: Map of South Western Zone Showing the Study Areas

3.4 Analytical Techniques

The analytical techniques used in this study includes: propensity score matching (PSM) descriptive statistics, Tobit regression model, and Foster- Greer- Thorbecke (1984) class of poverty measures (FGT).

3.4.1 Application of Statistical Matching To Impact Evaluation

Propensity Score Matching, one of the most commonly used quasi-experimental methods was used to address the evaluation problem following Nkonya *et al*, 2007 and Akinlade *et al*, 2011). This method of matching has an intuitive appeal because by constructing a control group with similar characteristics based on their propensity score and using difference in means, it mimics random assignment. In propensity score matching, each participant is matched to a non-participant on the basis of a single propensity score. Each beneficiary is matched to the non-beneficiary who is most similar in terms of probability of being a beneficiary, and the probability is calculated on the basis of individual characteristics. Therefore, propensity score matching avoids the "curse of dimensionality" associated with trying to match participants and non-participants on every possible characteristic (Rosenbaum and Rubin 1983).

The Main steps involved in the application of statistical matching to impact evaluation

i Estimating the propensity score

ii Matching the unit using the propensity score

iii Assessing the quality of the match

iv Estimating the impact and its standard error

The sample collected was matched using PSM; the aim of PSM is to find the comparison group from a sample of non-participants that is closest to the sample of programme participants so as to get the impact of the project on the beneficiaries. The procedure is enunciated below.

3.4.1.1 Estimating the Propensity Score (PS)

The propensity score is defined as the conditional probability of receiving a treatment given pre-treatment characteristics (Rosenbaum and Rubin, 1983). The propensity scores were computed using binary Probit regression models given as:

$$P(X) \equiv Pr\{D=1/X\} = E\{D/X\} \quad (3)$$

where,

D= {0, 1} is the indicator of exposure to treatment characteristics (dependent variable)

That is, D=1, if exposed to treatment and D=0 if not exposed to treatment.

The three Probit Regression models used are as follows:

(a) *RTEP* beneficiaries (RTEPB) compared with Non- *RTEP* beneficiaries within *RTEP* LGA (NRTEPBW). That is D=1, represents RTEPB; D=0 represents NRTEPBW.

(b) *RTEP* beneficiaries (RTEPB) compared to Non *RTEP* beneficiaries outside *RTEP* LGA (NRTEPBO). That is D=1, represents RTEPB; D=0 represents NRTEPBO.

(c) *RTEP* beneficiaries (RTEPB) compared with All Non-RTEP beneficiaries (ANRTEPB). That is D=1, represents RTEPB; D=0 represents ANRTEPB

X is the multidimensional vector of pre-treatment characteristics (explanatory variables). These explanatory variables are those which are expected to jointly determine the probability to participate in the project and the outcome. The explanatory variables include:

X_1 = Gender (Male=1, 0 otherwise)

X_2 = Years of education of respondent

X_3 = Household size (number)

X_4 = Age of the respondents (years)

X_5 = Marital status

X_6 = Area of land cultivated (hectares)

The *a priori* expectations of these variables are summarised in Table 3. These probit model results were employed to compute the propensity scores used in the PSM estimation of ATT.

Table 3: Variables used to compute propensity scores and their expected signs

Variable	Expected impact on participation in RTEP	Reason	Expected sign on income& wealth	Reason
Gender of respondent (Male=1)	+/-	RTEP supported both male and female	+	Men are richer than women
Household size	+	Larger families could be associated with poverty or other vulnerability that qualify for RTEP support	-	The larger the family the poorer
Age of respondent	+/-	Project supported both the elderly and the youth	+	Older respondents likely to be better off than young ones
Years of formal Education	+	Some projects requirement may need certain level of education	+	Education increases the income opportunities such as on-farm activities
Land area cultivated	-	RTEP was targeted to small holder farmers cultivating less than 2.5ha of land	+	More land enables households to invest more and get higher income
Marital status	+/-	Project supported both married and unmarried	-	The married are characterized by larger household size. The larger the family, the poorer

+: positive

- : Negative

Source: Nkonya *et al*, 2007 and RTEP PIM

3.4.1.2 Matching the unit using the Propensity Score

After the propensity score was estimated and the score computed for each unit, the next step was the actual matching. This was done using Kernel matching method. Kernel matching uses weighted averages of all individuals in the control group to construct the counterfactual outcome. One major advantage of this approach is the lower variance which is achieved because more information is used. The Kernel matching estimator is given as:

$$\tau^k = \frac{1}{N^T}\sum_{i\in T}\left\{Y_i^T - \frac{\sum_{j\in c} Y_j^c G\left(\frac{p_j - p_i}{h_n}\right)}{\sum_{k\in c} G\left(\frac{p_k - p_i}{h_n}\right)}\right\} \quad (4)$$

where G(.) is a kernel function and h_n is a bandwidth parameter. Under standard conditions on the bandwidth and kernel, $\frac{\sum_{j\in c} Y_j^c G\left(\frac{p_j - p_i}{h_n}\right)}{\sum_{k\in c} G\left(\frac{p_k - p_i}{h_n}\right)}$ is a consistent estimator of the counterfactual outcome Y_{0i}.

The advantage of using a weighted average as opposed to the nearest neighbour method is that it improves the efficiency of the estimator (Smith and Todd, 2005).

3.4.1.3 Assessing the Quality of the Match

The quality of the match was assessed by checking the common support between treatment and non-treatment using the minima and maxima criterion. All observations whose propensity score is smaller than the minimum and larger than the maximum in the opposite group were deleted (the range between minima PS of the treated and maxima PS of the non-treated). Observations which lie outside the region were discarded (dropped) from the analysis. Imposing the common support condition in the estimation improves the quality of the match.

3.4.1.4 Estimating the Impact of the Programme

Since the match has been deemed of good quality, this study then used the matched sample to compute the Average Treatment Effect for the Treated (ATT) to determine impact of the programme. This is defined by Rosenbaum and Rubin (1983) as follows:

$$E\left(Y^1 - Y^0 / D=1\right) = E\left(Y^1 / D=1\right) - E\left(Y^0 / D=1\right) \quad (5)$$

where, $E\left(Y^1 / D=1\right)$ is the observed outcome of the treated, that is, the expected income earned by programme beneficiaries while participating in the programme, and $E\left(Y^0 / D=1\right)$ is the counterfactual outcome - the expected income they would have received if they had not participated in the project. The counterfactual outcome, here, represents outcome of the non-beneficiaries since they have similar characteristics with beneficiaries. Standard errors were computed using the bootstrapping method suggested by Lechner (2002) to generate robust standard errors in the light of the fact that the matching procedure matches control households to treatment households 'with replacement'. This method is popularly used to estimate standard errors in case analytical estimates are biased or unavailable.

3.4.2 Descriptive Statistics

Objective 1 was achieved using descriptive statistics such as: frequency, mean, percentages, standard deviation and tables. Following Tiamiyu *et al*, (2009) and adapting it for this study, technology-use ranked score was computed for each of the RTEP respondents based on the identified elements of the technology package (Table 4) and adoption index was generated for individual farmer. Adoption index of individual RTEP farmer was calculated as follows:

$$AI_i = \frac{TS_i}{TTS} \quad \ldots\ldots\ldots\ldots(6))$$

$$AAI = \sum_i^n \frac{AI_i}{N} \quad \ldots\ldots\ldots\ldots(7)$$

Where,

AI_i= Adoption index of the i^{th} farmer

TS_i= Technology-use score of the i^{th} farmer

TTS= Total technology-use score obtainable

AAI= Average adoption index

Table 4: Elements of RTEP Improved Production Technology

S/N	Elements of RTEP Improved Production Technology
1	Cassava improved Varieties
2	Recommended spacing: 1m by 1m
3	Timely maintenance: weeding five times before harvesting, first weeding should be done four weeks after planting
4	Herbicide application: atraxime and paraquat compound, applied in the first week of planting
5	Fertilizer application: 400kg/ha or 8bags/ha of NPK(15-15-15) applied after first weeding

Source: RTEP PIM

3.4.3 Tobit Regression Model

Tobit regression model was used to analyse objective 2, following Maddala, (1992); Johnston and Dandiro, (1997) and Negash, (2007), the Tobit model for the continuous variable adoption level can be expressed as:

$$AL_i^* = \beta_0 + \beta_i X_i + \mu_i$$

$$AL_i = AL_i^* \quad if\ \beta_0 + \beta_i X_i + \mu_i > 0 \text{.....(8)}$$

$$= 0 \quad if\ \beta_0 + \beta_i X_i + \mu_i \leq 0$$

Where,

AL_i^* = the latent variable and the solution to utility maximisation problem of level/ extent of adoption subjected to a set of constraints per household and conditional on being above certain limit

AL_i = Adoption level for ith farmer

X_i = Vector of factors affecting adoption and level of adoption

β_i = Vector of unknown parameters

μ_i = Error term

The explanatory variables specified as determinants of adoption and level of adoption of the RTEP improved production technology were selected according to Chilot *et al*, (1996); Asfaw *et al*, (1997); Nkonya *et al* (1997); Mulugeta (2000); Mesfin(2005); Omonona *et al*,(2006) and Negash (2007);

The variables are defined as follows:

X_1= Age of the household head (years)

X_2= Age square of the household head (years)

X_3= Gender of the household head (male=1, 0 otherwise)

X_4= Marital status of the household head (married=1,0 otherwise)

X_5= Household size (numbers)

X_6= Level of education of household head

X_7= Years of experience of household head in cassava production

X_8= Main occupation (farming = 1,0 otherwise)

X_9= Participation in off-farm activity (yes= 1, 0 otherwise)

X_{10}= Land area cultivated (ha)

X_{11}= Distance of farm to nearest market (km)

X_{12}= Access to credit of the household head (yes=1, 0 otherwise)

X_{13}= Current cassava yield (tonnes/ ha)

X_{14}= Contact with extension agents (yes=1, 0 otherwise)

The explanatory variables and their expected signs are shown in table 5

Table 5: A priori expectations of the explanatory variables used in adoption analysis model

Variables	Description	Expected Signs	Literature
Age	Discrete	+/-	Techane,2006; Omonona et al, 2006
Male Gender	Dummy	+	Mesfin,2005
Marital status	Dummy	-	Omonona et.al,2006
Level of education	Discrete	+	Chilot,1994
Household size	Discrete	+/-	Omonona et.al,2006; Udoh and Omonona,2008
Main occupation	Dummy	+	Degnet *et al.*, 2001
Non-farm Activity	Dummy	+	Chilot et.al,1996
Market distance	Continuous	-	Hailu, 2008
Land cultivated	Continuous	+	Belay, 2003
Years of experience	Discrete	+	Chilot et.al, 1996
Yield	Continuous	+	Omonona et.al,2006
Access to credit	Dummy	+	Mulugeta, 2000
Extension agent contact	Dummy	+	Omonona et.al,2006

Source: Author's compilation from past literature

3.4.4 Measurement of Income

The differences in income of the *RTEP* and Non-*RTEP* households were analysed using descriptive statistics; frequency distribution and percentage. Household consumption expenditure was used as a proxy for household income in this study (Shaffer, 1998; Omonona, 2001). This is to overcome the problem of overstated or understated household income. Also, since beneficiaries and non-beneficiaries have similar characteristics, the impact of *RTEP* on income was analysed using ATT described in equation (5)

3.4.5 Measurement of Poverty

Differences in poverty of the RTEP and Non-RTEP households were achieved by using the Foster- Greer- Thorbecke (1984) class of poverty measures (FGT) which include the Headcount Index (P_0), the Poverty Gap Index (P_1), and the severity of Poverty Index (P_2). The three indices can be expressed into one general form and distinguish themselves for the different weights attributed to the distance between expenditure of the poor and the poverty line. P_0 attributes equal weight to all expenditure of the poor while P_1 and P_2 attribute increasingly more weight to distance of expenditure of the poor from the poverty line. They are widely used because they are consistent and additively decomposable (Verme, 2003).
The FGT is presented below:

$$P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{Z-y}{Z}\right]^\alpha \qquad (9)$$

Where,

Z = the poverty line defined as 2/3 of Mean per capita expenditure

Y = the annual per capita expenditure –poverty indicator/welfare index per capita

q = the number of poor households in the population of size n,

α = the degree of poverty aversion; α=0; is the Headcount index (P_0) measuring the incidence of poverty (proportion of the total population of a given group that is poor, based on poverty line). α=1; is the poverty gap index measuring the depth of poverty, that is on average, how far the poor is from the poverty line; α=2; is the squared poverty gap measuring the severity of poverty and inequality among the poor.

