EFFECT OF AGRICULTURAL TRANSFORMATION ON THE PRODUCTIVITY AND POVERTY STATUS OF RICE FARMERS IN KANO STATE, NIGERIA

BY

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(Ph.D/AGRIC/3096/2009/2010)

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

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ZARIA, KADUNA STATE
NIGERIA

APRIL, 2016

DECLARATION

I hereby declare that thisthesis titled **Effect of Agricultural Transformation on the Productivity and Poverty Status of Rice Farmers in Kano State, Nigeria**has been written by me and it is a record of my research work. No part of this has been presented in any previous application for another degree or any other institution. All borrowed information has been duly acknowledged in the text and a list of references provided.

....

Olusegun Stanley BALOGUN Date

CERTIFICATION

This thesis titled **''Effectof Agricultural Transformation on the Productivity and Poverty Status of Rice Farmers In Kano State, Nigeria''** by Olusegun Stanley Balogun meets the regulations governing the award of the Degree of Doctor of philosophy in Agricultural Economics of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicate this dissertation to the covenant keeping GOD, my Parents pastor and Mrs. T.A. Balogunand my children, Precious, Praise and Peace Balogun.

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ABSTRACT

The study was carried out to examine the effect of agricultural transformation on the beneficiary's productivity and poverty in Kano state Nigeria. A multi-stage sampling method was employed to select 571 respondents for the study. The first stage involves the random selection of two rice growing local government areas out of the three local governments that participated in the transformation project. The next stage was the selection of seven villages made up of three (3) from Bunkure and four (4) from Rano local government's areas. Data were collected through structured questionnaires on socio-economic and institutional variables such as respondent's age, marital status, gender, household size and level of education. Also, information's were collected on respondent's income, input and output quantities as well as their expenditure. Descriptive statistics was used to describe the socio-economic variable as it affects participation in the project and production activities. Cragg's model was used to examine the influence of some socio-economic and institutional variables on participation and intensity of use of the package of practices. Furthermore, the FGT was used to analyze the poverty status while the propensity score matching, LATE model, t-statistics and Z-test were used to examine the effect of the project on the farmers. Results from the study shows that farm size ((10%), gender of household head (5%), communication asset (10%), ownership of Oxen (10%), extension agent contact (5%) and Market distance (10%) influenced respondent's decision to participate. Also, the intensity of use of package of practices was influenced significantly by farm size (10%), household size (10%) and communication asset ownership (5%) respectively. On respondents productivity, the study revealed a significant difference of about 127 kg/ha in rice productivity between participants and non participants. Also, the LATE estimates revealed an average treatment effect on the treated (ATE0) of about 222.98kg/ha and 347.60kg/ha for the IPWS and the LARF respectively. Moreover, it was revealed that the project had significantly impacted the poverty status of the poorat 1% level with an observed increase in welfare of about 9.88%. Furthermore, the project had a significant impact of about ₦6732 and ₦ 34780 on the participant's total expenditure for the IPWS and the LARF respectively. There were complains of fluctuations of input/output prices insect pests and inadequate extension visits It was recommended that farmers' information and sensitization system should be greatly improved. Also, attention should be given to well organized extension visits for the farmers. Furthermore, priority should also be given to formidable marketing system in agricultural projects for input output delivery for the participants.

CHAPTER ONE

1.0 INTRODUCTION

1.1. Background to the study

Agriculture continues to be the most important sector of the Nigerian economy, in spite of the dominance of petroleum sector. It remains the largest contributor to the growth and development of Nigerian economy (Agbolahan*et. al.*, 2010; Umar, 2010; Abu *et. al.*, 2011) accounting for over 38% of the non-oil foreign exchange earnings and employing about 70% of the active labour force of the population (Izuchukwu, 2011). Agricultural GDP increased at an annual rate of 2.9% in 1990-98 to 5.5% in 1999, 6.1% and 6.5% in 2004 and 2005 respectively, while output increased at a steady rate of 5.7% from the first half of 2009 to 2010 (NPC, 2010).