Impact of the RTEP on poverty gap and its severity was determined using ATT described above in equation (5) while impact of the RTEP on poverty incidence was

determined using equation (10) since it cannot be incorporated into the counterfactual framework (Akinlade *et al*, 2011). It is stated as follows:

$$\text{Impact on } P_0(\%) = \frac{(P_{0B} - P_{0NB})}{P_{0B}} * 100 \qquad (10)$$

$$\text{Impact on } P_1 \text{ and } P_2 = \frac{\text{ATT}}{\text{Value of beneficiary}} * 100 \qquad (11)$$

P_{0B} - poverty incidence of beneficiaries

P_{0NB} - poverty incidence of non- beneficiaries

3.4.6 Measurement of Food Security

Following the adoption of Foster, Greer and Thorbecke- FGT (1984) class of poverty measures, households' expenditure on food per capita equivalent was used to determine households' food insecurity status (Omonona and Agoi, 2007).

This is defined as:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q} Gi \text{ ----------} (12)$$

Where,

$Gi = \left[\frac{Z-Y}{Z}\right]$ = food expenditure deficiency of household i

Head count ratio (H) = q/N

Z = food security line (2/3 mean per adult equivalent food expenditure)

q = the number of households below the food security line,

N = the total number of households in the total population,

Y_i = the per capita equivalent food expenditure of household *i*,

α = the degree of food insecurity aversion; α =0 measures the incidence of insecurity. α =1 measures the depth of food insecurity. α =2 measure the severity of food insecurity.

CHAPTER FOUR
RESULTS AND DISCUSSIONS

This chapter shows the results of the statistical matching and describes the socio-economic characteristics of respondents. It shows the adoption level and determinants of the RTEP improved production technology adoption; the household income, poverty and food security status as well as impact of the RTEP on income, poverty and food security status of respondents. The socio-economic characteristics considered in this study are gender, age, household size, level of education, area of land cultivated, credit accessibility, years of experience in cassava farming, participation in off-farm activity and expenditure.

4.1 Statistical Matching of Respondents

Probit regression models were employed in the estimation of the propensity scores used in matching of respondents. Three separate probit models were estimated for three comparisons: the RTEP beneficiaries compared with all the non-RTEP beneficiaries, the RTEP beneficiaries compared with the non-beneficiaries within the RTEP LGAs, and the RTEP beneficiaries compared with the non-beneficiaries outside the RTEP LGAs. The dependent variable in each of these models is a binary variable indicating whether the household was a beneficiary of the programme or not.

The results of the probit models are shown in Table 6. It was found that the RTEP beneficiaries were more likely to be male, to have larger households size and cultivate less land than non-beneficiaries (both within and outside RTEP LGAs). Compared to the non-beneficiaries within RTEP communities, the RTEP beneficiaries also tend to be older and have higher years of education. By contrast, beneficiaries tend to be younger and have lower years of education than non-participants in non-RTEP communities. These results suggest that the RTEP was targeted to vulnerable groups such as larger households, households with small farm size and are not targeted in terms of other factor, such as marital status.

Observations that were not in the common range of propensity scores for both groups (that is, lack "common support") were dropped from the analysis. Out of 482, only 387 beneficiaries and non-beneficiaries that had comparable propensity scores were matched (Table 7). After matching, the comparability test of the selected groups was done and the results (Table 8 and 9) show statistically insignificant difference in the explanatory variables used in the probit models between the matched groups of the RTEP beneficiaries and non-beneficiaries, indicating that the propensity score matching assured comparability of the comparison groups.

Table 6: Probit Regression Estimates of RTEP Participation Before Matching

Explanatory variables	All non-RTEP Beneficiaries	Non- RTEP Beneficiaries Within	Non -RTEP Beneficiaries Outside
Male Gender	0.1926	0.0044	0.5062**
	(0.1716)	(0.2109)	(0.2100)
Age (years)	-0.0090	0.0082	-0.0319***
	(0.0064)	(0.0082)	(0.0081)
Marital status (Married)	0.1408	0.2674	0.0516
	(0.0883)	(0.1145)	(0.1144)
Household size	0.0781 **	0.1136**	0.0003*
	(0.0373)	(0.0477)	(0.0466)
Years of formal education	-0.0012	0.0635***	-0.0838***
	(0.0148)	(0.0194)	(0.0197)
Land area cultivated	-0.5618***	-1.0985***	-0.3332***
	(0.0964)	(0.1712)	(0.0935)
Constant	-0.0480*	-0.4351**	0.2276***
	(0.4092)	(0.5134)	(0.5703)
Sample size	482	324	321
Pseudo R^2	0.65	0.53	0.49
Prob>chi^2	0.0000	0.0000	0.0000
Log likelihood	-276.91	-197.34	-132.13

Source: Field Study, 2011

***,**,* means associated coefficient is significant at 1%, 5% and 10% respectively. Figures in parenthesis are standard errors.

Table 7: Summary of Matched Respondents

States	RTEP Beneficiaries Frequency	All Non RTEP Beneficiaries Frequency	Non RTEP Beneficiaries Within Frequency	Non RTEP Beneficiaries Outside Frequency	Total
Ogun	80	117	63	54	197
Ondo	77	113	60	53	193
Total	157	230	123	107	387

Source: Field Study, 2011

Table 8: Probit Regression Estimates of RTEP Participation After matching

Explanatory variables	Coefficients	Standard Errors	P>/z/
Gender (male=1, female=2)	0.3195	0.1786	0.8581
Age	-0.0087	0.0069	0.2054
Marital status	0.0966	0.0895	0.2802
Household Size	0.0594	0.0406	0.1432
Years of education	0.0020	0.0159	0.9510
Land area cultivated	-0.1451	0.1427	0.3093
Constant	-0.1761	0.4468	0.6930
Sample size	387		
Pseudo R^2	0.74		
Prob> chi^2	0.69		
Log likelihood	-261.54		

Source: Field Study, 2011

Table 9: Estimates of Test of Comparability After Matching

Variables	Mean		%bias	P>/t/
	Treated	control		
Gender	0.7462	0.7604	-1.0	0.702
Age	45.362	45.081	2.5	0.832
Marital status	1.3875	1.3954	-0.9	0.929
Household Size	5.7188	5.5479	8.6	0.832
Education years	8.1563	8.6879	-11.8	0.478
Land cultivated	0.9788	1.0054	3.5	0.847

Source: Field Study, 2011

4.2 Socio-economic Characteristics of Respondents

Table 10 shows the distribution of the respondents by socio-economic characteristics across the three types of respondents considered which are: the RTEP beneficiaries (RTEPB), the Non-RTEP beneficiaries within the RTEP LGAs (NRTEPBW) and the Non-RTEP beneficiaries outside the RTEP LGAs (NRTEPBO). The average values of their socio-economic characteristics are within the same range due to propensity score matching (PSM) used in selecting the respondents with similar observable characteristics. The male respondents constitute the larger percentage across the three types of respondents with the RTEP beneficiaries having 74.63% which shows that more males were involved in the programme. The average household size was 6 persons for the RTEP, all the Non-RTEP beneficiaries and the Non-RTEP beneficiaries outside while the mean household size for the Non-RTEP beneficiaries within was 5. The majority of the respondents have their household sizes falling within the range of 5 to 9 persons, with the average age of the respondents being 44 and 45 for the RTEP beneficiaries and all the non-beneficiaries, respectively. Implicit in these findings is that a large proportion of the respondents were middle-aged and can, therefore, be regarded as active, agile and with more energy to dissipate and concentrate on productive effort. The average years of experience in cassava farming was 16 years for all respondents. The average area of land cultivated was about 1 hectare for all the respondents. Accessibility to credit facility and participation in off-farm activity was more among the RTEP beneficiaries compared to non-beneficiaries. The average cassava yield (tonnes/ ha) was 14.56, 10.38, 11.61 and 9.97 for the RTEP beneficiaries, all the Non-RTEP beneficiaries, Non-RTEP beneficiaries within and the Non-RTEP beneficiaries outside the RTEP LGAs respectively.

Table 10: Distribution of Respondents by Socio-economic characteristics

Characteristics	Categories/ Statistics	RTEP Beneficiries (n= 157) Percentage	All Non RTEP Beneficiaries (n= 230) percentage	Non RTEP Beneficiaries Within (n=123) Percentage	Non RTEP Beneficiaries Outside (n=107) percentage
Gender	Female	24.37	22.17	17.07	28.04
	Male	74.63	77.83	82.93	71.96
Household size	1-4	16.25	26.09	30.89	20.56
	5-9	77	68.26	63.41	73.83
	>9	6.75	5.65	5.70	5.61
	Mean	6	6	5	6
	SD	1.9942	1.9576	1.96	1.91
Age	≤30	13.12	6.09	10.57	9.36
	31-40	30.25	26.09	34.96	15.89
	41-50	35.63	36.95	34.96	39.25
	>50	21	30.87	19.51	34.50
	Mean	44.2685	45.1913	45.07	44.97
	SD	10.1317	10.7219	10.99	10.84
Level of education	No formal	35.67	26.09	25.20	17.11
	Primary	51.59	36.52	40.65	31.78
	Secondary	12.74	37.39	34.15	41.12
Credit access	Yes	82.50	48.26	54.47	50.47
	No	17.50	51.74	45.53	49.53
Years of experience in cassava farming	≤5	10.19	6.09	3.25	9.35
	6-10	21.65	7.83	22.76	13.08
	11-15	32.48	30.00	32.52	34.58
	16-20	23.56	36.96	34.96	33.64
	>20	12.10	19.12	6.50	9.35
	Mean	15.57	16.44	15.91	15.65
	SD	10.30	10.57	10.94	10.49
Area of land cultivated(ha)	≤0.5	26.75	22.17	22.76	14.95
	0.6-1.0	64.33	50.00	54.47	53.93
	1.1-1.5	8.92	28.63	22.76	31.12
	Mean	0.98	1.01	1.03	1.01
	SD	0.35	0.56	0.47	0.59
Off-farm activity	Yes	73.13	67.78	68.67	66.88
	No	26. 87	32.22	31.33	33.12
Cassava yield	≤5		30.00	9.76	53.27
	6-10	28.12	48.26	63.41	30.84
	11-15	81.87	21.74	26.83	15.89
	Mean	14.56	10.95	11.31	9.97
	SD	1.27	1.01	0.39	0.46

Source: Field Survey, 2011

4.2.2 The Adoption level of the RTEP Improved Production Technology

The adoption level refers to the intensity of use of improved technology by the farmers using their adoption scores. The adoption index generated shows to what extent the farmers have adopted the whole technology package. The mean adoption index for the whole sample of the RTEP beneficiaries was 0.7601, indicating that the RTEP farmers adopted 76.01% of the complementary technologies on the average. This implies that the adoption of RTEP improved production technology made an appreciable headway in the study area.

Table 11 shows the distribution of the RTEP cassava farmers (beneficiaries) by Socio-economic characteristics and level of adoption (technology-use) of the RTEP cassava improved production technology. More than half (74.63%) of the RTEP farmers are male compared to 25.37% female beneficiaries. The mean adoption index of the male RTEP farmers was 0.89 while that of their female counterparts was 0.63. This implies that more male farmers are involved in cassava production and adopted improved cassava production technology. This might be because cassava production is tedious and that male headed households have better access to information and other resources on improved cassava production technology. This is consistent with Nweke *et al* (2002) and Tijani and Thomas (2009) that more males are involved in cassava farming in Nigeria.

The average age of the beneficiaries was 44 years. Comparing the various age groups, farmers between 31 and 40 years of age had the highest mean adoption index of 0.82 while those above 50 years of age had the least mean adoption index of 0.63. This points to the innovativeness of younger farmers. The average household size among the RTEP farmers was 6 persons per family. Households with above 9 persons had the highest mean adoption index of 0.80 while those with between 1 and 4 household size had the least mean adoption index of 0.70. The majority (51.59%) of the RTEP farmers had primary education while 12.74% and 35.67% had secondary and no formal education respectively. Those with secondary education had the highest mean adoption index of 0.88 while those with no formal education had the least mean adoption index of 0.66. This shows the importance of education in technology adoption. Education increases farmers' ability to obtain, process, and use information relevant to technology adoption.

The average years of cassava farming experience of the RTEP farmers was 16 years. The beneficiaries with above 20 years of cassava farming experience had the highest mean adoption index (0.87) while those that had years of farming experience of 5 years and below, had the least adoption index of 0.61. Experience improves farmers' skill of cassava

production. A more experienced farmer may have a lower level of uncertainty about the technology's performance (Chilot *et al*, 1996). The average land area cultivated by the beneficiaries was 0.98 hectare, this is in agreement with Tijani and Thomas (2009) and Uchechi and Nwachukwu (2010) that the majority of the cassava farmers in Nigeria have small land holdings. This also reveals the main target of the RTEP which provides support for farmers cultivating less than 2.0 hectares of land. Farmers cultivating between 1.1 and 1.5hectares of land had the highest mean adoption index of 0.85 while those cultivating 0.5hectares and below had the least adoption index (0.63). This is attributed to the fact that farmers with large land area can afford the expenses on agricultural technology.

The average cassava yield was 14.56 tonnes /ha. This shows the high yield potential of the RTEP improved cassava production technology. The majority (81.88%) of the RTEP farmers had cassava yield of above 10 tonnes/ha with a mean index of 0.80 while those with cassava yield between 6 and 10 tonnes/ha had a mean adoption index of 0.73. The majority (73.13%) of the RTEP farmers participate in off-farm activities with a mean adoption index of 0.84 while those not participating had a mean index of 0.68. Those that had access to credit facilities (82.50%) had a mean index of 0.86 compared with a mean adoption index of 0.65 for those with no access to credit. This is attributed to the fact that farmers with credit access can overcome their financial constraints and attain new technology. They also require yield increasing crop varieties in order to be able to get higher output to pay for the credit obtained.

Table 11: Socio-economic Characteristics of RTEP Beneficiaries by Adoption Index

CHARACTERISTICS	PERCENTAGE	MEAN ADOPTION INDEX	PROBABILITY VALUE
Gender			
Male	74.63	0.89	0.0000
Female	25.37	0.63	
S.D	0.24		
Age(years)			
≤ 30	13.12	0.80	0.9560
31-40	30.25	0.82	
41-50	35.63	0.79	
>50	21.00	0.63	
S.D	0.21		
Household size			
1-4	16.25	0.70	0.7450
5-9	77.00	0.78	
>9	6.75	0.80	
S.D	0.21		
Level of education			
No formal	35.67	0.66	0.0150
Primary	51.59	0.74	
Secondary	12.74	0.88	
S.D	0.15		
Years of farming experience			
≤5	10.19	0.61	0.0000
6-10	21.65	0.74	
11-15	32.48	0.77	
16-20	23.56	0.81	
>20	12.10	0.87	
S.D	0.25		

Source: Field Survey, 2011

Table 11b: Socio-economic Characteristics of RTEP Beneficiaries by Adoption Index

CHARACTERISTICS	PERCENTAGE	MEAN ADOPTION INDEX	PROBABILITY VALUE
Area cultivated(ha)			
≤0.5	26.75	0.63	0.0000
0.6-1.0	64.33	0.80	
1.1-1.5	8.92	0.85	
S.D	0.13		
Credit access			
Yes	82.50	0.86	0.0010
No	17.50	0.65	
S.D	0.12		
Cassava yield (tonnes/ha)			
6-10	28.12	0.67	0.0000
11-15	81.88	0.85	
S.D	0.18		
Off-farm activity			
Yes	73.13	0.84	0.0214
No	26.87	0.68	
S.D	0.24		
Extension services			
Yes	100	0.76	
No	-	-	
S.D	0.21		

Source: Field Survey, 2011

4.3 Determinants of Adoption Level of the RTEP Improved Production Technology

The result of the determinants of adoption level of the RTEP improved production technology by participating cassava farming households in the study area is shown in Table 12. The result of the Tobit regression model shows that the log likelihood is -199.6923 and is significant at 1% level of significance. This indicates that the model has a good fit to the data. The result shows that out of the 14 explanatory variables included in the model, only eight variables were found to significantly influence level of adoption. These are gender, participation in off-farm activities, distance to input market, land area cultivated, years of experience in cassava production, cassava yield, access to credit and level of education. A positive sign on a parameter indicates that the higher the value of the variable, the higher the adoption level and vice-versa.

The gender of the farmer is significant ($p<0.01$) and has a positive sign, implying that male household heads are more likely to adopt the use of improved cassava production technology than their female counterparts. From the result, being a male household head will increase the level of adoption by 13.83%. This is as a result of the fact that male headed households have better access to information and other resources on improved cassava production technology, and are more likely to adopt new technology than female headed households. This result is in agreement with Tesfaye *et al* (2001); Mesfin (2005) and Omonona *et al* (2006). The coefficient of years of experience in cassava production is positive and significant ($p<0.01$). A unit increase in years of experience in cassava production will increase the adoption level by 5.06%. This is due to the fact that farmers with higher experience in cassava production appear to have full information and better knowledge hence able to evaluate the advantage of the technology. This finding is in accordance with Chilot (1994).

Participation in off-farm activity has a positive and significant ($p<0.05$) influence on level of adoption. During slack periods many farmers can earn additional income by engaging in various off-farm activities. This is believed to raise their financial position to acquire new inputs. Participation in off farm activity will increase adoption level by 0.0468. This result is in line with Chilot *et al* (1996). The level of adoption of the RTEP improved cassava production technology is significantly but negatively influenced by distance to the nearest input market. Market distance significantly ($p<0.01$) reduced adoption level. This indicates that farmers nearer to the markets have more access to input. The result from this study showed that a unit decrease in market distance will increase the likelihood of adopting the

RTEP technology by 0.0180. This concurs with Mesfin (2005); Tesfaye (2006) and Hailu (2008) who reported that market distance is negatively and significantly associated with adoption of crop technologies in different parts of Ethiopia.

Access to credit has positive and significant influence ($p<0.01$) on the adoption of the RTEP improved cassava production technology. From the result of this study, access to credit facilities leads to 15.82% increase in the adoption level. This is attributed to the fact that credit increases the farmers' economy to purchase improved seed, fertilizer and other inputs. This is in agreement with Mulugeta (2000) and Tesfaye *et al* (2001). The level of education of the household head positively and significantly ($p<0.05$) influenced adoption level of the RTEP improved production technology. Educational level increased adoption level by 0.1755. Education increases farmers' ability to obtain, process, and use information relevant to technology adoption. This result is in line with Chilot (1994).

The coefficient of land cultivated is positive and significant ($p<0.01$). From the result of this study, a unit increase in land cultivated will increase adoption level of the RTEP improved production technology by 0.6345. Land is perhaps the single most important resource, as it is a base for any economic activity, especially in rural and agricultural sector. It is frequently argued that farmers cultivating larger farm land are more likely to adopt an improved technology (especially modern varieties) compared with those with small farmland. This finding is consistent with Hailu (2008) that farm size exerts a positive influence on adoption of improved teff and wheat production technology in northern and western shewa zones of Ethiopia. Cassava yield has a positive and significant ($p<0.01$) influence on adoption level. A unit increase in last season's yield will increase the adoption level of the RTEP improved production technology by 0.1431. This is in agreement with Omonona *et al* (2006).

Table 12: Estimates of Tobit Regression for the Determinants of Adoption Level

Variables	Marginal effect	Standard error	t- value
Gender	0.1383***	0.0515	2.69
Age	-0.0223	0.0239	-0.93
Marital status	0.1834	0.1759	1.04
Level of education	0.1755**	0.0834	2.10
Main occupation	0.0248	0.0430	0.58
Off- farm activity	0.0468**	0.0229	2.04
Distance to market	-0.0180***	0.0058	-3.09
Land cultivated	0.6345***	0.1375	4.61
Year of experience	0.0506***	0.0086	5.88
Cassava yield	0.1431***	0.0115	12.41
Credit access	0.1582***	0.0567	2.79
Extension agent	0.0126	0.0566	0.22
Household size	0.0021	0.0048	0.08
Age square	0 .0003	0.0003	1.15
Constant	-1.2732 ***	0.3942	-3.23
Sigma	0.5806	0.0319	
Prob>chi^2	0.0000		
Pseudo R^2	0.4458		
Log likelihood	-199.69		

Source: Field Survey, 2011

*,**,*** are significant levels at 10%,5% and 1% respectively

4.4 Level of Income of RTEP and NON-RTEP Households

This section focuses on the household income and the impact of the RTEP improved cassava production technology on the income of the beneficiaries due to participation in the programme by type of respondents, gender, credit accessibility and participation in off-farm activities. The household consumption expenditure was used as a proxy for household annual income because of easy measurement (Shaffer, 1998; Omonona, 2001). The impact of the production technology promoted in the programme on the income of the beneficiaries is shown using the Average Treatment effect on the Treated (ATT). However, other parameters such as, population Average Treatment Effect (ATE) and Average Treatment Effect on the Untreated (ATU) were also estimated.

4.4.1 Household income of the Respondents

The household income per annum of the respondents is shown in Table 13, the mean income of all the three types of respondents was ₦308,304.80 for the RTEP beneficiaries, ₦297,678.80 for the Non-RTEP beneficiaries living within the RTEP LGAs, and ₦277,787.10 for the Non-RTEP beneficiaries living outside the RTEP LGAs. The population average treatment effect (ATE) was ₦23485.75 and the average treatment effect on the untreated (ATU) was ₦16216.35. The impact results in the table show that RTEP technology adoption had a positive and significant effect on household income of the beneficiaries. The average treatment effect on the treated (ATT) shows that adoption of the RTEP production technology increased the income of the beneficiaries by ₦35,387.02 and significant at 1% corresponding to 11.48% increase in income due to participation in the programme. Considering the spill over effect of the programme, the increase in the income of the RTEP beneficiaries when compared with non-beneficiaries outside the RTEP LGAs was higher than when compared with non-beneficiaries within RTEP LGAs. The result shows 1% significant increase in income by 8.53% when compared with the non-beneficiaries within the RTEP LGAs, while there was 5% significant increase by 16.68% when compared with non-beneficiaries outside RTEP LGAs. These results suggest that the RTEP non-beneficiaries within the RTEP LGAs have benefited from spill over effect of the programme. For example, non-beneficiaries could get the improved cultivars from the beneficiaries, and the beneficiaries could also offer on-farm employment to the non-beneficiaries.

Table 13: Level of Income of Respondents (Per Annum)

Type of respondent	Statistics	Income	ATE	ATU	ATT	% change due to participation
RTEP Beneficiries	Mean SD	308304.80 155246.40				
All non-RTEP Beneficiaries	Mean SD	287041.00 152714.10	23485.75	16216.35	35387.02*** (17337.79)	11.48
Non-RTEP Beneficiaries Within	Mean SD	297678.80 151290.40			26292.18* (13681.74)	8.53
Non-RTEP Beneficiaries Outside	Mean SD	277787.10 153958.60			51413.25** (31500)	16.68

Source : Field Survey, 2011

*,**,*** are significant levels at 10%,5% and 1% respectively. The values in parenthesis are errors.

4.4.2 Level of Income by Gender

The mean income of all female respondents was lower than male (Table 14). The mean income of the female RTEP cassava farmers was ₦304,857.90 compared to ₦312,794.10 for their male counterparts. When the mean income of the female beneficiaries and non-beneficiaries were compared with one another, the result shows that mean income of the RTEP beneficiaries was higher than non-beneficiaries, this was also observed in the income of male beneficiaries. The mean income of the female non-beneficiaries was ₦257,933.30, ₦268,136.80 and ₦243,356.90 for the all non-beneficiaries, non-beneficiaries within the RTEP LGAs and non-beneficiaries outside the RTEP LGAs, respectively, while that of their male counterparts was ₦295,334.30, ₦305,188.60 and ₦284,875.60, respectively.

The impact of the RTEP improved production technology was positive though not statistically significant on the income of female beneficiaries while it is significant on the increase in income of the male beneficiaries at 5% and 1% when compared with all male non-beneficiaries and male non-beneficiaries outside the RTEP LGAs, respectively. The impact of the programme on the income of male beneficiaries was higher than female beneficiaries. The increase in income of the male beneficiaries due to participation was 20.31%, 13.63% and 22.06% when compared with all non-beneficiaries, non-beneficiaries within the RTEP LGAs and non-beneficiaries outside the RTEP LGAs, respectively, while it was 9.51%, 7.63% and 13.94% for their female counterparts. This might be due to the higher adoption level of the male beneficiaries.

4.4.3 Level of Income of Respondents by Credit Accessibility

Table 15 reveals that the mean income of all the respondents varied by credit accessibility with the beneficiaries having a higher mean income than the non-beneficiaries. The mean income of the respondents with access to credit was higher than those without access. For those with credit access, the mean income was ₦321,758.50, ₦283,013.50, ₦293,436.50 and ₦277,734.20 for the RTEP beneficiaries, all non-beneficiaries, non-beneficiaries within the RTEP LGAs and non-beneficiaries outside the RTEP LGAs, respectively, while it was ₦287,110.90, ₦248,495.50, ₦266,631.80 and ₦245,621.30 for their respective counterparts without credit access.

Table 14: Level of Income of Respondents by Gender (Per Annum)

Type of respondents	Statistics	Income	ATT	%Change due to participation
RTEP Beneficiaries				
Female	Mean	304857.90		
	SD	153145.00		
Male	Mean	312794.10		
	SD	157510.90		
All non-RTEP Beneficiaries				
Female	Mean	257933.30	28986.79	9.51
	SD	136049.80	(11517.12)	
Male	Mean	295334.30	59975.29**	20.31
	SD	156500.50	(29785.30)	
Non-RTEP Beneficiaries Within				
Female	Mean	268136.80	23250.83	7.63
	SD	119130.00	(28752.67)	
Male	Mean	305188.60	42652.29	13.63
	SD	161337.40	(19785.70)	
Non-RTEP Beneficiaries Outside				
Female	Mean	243356.90	42503.86	13.94
	SD	159110..70	(162078.8)	
Male	Mean	284875.60	68992.29***	22.06
	SD	152713.10	(59384.30)	

Source: Field survey, 2011

,* are significant levels at 5% and 1% respectively. The values in parenthesis are errors.

Table 15: Level of Income of Respondents by Credit Accessibility (Per Annum)

Type of respondent	Statistics	Income	ATT	%Change due to participation
RTEP Beneficiries				
Credit access	Mean	321758.50		
	SD	188906.80		
No access	Mean	287110.90		
	SD	174359.30		
All non-RTEP Beneficiaries				
Credit access	Mean	283013.50	64945.19**	20.18
	SD	145538.30	(19906.05)	
No access	Mean	248495.50	33964.79	11.83
	SD	150145.70	(25773.32)	
Non-RTEP Beneficiaries Within				
Credit access	Mean	293436.50	48122.89***	
	SD	161329.30	(60707.63)	14.96
No access	Mean	266631.80	26858.29	
	SD	125952.70	(96136.00)	9.35
Non-RTEP Beneficiaries Outside				
Credit access	Mean	277734.20	77965.85**	
	SD	98054.98	(25364.47)	24.23
No access	Mean	245621.30	39600.16	
	SD	151244.12	(22587.56)	13.79

Source: Field Survey, 2011

** ,*** are significant levels at 5% and 1% respectively. The values in parenthesis are standard errors.

Furthermore, Table 15 presents the impact of the programme on the beneficiaries due to participation compared with the non-beneficiaries. For those with credit access, the RTEP production technology had a significant ($p<0.05$) impact on the income of the beneficiaries when compared with all non-beneficiaries and non-beneficiaries outside the RTEP LGAs while the impact is significant ($p<0.01$) when compared with non-beneficiaries within RTEP LGAs. Participation in the programme led to an increase in income of beneficiaries with access to credit by 20.18%, 14.96% and 24.23% when compared with all non-beneficiaries, non-beneficiaries within the RTEP LGAs and non-beneficiaries outside RTEP LGAs, respectively while the impact on the mean income was not statistically significant, though positive on the beneficiaries without credit access. The impact was 11.83%, 9.35% and 13.79% when compared with all non-beneficiaries and non-beneficiaries within the RTEP LGAs and non-beneficiaries outside RTEP LGAs, respectively.

4.4.4 Level of Income of Respondents by Participation in Off-farm Activity

Table 16 reveals that the mean income of the respondents participating in off-farm activity was higher than those not participating. For those participating, the mean income was ₦328,021.30, ₦311,417.20, ₦316,927.40 and ₦304,532.60 for the RTEP beneficiaries, all non-beneficiaries, non-beneficiaries within the RTEP LGAs and non-beneficiaries outside the RTEP LGAs, respectively, while it was ₦285,554.80, ₦251,624.00, ₦263,554.80 and ₦243,488.30 for their non-participating counterparts. Furthermore, Table 16 presents the impact of the programme on the beneficiaries due to participation. The RTEP production technology had a significant ($p<0.1$) impact on the income of the beneficiaries with off-farm activity participation when compared with all non-beneficiaries. Participation in the programme led to an increase in income of beneficiaries with off-farm activity by 17.42%, 15.54% and 20.34% when compared with all non-beneficiaries, non-beneficiaries within the RTEP LGAs and non-beneficiaries outside the RTEP LGAs respectively while the impact on the mean income was not significant though positive on the beneficiaries without off-farm activity. The impact was 7.51%, 6.97% and 13.98% when compared with all non-beneficiaries, non-beneficiaries within the RTEP LGAs and non-beneficiaries outside the RTEP LGAs, respectively.

Table 16: Level of Income of Respondents by Participation in Off-farm Activity (Per Annum)

Type of respondents	Statistics	Expenditure	ATT	%Change due to participation
RTEP Beneficiaries				
Participation	Mean	328021.30		
	SD	133292.20		
Non participation	Mean	285554.80		
	SD	128812.20		
All non-RTEP Beneficiaries				
Participation	Mean	311417.20	57148.90*	17.42
	SD	170508.90	(39218.94)	
Non participation	Mean	251624.00	21457.33	7.51
	SD	146781.40	(17285.87)	
Non-RTEP Beneficiaries Within				
Participation	Mean	316927.40	50982.31**	15.54
	SD	155152.60	(34448.8)	
Non participation	Mean	263554.80	19890.21	6.97
	SD	148812.20	(69336.30)	
Non-RTEP Beneficiaries Outside				
Participation	Mean	304532.60	66717.35**	20.34
	SD	155813.90	(47574.37)	
Non participation	Mean	243488.30	45651.83	13.98
	SD	169320.50	(35548.19)	

Source: Field Survey, 2011

* ,*** are significant levels at 10% and 1% respectively. The values in parenthesis are standard errors.

4.5 Poverty Status of RTEP and Non-RTEP Households

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 the RTEP improved production technology on the poverty status of cassava farming households. The impact of the production technology promoted in the programme on the poverty status of the beneficiaries is shown using the Average Treatment effect on the Treated (ATT). However, other parameters such as: population Average Treatment Effect (ATE) and Average Treatment Effect on the Untreated (ATU) were also estimated.

Table 17 presents the summary statistics of the expenditure profile of the households. The table shows that the estimated annual household expenditure on food consumed was ₦172,726.53 which constitutes 58.40% 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 the remaining 41.60%. Clothing is next in priority to food, followed by transportation while health and medicare accounted for the least percentage (2.4%) of household expenditure. The result indicates that the mean expenditure of households in the study area is ₦295,764.60, while the mean per capita household expenditure (MPCHHE) is ₦51,709.49. The poverty line was computed for respondents using the two-thirds MPCHHE, the poverty line was ₦34,473.00 per annum.

4.5.1 Poverty Status of Respondents

Based on the poverty line, 55% of cassava farming households that are beneficiaries of the RTEP live below the poverty line (poor) (Table 18). The poverty status of the respondents is presented in Table 18, the poverty incidence of the RTEP beneficiaries was lower than that of the non-beneficiaries, this reveals that the RTEP improved production technology has the potential to reduce poverty. The poverty incidence was 0.5500 for the RTEP beneficiaries compared to 0.6113, 0.5954 and 0.6181 for all the Non-RTEP beneficiaries, the Non-RTEP beneficiaries within the RTEP LGAs and the Non-RTEP beneficiaries outside the RTEP LGAs, respectively. The poverty gap and severity of poverty indices shows that the non-beneficiaries are farther away from the poverty line and that poverty is more severe among them compared with the beneficiaries.

Table 17: Annual Household Expenditure Profile

Item	Average annual expenditure	% of total expenditure
Food	172,726.53	58.4
Clothing and footwear	21,886.58	7.4
Health and medicare	7,098.35	2.4
Education	14,196.70	4.8
Fuel and lightning	10,351.76	3.5
Transportation	20,111.99	6.8
Remittance	19,816.23	6.7
Rent	14,196.70	4.8
Others	153,79.76	5.2
Total Expenditure	295,764.60	100
Mean per capita household expenditure (MPCHHE)	51,709.49	
Poverty line(2/3 MPCHHE)	34,473.00	
Mean per capita household food expenditure (MPCHHFE)	30,198.34	
Food insecurity line (2/3 MPCHHFE)	20,132.22	

Source: Field Survey, 2011

Table 18: Poverty Status of the Respondents

Type of Respondents	Statistics	Poverty status	ATE	ATU	ATT	Impact(%)
RTEP Beneficiaries	P0	0.5500				
	P1	0.1463				
	P2	0.0810				
All Non-RTEP Beneficiaries	P0	0.6113				-11.15
	P1	0.2442	-0.0258	-0.0122	-0.0423	-28.91
	P2	0.1281	-0.0215	-0.0097	-0.0385	-47.53
Non-RTEP Beneficiaries Within	P0	0.5954				-8.25
	P1	0.2273			-0.0239	-16.33
	P2	0.1024			-0.0166	-20.37
Non-RTEP Beneficiaries Outside	P0	0.6181				-12.38
	P1	0.2664			-0.0576	-32.54
	P2	0.1345			-0.0399	-49.26

Source: Field Survey, 2011

Furthermore, the table reveals the impact of the improved production technology promoted in the programme on the poverty incidence, depth and severity of beneficiaries. It has a negative impact though not significant on the poverty incidence of beneficiaries. The poverty incidence of the RTEP beneficiaries reduced by 11.15%, indicating that 11.15% of the beneficiaries moved above the poverty line due to participation in the programme.

However, considering the spill over effect of the programme, the reduction in poverty incidence was higher on the beneficiaries when compared with the Non-RTEP beneficiaries outside the RTEP LGAs (12.38%) than the Non-RTEP beneficiaries within the RTEP LGAs (8.25%) indicating that there is spill over effect of the programme on the Non-RTEP beneficiaries within. The result also shows that poverty gap and severity of the beneficiaries dropped but there is no significant impact of the programme on these indices when compared with non-beneficiaries. The poverty gap of the beneficiaries reduced by 28.91%, 16.33% and 32.54%, while the poverty severity dropped by 47.53%, 20.37% and 49.26% when compared with all the Non-RTEP beneficiaries, the Non-RTEP beneficiaries within and the Non-RTEP beneficiaries outside the RTEP LGAs, respectively. This is an indication that the RTEP improved production technology has reduced the average gap between poor households' standard of living and poverty line. Also, the inequality among the poor reduced due to participation in the programme.

4.5.2 Poverty Status of Respondents by Gender

From Table 19, the FGT poverty indices of the female RTEP beneficiaries were higher than that of the male RTEP beneficiaries. The headcount of the female RTEP beneficiaries was 0.5585, while it was 0.5139 for the male RTEP beneficiaries. Also, for the non-beneficiaries, the poverty indices of the female were higher than their male counterparts. However, the headcount of female and male Non-RTEP beneficiaries within were lower than their counterparts outside RTEP LGAs. This is likely due to the spill over effect of the programme on the Non-RTEP beneficiaries within the RTEP LGAs. The poverty incidence was 0.5686 and 0.6091 for the female Non-RTEP beneficiaries within and the Non-RTEP beneficiaries outside the RTEP LGAs, respectively, while it was 0.5588 and 0.5864 for their male counterparts.

Table 19: Poverty Status by Gender

Type of respondent/ Gender	Statistics	Poverty Status	ATT	Impact (%)
RTEP Beneficiaries				
Female	P0	0.5585		
	P1	0.1664		
	P2	0.0660		
Male	P0	0.5139		
	P1	0.1342		
	P2	0.0163		
All Non-RTEP Beneficiaries				
Female	P0	0.5899		-5.62
	P1	0.1894	-0.0309	-18.57
	P2	0.0792	-0.0126	-19.09
Male	P0	0.5785		-12.57
	P1	0.1576	-0.0417	-31.07
	P2	0.0413	-0.0079	-48.47
Non-RTEP BeneficiariesWithin				
Female	P0	0.5686		-5.38
	P1	0.1808	-0.0213	-12.80
	P2	0.0699	-0.0118	-17.88
Male	P0	0.5588		-7.69
	P1	0.1517	-0.0374	-27.87
	P2	0.0270	-0.0056	-34.36
Non-RTEP Beneficiaries Outside	P0	0.6091	.	-9.53
Female	P1	0.1935	-0.0425	-25.54
	P2	0.0922	-0.0248	-37.58
	P0	0.5864	.	-14.11
Male	P1	0.1623	-0.0600***	-44.71
	P2	0.0504	-0.0081	-49.69

Source: Field Survey, 2011

*** is significant levels at 1%.

Moreover, Table 19, presents the impact of the project on the poverty incidence, depth and severity of the beneficiaries. The impact of the RTEP improved technology on the headcount index of the male (12.57%) was higher than female beneficiaries (5.62%) when compared with all the Non-RTEP beneficiaries while there was 7.69% and 5.38% reduction in poverty incidence of male and female beneficiaries respectively when compared with Non-RTEP beneficiaries within. In the same vein, poverty incidence of male reduced more than that of female (14.11% and 9.53% respectively) when compared with the Non-RTEP beneficiaries outside the RTEP LGAs. This is likely due to higher adoption level of the male beneficiaries.

However, due to spill over effect of the programme, the decline on the poverty indices was higher when compared with the Non-RTEP beneficiaries outside than Non-RTEP beneficiaries within RTEP LGAs. The impact of the programme was only statistically significant (at 1%) on poverty gap of the male RTEP beneficiaries when compared with the Non-RTEP beneficiaries outside the RTEP LGAs. The poverty gap and severity of male reduced more than that of the female. This shows that the RTEP improved production technology reduced the average gap between poor households' standard of living and poverty line of the male beneficiaries more than their female counterparts.

4.5.3 Poverty Status of Respondents by Credit Accessibility

Table 20 presents the poverty status of respondents by credit accessibility. Fifty point ninety-one percent of the RTEP beneficiaries with access to credit were poor compared to 56.43% of their counterparts without access to credit. For the non-beneficiaries with credit accessibility, poverty incidence was about 56.91%, 53.74% and 57.64% for all Non-RTEP beneficiaries, non-beneficiaries within and non-beneficiaries outside RTEP LGAs respectively while it was 59.37%, 58.41% and 60.46% for their counterparts without access to credit. This shows that poverty incidence among the beneficiaries and the non-beneficiaries were lower among those with credit accessibility than those without access to credit. This is an indication that the RTEP improved cassava production technology has poverty-reducing capacity and credit accessibility reduces poverty.

The impact of the programme on poverty status showed a higher decline in the poverty indices of the beneficiaries with access to credit than their counterparts without credit access.

Table 20: Poverty status by Credit Accessibility

Type of Respondents/ Credit accessibility	Statistics	Poverty status	ATT	Impact(%)
RTEP Beneficiaries				
Credit access	P0	0.5091		
	P1	0.1039		
	P2	0.0238		
No access	P0	0.5643		
	P1	0.1268		
	P2	0.0419		
All Non-RTEP Beneficiaries				
Access	P0	0.5691	……	-11.78
	P1	0.1197	-0.0322**	-30.99
	P2	0.0229	-0.0084	-35.29
No access	P0	0.5937	……..	-5.21
	P1	0.1304	-0.0181	-14.27
	P2	0.0516	-0.0072	-17.18
Non-RTEP Beneficiaries Within	P0	0.5374	…….	-5.56
Access	P1	0.1119	-0.0235	-22.62
	P2	0.0166	-0.0063	-26.47
No access	P0	0.5841	…….	-3.51
	P1	0.1291	-0.0119	-9.38
	P2	0.0386	-0.0058	-12.89
Non-RTEP Beneficiaries Outside				
Access	P0	0.5764	…….	-13.22
	P1	0.1211	-0.0503	-38.41
	P2	0.0293	-0.0104	-43.70
No access	P0	0.6046	……..	-7.14
	P1	0.1385	-0.0257	-20.27
	P2	0.0516	-0.0093	-22.20

Source: Field Survey, 2011. ** is significant levels at 5%.

The poverty incidence of the beneficiaries with access to credit reduced by 11.78%, 5.56% and 13.22% when compared with all the non-beneficiaries, non-beneficiaries within and the non-beneficiaries outside the RTEP LGAs, respectively, while the decline was 5.21%, 3.51% and 7.14% for their counterparts without credit access. The poverty gap and severity of the RTEP beneficiaries also reduced more when compared with the Non-RTEP beneficiaries with access to credit than those without access. However, change due to participation was only significant on the poverty gap when compared with all the non-beneficiaries that has credit accessibility where the impact on poverty gap was negative (30.99%) and statistically significant at 5%.

4.5.4 Poverty Status of Respondents by Participation in off-farm Activity

Table 21 presents the poverty status of respondents by participation in off- farm activity. The headcount index for the respondents with off-farm activity was 0.4872, 0.5563, 0.5177 and 0.5644 for the RTEP beneficiaries, all the Non-RTEP beneficiaries, the Non-RTEP beneficiaries within and the Non-RTEP beneficiaries outside the RTEP LGAs, while it was 0.5533, 0.5987, 0.5718 and 0.6103 for their counterparts not participating in off-farm activities. This shows that poverty incidence of the beneficiaries and the non-beneficiaries were lower among those participating in off-farm activities than those not participating. This might be attributed to the fact that farmers earn additional income by engaging in off-farm activity and this increases their financial position.

The impact of the programme on poverty status showed a higher decline in the poverty indices of the beneficiaries participating in off-farm activity than their non-participating counterparts. The poverty incidence of the beneficiaries participating in off-farm activity reduced by 14.13%, 6.26% and 15.85% when compared with all the Non-RTEP Beneficiaries, non-beneficiaries within and the non-beneficiaries outside the RTEP LGAs, respectively, while the decline was 8.21%, 3.34% and 10.30% for their counterparts without off-farm activity. The poverty gap and severity of the beneficiaries participating in off-farm activity reduced more than those not participating. However, the impact was only significant on the poverty gap of the beneficiaries when compared with all the Non-RTEP beneficiaries and the Non-RTEP beneficiaries outside the RTEP LGAs with off-farm activity where impact on poverty gap was negative and statistically significant at 5% and 1%, respectively.

Table 21: Poverty status by Participation in Off-farm Activity

Type of Respondents/ participation	Statistics	Poverty status	ATT	Impact(%)
RTEP Beneficiaries				
Participation	P0	0.4872		
	P1	0.1057		
	P2	0.0145		
Non participation	P0	0.5533		
	P1	0.1308		
	P2	0.0218		
All Non-RTEP Beneficiaries				
	P0	0.5563	……	-14.13
Participation	P1	0.1126	-0.0317**	-29.99
	P2	0.0266	-0.0052	-35.86
Non participation	P0	0.5987	……..	-8.21
	P1	0.1518	-0.0162	-12.39
	P2	0.0329	-0.0036	-16.51
Non-RTEP Beneficiaries Within Participation	P0	0.5177	…….	-6.26
	P1	0.1083	-0.0182	-17.22
	P2	0.0200	-0.0048	-33.10
	P0	0.5718	…….	-3.34
Non participation	P1	0.1375	-0.0095	-7.26
	P2	0.0237	-0.0023	-10.55
Non-RTEP Beneficiaries Outside Participation	P0	0.5644	…….	-15.85
	P1	0.1184	-0.0416***	-39.36
	P2	0.0283	-0.0071	-48.97
Non participation	P0	0.6103	……..	-10.30
	P1	0.1573	-0.0237	-18.12
	P2	0.0350	-0.0044	-20.18

Source: Field Survey, 2011

*** is significant levels at 1%.

4.6 Food Insecurity Status of the RTEP and Non-RTEP Households

This section focuses on household expenditure on food items, the estimation of food insecurity line and the impact of the RTEP improved production technology on the food security status of cassava farming households. From Table 17, the estimated annual household expenditure on food consumed was ₦172,726.53 while the mean per capita household food expenditure (MPCHHFE) was ₦30,198.34. The food insecurity line was computed for respondents using the two-thirds MPCHHFE, the food insecurity line was ₦20,132.22 per annum. The impact of the production technology promoted in the programme on the poverty status of the beneficiaries is shown using the Average Treatment effect on the Treated (ATT). However, other parameters such as: population Average Treatment Effect (ATE) and Average Treatment Effect on the Untreated (ATU) were also estimated.

4.6.1 Food Insecurity Status of Respondents

Based on the food insecurity line, 51.25% of cassava farming households that are beneficiaries of the RTEP live below the food insecurity line (food insecure) (Table 22). The food insecurity incidence of the RTEP beneficiaries was lower than that of the non-beneficiaries, this reveals that the RTEP improved production technology has the potential to improve food security. The food insecurity incidence was 0.5125 for RTEP beneficiaries compared to 0.5959, 0.5741 and 0.6229 for all the Non-RTEP beneficiaries, Non-RTEP beneficiaries within and the Non-RTEP beneficiaries outside the RTEP LGAs, respectively. The food insecurity gap and severity shows that the non-beneficiaries are farther away from the food insecurity line and that food insecurity is more severe among them compared with the beneficiaries.

Furthermore, the table reveals the impact of the RTEP improved production technology on the food insecurity incidence, depth and severity of beneficiaries. The food insecurity incidence of the RTEP beneficiaries reduced by 16.27%, 12.02% and 21.54% when compared with all the Non-RTEP beneficiaries, Non-RTEP beneficiaries Within and Non-RTEP beneficiaries outside the RTEP LGAs, respectively. Due to spill over effect of the programme, the impact was higher on FGT food insecurity indices of the RTEP beneficiaries when compared with the Non-RTEP beneficiaries outside than when compared with the Non-RTEP beneficiaries within the RTEP LGAs.

Table 22: Food Insecurity Status of the Respondents

Type of Respondents	Statistics	Food insecurity status	ATE	ATU	ATT	Impact (%)
RTEP Beneficiaries	F0	0.5125				
	F1	0.1414				
	F2	0.0366				
All Non-RTEP Beneficiaries	F0	0.5959				-16.27
	F1	0.1653	-0.0240	-0.0135	-0.0355	-25.11
	F2	0.0448	-0.0083	-0.0048	-0.0121	-33.06
Non-RTEP Beneficiaries Within	F0	0.5741				-12.02
	F1	0.1615			-0.0359	-22.56
	F2	0.0444			-0.0116	-31.69
Non-RTEP Beneficiaries Outside	F0	0.6229				-21.54
	F1	0.1696			-0.0546	-45.69
	F2	0.0456			-0.0186	-50.82

Source: Field Survey, 2011

Table 22 also shows that food insecurity gap and the severity of food insecurity indices dropped but there is no significant impact on these indices when compared with non-beneficiaries. The food insecurity gap of the RTEP beneficiaries dropped by 25.11%, 22.56% and 45.69%, while the food insecurity severity reduced by 33.06%, 31.69% and 50.82% when compared with all the Non-RTEP beneficiaries, the Non-RTEP beneficiaries within and the Non-RTEP beneficiaries, respectively.

4.6.2 Food Insecurity Status of Respondents by Gender

From Table 23, the FGT food insecurity indices of the female RTEP beneficiaries were higher than that of the male RTEP beneficiaries. The food insecurity incidence of the female RTEP beneficiaries was 0.5966, while it was 0.5089 for the male beneficiaries. Also, for the non-beneficiaries, the food insecurity incidence of the female was higher than their male counterparts. The food insecurity incidence was 0.5996, 0.5578 and 0.6233 for the male all Non-RTEP beneficiaries, the Non-RTEP beneficiaries within and the Non-RTEP beneficiaries outside the RTEP LGAs, respectively while it was 0.6443, 0.6287 and 0.6700 for their female counterparts. However, due to spill over effect of the programme, the incidence among female and male Non-RTEP Beneficiaries within were lower than their counterparts outside RTEP LGAs.

Moreover, the table presents the impact of the programme on the food insecurity incidence, depth and severity of beneficiaries. The impact of the RTEP improved technology on the food insecurity indices of the male was lower than female beneficiaries. The food insecurity incidence of the RTEP Beneficiaries declined by 7.99% and 17.82% for female and male respectively when compared with all the Non-RTEP beneficiaries. In the same vein, food insecurity incidence of male reduced more than that of female when compared with the non-beneficiaries within and non-beneficiaries outside the RTEP LGAs but the reduction was more when compared with non-beneficiaries outside than non-beneficiaries within. This reveals spill over effect of the programme. There was 5.38% and 12.30% reduction in the food insecurity incidence when compared with female with non-beneficiaries within and non-beneficiaries outside RTEP LGAs, respectively, while it was 9.61% and 22.48% decline for their male counterparts. The impact of the programme was not statistically significant on food insecurity gap and severity of both male and female beneficiaries though there was decline in their food insecurity gap and severity.

Table 23: Food Insecurity Status by Gender

Type of respondent/ Gender	Statistics	Food insecurity Status	ATT	Impact (%)
RTEP Beneficiaries				
Female	F0	0.5966		
	F1	0.1733		
	F2	0.0456		
Male	F0	0.5089		
	F1	0.1310		
	F2	0.0336		
All Non-RTEP Beneficiaries				
Female	F0	0.6443	……..	-7.99
	F1	0.1826	-0.0299	-17.25
	F2	0.0448	-0.0131	-28.73
Male	F0	0.5996	…….	-17.82
	F1	0.1604	-0.0422	-32.21
	F2	0.0448	-0.0167	-49.70
Non-RTEP Beneficiaries Within				
Female	F0	0.6287	……..	-5.38
	F1	0.1823	-0.0219	-12.64
	F2	0.0446	-0.0094	-20.61
Male	F0	0.5578	……..	-9.61
	F1	0.1573	-0.0295	-22.52
	F2	0.0439	-0.0117	-34.82
Non-RTEP Beneficiaries Outside				
Female	F0	0.6700	……..	-12.30
	F1	0.1827	-0.0387	-21.23
	F2	0.0450	-0.0154	-33.77
Male	F0	0.6233	……..	-22.48
	F1	0.1644	-0.0522	-39.85
	F2	0.0459	-0.0178	-52.98

Source: Field Survey, 2011

4.6.3 Food Insecurity Status of Respondents by Credit Accessibility

Table 24 presents the food insecurity status of respondents by credit accessibility. Based on the food insecurity line, 47.15% of the RTEP beneficiaries with credit accessibility were food insecure compared to 53.27% of their counterparts with no access to credit. Food insecurity incidence was 56.98%, 53.65% and 58.96% for all Non-RTEP beneficiaries, Non-RTEP beneficiaries within and Non-RTEP beneficiaries outside RTEP LGAs with access to credit, respectively, while it was 58.49%, 56.33% and 60.44% for their counterparts without credit accessibility. This shows that food insecurity incidence among the respondents with credit accessibility was lower than those without credit accessibility.

This might be attributed to the fact that credit accessibility increases the adoption level of the RTEP improved cassava production technology which has the capacity to improve food security. The impact of the programme on food security status showed that the food insecurity incidence of the beneficiaries declined by 20.85%, 13.79% and 25.05% when compared with all Non-RTEP beneficiaries, Non-RTEP beneficiaries within and Non-RTEP beneficiaries outside with access to credit respectively while the reduction was 9.80%, 5.74% and 13.46%, respectively, when compared with their counterparts with no credit access. Considering the spill over effect of the programme, the decline on the food insecurity indices was higher when compared with non-beneficiaries outside than non-beneficiaries within RTEP LGAs. Furthermore, there was reduction in the food insecurity gap and severity of the beneficiaries though the impact was only significant on the food insecurity gap of the beneficiaries when compared with all non-beneficiaries with credit accessibility at 5% significant level. The food insecurity gap of the beneficiaries reduced by 31.84%, 19.50% and 37.40% when compared with all Non-RTEP beneficiaries, Non-RTEP beneficiaries within and Non-RTEP beneficiaries outside RTEP LGAs with credit accessibility, respectively, while the decline was 21.25%, 10.84% and 24.53% when compared with their counterparts with no access to credit. Similarly, the decline on food insecurity severity was higher when compared with non-beneficiaries with credit accessibility than when compared with those without credit accessibility.

Table 24: Food Insecurity Status by Credit Accessibility

Type of Respondents/ credit access	Statistics	Food Insecurity status	ATT	Impact (%)
RTEP Beneficiaries				
Credit access	F0			
	F1			
	F2			
No access	F0			
	F1			
	F2			
All Non-RTEP Beneficiaries				
Credit access	F0	-20.85	……	
	F1	-31.84	-0.0418**	
	F2	-45.10	-0.0152	
No access	F0	-9.80	……..	
	F1	-21.25	-0.0337	
	F2	-32.94	-0.0138	
Non-RTEP Beneficiaries Within				
Credit access	F0	-13.79	……	
	F1	-19.50	-0.0256	
	F2	-28.49	-0.0096	
No access	F0	-5.74	…….	
	F1	-10.84	-0.0192	
	F2	-19.09	-0.0084	
Non-RTEP Beneficiaries Outside				
Credit access	F0	-25.05	…….	
	F1	-37.40	-0.0491	
	F2	-48.37	-0.0163	
No access	F0	-13.46	……..	
	F1	-24.53	-0.0389	
	F2	-36.28	-0.0152	

** is significant level at 5%

Source: Field Survey, 2011

4.6.4 Food Insecurity Status of Respondents by Participation in Off-farm Activity

Table 25 shows the food security status of respondents by participation in off-farm activity. Based on the food insecurity line, 50.27% of the RTEP beneficiaries participating in off-farm activities were food insecure compared to 55.63% of their counterparts without participation. Food insecurity incidence was 58.99%, 55.26% and 59.91% for all the Non-RTEP beneficiaries, Non-RTEP beneficiaries within, and Non-RTEP beneficiaries outside RTEP LGAs participating in off-farm activity, respectively, while it was 60.86%, 58.18% and 62.26% for their counterparts without participation. This reveals that food insecurity incidence among the respondents participating in off-farm activity was lower than those not participating. This might be as a result of the fact that off-farm activity increases the adoption level of the RTEP improved cassava production technology in the study area.

The impact of the programme on food security status showed that the food insecurity incidence of the beneficiaries declined by 17.45%, 9.93 and 19.18% when compared with all the non-beneficiaries, non-beneficiaries within, and non-beneficiaries outside RTEP LGAs with off-farm activity respectively while the reduction was 9.40%, 4.58% and 11.92%, respectively, when compared with their counterparts with no participation.

Furthermore, there was reduction in the food insecurity gap and severity of the beneficiaries when compared with non-beneficiaries but the impact was only significant ($p<0.05$) on the food insecurity gap of the beneficiaries when compared with all the non-beneficiaries participating in off-farm activity. The food insecurity gap of the beneficiaries declined by 38.24%, 28.35% and 40.44% when compared with all non-beneficiaries, non-beneficiaries within and non-beneficiaries outside RTEP LGAs participating in off-farm activity, respectively, while it reduced by 14.68%, 10.27% and 19.95% when compared with their counterparts without off-farm activity.

In the same vein, the impact was higher on the food insecurity severity of the beneficiaries with off-farm activity than those with no participation. The severity reduced by 44.34%, 38.36% and 49.06% when compared with all the non-beneficiaries, non-beneficiaries within and non-beneficiaries outside the RTEP LGAs with participation, respectively, while it was 19.92%, 12.73% and 24.44% when compared with their counterparts without off-farm activity. Similarly, due to the spill over effect of the RTEP, the decline on the food insecurity indices was deeper when compared with non-beneficiaries outside than non-beneficiaries within RTEP LGAs.

Table 25: Food Insecurity Status by Participation in Off-farm Activity

Type of Respondents/ off-farm activity	Statistics	Food Insecurity status	ATT	Impact (%)
RTEP Beneficiaries				
Participation	F0	0.5027		
	F1	0.1224		
	F2	0.0318		
Non participation	F0	0.5563		
	F1	0.1451		
	F2	0.0487		
All Non-RTEP Beneficiaries				
Participation	F0	0.5899	……	-17.45
	F1	0.1304	-0.0468**	-38.24
	F2	0.0368	-0.0141	-44.34
Non participation	F0	0.6086	……..	-9.40
	F1	0.1477	-0.0213	-14.68
	F2	0.0565	-0.0097	-19.92
Non-RTEP Beneficiaries Within				
Participation	F0	0.5526	…….	-9.93
	F1	0.1270	-0.0347	-28.35
	F2	0.0334	-0.0122	-38.36
Non participation	F0	0.5818	…….	-4.58
	F1	0.1459	-0.0149	-10.27
	F2	0.0515	-0.0062	-12.73
Non-RTEP Beneficiaries Outside				
Participation	F0	0.5991	…….	-19.18
	F1	0.1389	-0.0495	-40.44
	F2	0.0411	-0.0156	-49.06
Non participation	F0	0.6226	……..	-11.92
	F1	0.1526	-0.0275	-19.95
	F2	0.0591	-0.0119	-24.44

** is significant level at 5%

Source: Field Survey, 2011

CHAPTER 5

SUMMARY OF MAJOR FINDINGS, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Summary of Major Findings

The study assessed the impact of the RTEP improved production technology on the food security and poverty status of cassava farming households in Southwest, Nigeria. The data were collected with structured questionnaire through a multistage sampling technique for the selection of states, the RTEP and the Non-RTEP LGAs, communities and households. A sample of 482 households were selected comprising the RTEP beneficiaries, the Non-RTEP beneficiaries within the RTEP LGAs and the Non-RTEP beneficiaries living outside the RTEP LGAs. The data were analysed using Propensity Score Matching, descriptive statistics, Tobit Regression Model and Foster-Greer-Thorbecke weighted poverty index. Out of the 482 households, 387 with similar characteristics were used for analysis in the study. The following are the major findings of the study:

- The adoption level of the RTEP improved cassava production technology by the RTEP farmers was 76.01%.
- The socio-economic factors that significantly influenced adoption and adoption level of the RTEP improved cassava production technology are: Gender, level of education, years of experience in cassava production, participation in off- farm activity, land area cultivated, distance to the nearest market, cassava yield and access to credit.
- The household income of the RTEP beneficiaries was higher than Non-beneficiaries in the South-West, Nigeria.
- The result of the impact of the RTEP improved cassava production technology on the beneficiaries using ATT shows that the average increase in household income of beneficiaries due to participation in the programme was 11.48% and significant at 1% when compared with all the Non-RTEP beneficiaries; it was 8.53% and significant at 10% when compared with the Non-RTEP beneficiaries within while it was 16.68% (5% significance) when compared with the Non-RTEP beneficiaries outside RTEP LGAs.

- The income of the male beneficiaries was higher than their female counterparts. The impact of the RTEP improved production technology was not statistically significant on the income of female beneficiaries but significant on that of male beneficiaries when compared with all the Non-RTEP beneficiaries and the Non-RTEP beneficiaries outside the RTEP LGAs at 5% and 1% significant level respectively.

- The poverty incidence of the RTEP beneficiaries was lower than that of the non-beneficiaries, this reveals that the RTEP improved production technology has the potential to reduce poverty. The poverty incidence was 0.5500 for the RTEP beneficiaries compared to 0.6113, 0.5954 and 0.6181 for all the Non-RTEP beneficiaries, the Non-RTEP beneficiaries within and the Non-RTEP beneficiaries outside RTEP LGAs, respectively.

- The FGT poverty indices of the beneficiaries declined due to participation in the programme. The poverty incidence reduced by 11.15%, 8.25% and 12.38% when compared with all Non-RTEP beneficiaries, Non-RTEP beneficiaries within and Non-RTEP beneficiaries outside RTEP LGAs, respectively, but the impact was not statistically significant on the poverty indices.

- The female beneficiaries have a higher poverty incidence than their male counterparts. Though participation in the RTEP reduced the FGT poverty indices of both male and female, the decline was more in male than female. However, the impact was only statistically felt on the poverty gap of the male beneficiaries when compared with the Non-RTEP beneficiaries outside RTEP LGAs, where net poverty gap was negative and significant at 1%.

- Beneficiaries with credit accessibility have lower poverty incidence than those with no credit access. The RTEP technology adoption reduced the poverty indices of beneficiaries with and without credit accessibility but the impact was only significantly felt on the poverty gap of the beneficiaries with credit accessibility.

- Poverty incidence was lower among respondents participating in off-farm activity than those not participating with beneficiaries having the least headcount index. The impact of the RTEP production technology was statistically significant on the poverty

gap of the beneficiaries with participation in off-farm activity when compared with all Non-RTEP beneficiaries and Non-RTEP beneficiaries outside the RTEP LGAs.

- The food insecurity incidence of the RTEP beneficiaries was lower than that of the non-beneficiaries. This reveals that the RTEP improved production technology has the potential to improve food security. The food insecurity incidence was 0.5125 for the RTEP beneficiaries compared to 0.5959, 0.5741 and 0.6229 for all Non-RTEP beneficiaries, Non-RTEP beneficiaries within and Non-RTEP beneficiaries outside RTEP LGAs respectively.

- The food insecurity indices of the beneficiaries declined due to participation in the programme. The food insecurity incidence reduced by 16.27%, 12.02% and 21.54% when compared with all Non-RTEP beneficiaries, Non-RTEP beneficiaries within and Non-RTEP beneficiaries outside RTEP LGAs, respectively, but the impact was not significant on the indices.

- The female beneficiaries have a higher food insecurity incidence than their male counterparts. Though the RTEP technology adoption reduced the FGT food insecurity indices of both male and female, the decline was more on male than female. However, the impact was not significantly felt on the food insecurity indices of both male and female beneficiaries when compared with non-beneficiaries.

- Incidence of food insecurity was lower among respondents with credit accessibility than those with no credit access. The impact of the RTEP production technology was only significant on the food insecurity gap of the beneficiaries with credit accessibility when compared with all the Non-RTEP beneficiaries.

- Food insecurity incidence was lower among respondents participating in off-farm activity than those not participating with beneficiaries having the lowest incidence. The impact of the RTEP production technology was only statistically significant on the food insecurity gap of the beneficiaries with participation in off-farm activity when compared with all Non-RTEP beneficiaries.

5.2 Conclusion of the Study

This study examines the impact of the RTEP improved production technology on the food security and poverty status of cassava farming households in rural Southwest Nigeria. The study revealed that the adoption level of the RTEP improved cassava production technology by the RTEP farmers was 76.01% and that adoption of the technology is significantly influenced by credit accessibility, participation in off-farm activities, level of education among others. On the basis of the empirical evidence emanating from this study, RTEP improved production technology contributed positively to the income of the beneficiaries in South-Western Nigeria. The income of the male beneficiaries increased more than that of the female beneficiaries which implies a higher impact of RTEP improved production technology on male beneficiaries and that it is not gender sensitive. There is a reduction in the food insecurity and poverty status of the RTEP beneficiaries; this reveals that the cassava production technology promoted under the programme is food insecurity and poverty reducing.

5.3 Policy Implications and Recommendation

Based on the findings of this study and conclusion drawn, the following are recommended.

- Level of education, distance to the nearest market, participation in off-farm activities, and credit accessibility among other factors significantly influenced level of adoption. Hence, effective extension services should be put in place to give some levels of trainings to farmers. Rural development policies should promote the creation of enabling environment through the provision of social infrastructure especially access roads to market in order to enhance technology adoption. Policy measures should be oriented towards the support and improvement of rural off-farm income opportunities. Furthermore, improving credit or grant access should be considered as a core component of any development intervention such as RTEP.

- There was an increase in mean income of the beneficiaries; a reduction in their poverty and food insecurity indices though not significantly, this indicates that the technology has impacted food insecurity and poverty negatively, suggesting that there is scope for reducing poverty and food insecurity through increased adoption of this technology by farmers. Hence, there should be wide dissemination of this technology to regions with high poverty and food insecurity rates and the aids given to the

farmers should include provision of agro-chemicals at a subsidised rate in order to improve food security and alleviate poverty. The programme should also be reorganised in the second phase to maximise its poverty and food insecurity decreasing potentials in order to enhance performance.

- Although there was a reduction in the FGT poverty and food insecurity indices of both female and male RTEP beneficiaries, the decline was higher in male compared to their female counterparts. Hence, enabling environment should be provided to enhance participation of women and equal opportunities for men and women to benefit should be prioritized in the second phase of the programme.

5.4 Suggestion for Further Studies

- This study is limited in its inability to cover all geopolitical zones in Nigeria. Therefore, future research should examine the impact of RTEP across the geopolitical zones of the country.

- This study assessed the impact of only one component of the programme which is improved production technology. Hence, further research should focus on other aspects of the programme such as agro processing and marketing so as to give details on the impact of the programme.

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APPENDIX

Analysis of the Objective

S/No	Objective	Meaning	Data requirement	Tools of analysis
1	To determine the adoption level of RTEP production technology among cassava-farming households in South-west Nigeria.	Investigating the adoption level of RTEP production technology among cassava-farming households.	Adoption status, elements of RTEP production technology package, activities involved in each elements.	Descriptive statistics such as: frequency, mean, percentages and tables.
2	To examine the factors influencing the adoption level of RTEP production technology by cassava farming households in the study area.	Determine the factors affecting the adoption level of RTEP production technology among cassava-farming households	Socio-economic characteristics like: age, gender, level of education, household size, credit access, years of farming experience, land area cultivated etc.	Tobit Regression Model
3	To compare the level of income of RTEP and Non-RTEP cassava-farming	Determine and compare level of income of RTEP and Non-RTEP cassava farming households.	Information on consumption expenditure	Propensity Score Matching (PSM), Percentage, Standard deviation, Mean.
4	Evaluate the impact of RTEP production technology on cassava- farming households' food security and poverty status in the study area.	Determine and compare the level of food insecurity and poverty status of RTEP and Non-RTEP households after the project. Estimate the impact of RTEP on food security and poverty level of beneficiaries	Information on expenditure. Socio-economic characteristic like: age, sex, level of education, assets, Household size, land area cultivated etc	Foster –Greer – Thorbeck (FGT) Class of poverty and food security measures, Average Treatment Effect on the Treated (ATT).

Source: Author's compilation

Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria.

Questionnaire on Impact of Root and Tuber Expansion programme (RTEP) production technology adoption on cassava farming households poverty status and food security in southwestern Nigeria

Sir/ ma,

I am a research student of the University of Ibadan conducting a survey on a project titled above. Please kindly fill or tick appropriate responses. All responses will be used strictly for research purposes only. Thank you.

State _____ADP Zone _____ Local Government _____

Community _____ Household No: _____ Type of respondent :1= RTEP participant, 2= NonRTEP Participant(within RTEP LGA), 3= Non RTEP Participant (outside RTEP LGA)

SECTION A : HOUSEHOLD CHARACTERISTICS

No	Socioeconomic/ demographic Characteristics	Responses	Codes for Options
1.	Sex		1= Male, 0 = Female
2.	Age (Year)		
3.	Marital Status		1 = Married, 2 = Single, 3 = Widowed, 4 = D
4.	Family type, if married		1 = Monogamous, 0 = Polygamous
5.	Household size (number)		
6.	**Household composition** Number of adult males(>15 years) Number of adult females(>15 years) Number of male children(<15 years) Number of female children(<15years)		
7.	Head of the household		1=male head, 2= female head
8.	Number of years household head spent in school		
9.	Highest Educational Qualification household head attained		0 = No formal,1 = Primary, 2 = Secondary 3 = Tertiary
10.	Religion		1 = Christianity,2 = Islamic,3 = Traditional Others (specify)……..
11.	Primary occupation of household head		1= Farming, 2= Trading, 3=Civil servant 4=Private salary job,5= Craft / Artisan,6 =Pr

			Others (specify)
No	**Socioeconomic/ Demographic Characteristics**	**Responses**	**Codes for options**
12.	Secondary occupation of household head		1= Farming,2= Trading,3=Civil servant, 4=Private salaried job ,5= Artisan, 6 = proce (specify)
13.	Indigene of the village		1= yes , 0= No
14.	Year(s) spent in village		
15	Ownership of farm/ land		1= Yes, 0=No
16	Size of land(in hactares)		
17	Land acquisition methods		1= rented, 2= inherited, 3= purchased, 4= lea 5= encroachment, 6= gifts , 7= others (speci
18	Farming system practiced by household		1= sole cropping, 2= intercropping,3= mixed farming ,4= others (specify)
19	Type of Labour		1= family, 2= hired, 3= both
20	Distance of farm from main market(km)		
21	Membership of farmers'group		1= yes, 0= otherwise
22.	Registered group		1= Yes, 0 = No
23	Number in group		
24	Membership of other group		1= co-operative, 2= religious, 3= social g
25	Farm implements		1= manual, 2= mechanical
26	Means of transportation		1= bicycle, 2= motorcycle, 3= car, 4= pi others (specify) …….
27	Communication equipment		1= radio, 2= television, 3= video 4= GS
28	Ownership of accommodation		1= yes, 0= No
29	Type of housing materials		1= mud/ thatched, 2= mud/zinc 3= brick 4= concrete block/ zinc 5= others(specify)……
30	Source of power		1= PHCN, 2= own generator, 3= kerosene, 4= firewood 5= others
31	Source of water		1= stream/river, 2= deep well 3= boreho public tap water , 5= others
32	Bank account		1= Yes, 0 =No

SECTION B: HOUSEHOLD EXPENDITURE

33. What is the value of your produce (in Naira) consumed in the household?……

34. If you live in your personal house, how much would you have paid if it is rented?.....

35. How much does your household spend on the following items per month in Naira?.....

ITEMS	AMOUNT SPENT WEEKLY	MONTHLY	ANNUALLY
Food			
Clothing & footwear			
Health care/ medicine			
Transportation			
House rent			
Fuel & lighting			
Education (school fees, books)			
Remittances(money sent to household members not living in the household)			
Other expenses(specify)			

SECTION C : ROOT AND TUBER CROPS PRODUCTION

35.	Crops cultivated		1=cassava, 2=yam ,3= cocoyam, 4= potatoes, 5= others……
36.	Area of land available to farmer		
37.	Average area cultivated in the last planting season		
38.	Average area cultivated to root and tuber crops		
39.	Average area cultivated to cassava		
40.	Average area cultivated to		

	others(yam, cocoyam, potatoes)		
41.	Years of experience in cassava production		

42	Cost of production per ha.(Naira)	Cassava	Yam	Cocoyam	Potatoes
	Cost of land				
	Planting materials				
	Equipment				
	Herbicide				
	Pesticide				
	Fertilizer				
	Labour land preparation				
	Weeding				
	Fertilizer and pesticide application				
	Harvesting				
	Transportation				
	Total				
		Cassava	Yam	Cocoyam	Potatoes
43.	Average yield in last planting season (tonnes)				
44.	Average value realized (naira)				

44. Do you have contact with extension agents? (a) Yes (b) No

45. Main source of farm inputs (a) ADP (b) MANR (c)open market (d)others(specify)……..

46. How do you market your produce? (a) Farm gate (b) factory (c) rural market (d) urban market (e) direct to end user (f) future market (g) group marketing

47.Do you have access to market information? (a) Yes (b) No

48. If yes, what are your source(s) of market information (a) farmers group (b) brokers (c) relatives

(d) other farmers (e) ADP (f) radio

49. Do you participate in group marketing? (a) Yes (b) No

50. If No, why (state your reason)

51. How much of your produce were you able to sell?..... & how many tonnes of your produce do you market through the following channels

Channels	Produce in tonnes	Produce in percentage
Brokers		
Group marketing		
Rural /urban retailer		
ADP		

52. Do you have access to credit facilities? (a) Yes (b) No

53. If yes, what is your source of credit? (a) Esusu/ thrift (b)co-operatives (C) Microfinance/community bank (d) govt. agencies (e) farmers group (f) relatives and friends (g) others (specify)…….

If yes, please complete the table below

Source(s)	Amount requested	Amount granted	Distance to credit restitution	Interest paid	Payback period

SECTION D: RTEP PARTICIPATION

54. Are you a beneficiary of **RTEP** (a) yes (b)No

55. Are you aware of and have you tried any **RTEP** improved varieties of the listed crops?(tick if yes)

Crops	**Aware of RTEP improved varieties**	**Have tried RTEP improved varieties**
Cassava		

Yam		
Cocoyam		
Potatoes		

56. If you have not tried it, what are your reasons? (a) not aware (b) aware but not interested (C) other reasons (specify)……

57. If you have tried, did you adopt after trial? (a) Yes (b) No

58. If No, what are your reasons for not adopting? (a) not better than my local varieties (b) varieties not readily available (c) not affordable (d) other reasons (specify)……

59. If yes, which ones have you adopted? (name them)

Crops	**RTEP Variety 1**	**RTEP Variety 2**	**RTEP Variety 3**
Cassava			
yam			
Cocoyam			
Potatoes			

60. What are your reasons for adopting the varieties above? (please state)

61. Since when have you been cultivating **RTEP** varieties?(a) last 1 year (b) last 2 years (c) last 3 years (d) above 4 years

62 .Are you still cultivating the varieties ? (a) Yes (b) No

63. If No, why? (a) not better than my local varieties (b) varieties not readily available (c) not affordable (d) not profitable (e)other reasons (specify)

64. How readily do you access **RTEP** improved varieties (a) very readily (b) fairly readily (c) not easy

65. Did you adopt other improved varieties not pushed under RTEP? (a) Yes (b) No

66. If yes, name them……

67. Which of the following **RTEP** agronomic practices have you been exposed to, adopted and still using

RTEP Agronomic practices	**Exposed to**	**Adopted**	**Specify rate**	**Still using**
Recommended spacing				

Timely maintenance (time of 1st weeding & no of times of weeding before harvesting)				
Herbicide application(type & when applied)				
Fertilizer application(type, quantity and time of application)				
Others (specify)				

69. What is your source(s) of information ?(a) ADP (b) Ministry of Agric. (c) other farmers (d) friends/ relatives (e) NGO (f) others (specify)

SECTION F : PEST/ DISEASE CONTROL

70. Which diseases/ pests do you frequently encounter? (list them)

71. Which pest/ disease control measures are you exposed to? (list them)

72. Which control measure have you adopted ? (list them)