Nigeria's food imports are growing at an unsustainable rate of 11% per annum therefore; relying on the import of expensive food on global markets fuels domestic inflation as excessive imports continues to put high pressure on the Naira and hurting the economy. Nigeria is importing what it can produce in abundance. Import dependency is also hurting Nigerian farmers, displacing local production and creating rising unemployment. This has made import dependency neither acceptable, nor sustainable fiscally, economically or politically (Akinwumi, 2012).

Nigeria government has come up with various poverty reduction plans aimed at reducing the level of poverty from 70% to 35% by 2015 using various poverty reduction plans amongst which includes "The National Empowerment and Development Strategy (NEEDS), National Fadama Projects and recently Agricultural Transformation

Agenda.To make Nigeria an agriculturally industrialized economy" agriculture must be treated as a business. Also, it is important to Integrate food production, storage, food processing and industrial manufacturing by value chains ('farm to fork'); Focusing on value chains where Nigeria has comparative advantage and using agriculture to create jobs, wealth and ensure food security Investment-driven strategic partnerships with the private sector investment drives to unlock potential of the country in agriculture (Akinwumi, 2012).

Also, the National Economic Transformation Agenda whose aim is to diversify the economy from reliance on oil, assure food security and create jobs, especially for the youth was instituted. In line with this, the Federal Ministry of Agriculture and Rural Development is implementing an agricultural transformation that is expected to promote agribusiness, attract private sector investment in agriculture, reduce post-harvest losses, add value to local agricultural produce, develop rural infrastructure and enhance access of farmers to financial services and markets. The programme was expected to create over 3.5 million jobs along the value chains of the priority crops of rice, sorghum, cassava, horticulture, cotton, cocoa, oil palm, livestock, fisheries, etc. for Nigeria's teeming youths and women, in particular. The expected impact of the Agricultural Transformation Support Program is to contribute to the private sector-led agricultural growth for food security, creation of jobs and shared wealth. Its specific objective is to increase, on a sustainable basis, the income of smallholder farmers and rural entrepreneurs that are engaged in the production, processing, storage and marketing of the priority commodity value chains. In a nut shell, agricultural transformation aims to improve agricultural production, productivity and reduce poverty (Akinwumi, 2012).

The resent Agricultural transformation by the Federal government has been implemented in four Staple Crops Processing Zones (SCPZs) of Adani-Omor, Bida-Badeggi, Kano-Jigawa, Kebbi-Sokoto and cover 21 LGAs in seven States: Anambra (Ogbaru and Orumba North LGAs), Enugu (UzoUwani LGA); Jigawa (Hadejia LGA); Kano (Bunkure, Kura and Rano LGAs); Kebbi (Argungu, Bagudo, BirninKebbi, Dandi, Ngaski, Shanga and Suru LGAs); Niger (Agaie, Gbako, Lapai, Lavun, Katcha and Mokwa LGAs); and Sokoto (Kware LGA).

1.2 Problem Statement.

In Nigeria, agriculture is a robust alternative for stimulating economic growth, overcoming ruralpoverty and enhancing food security as well as achieving sustainable development (world Bank, 2008; Sunday *et.,al*, 2009; Sunday *et.,al*, 2010; CBN statistical bulletin 2010). Wanyama*et.,al*, (2009) observed thatagricultural productivity in the Sub Saharan Africa and Nigeria declined over the last decades and poverty levels have increased. Currently, agricultural productivity growth and development in the country are far behind that of other regions in the world, and is well below that which is required to achieve food security and poverty reduction goals in the country. Many farmers in the Sub-Sahara African countries Nigeria inclusive are facing declining crop yields, which have adverse effect on the region's economic growth. A prominent constraint to higher productivity among farmers is the "soil infertility" related mainly to the low nutrient status of the soils and continuous cultivation without planned replenishment of the depleted soil nutrients. Most of the farmers only have minimum access to production inputs and improved facilities (USAID,2009). According to Fadama Development Project Appraisal Report (FDP, 2005) the farming systems in the rural areas are predominantly based on subsistence agriculture. The use of inputs such

as fertilizer, improved seed, and mechanization is low. The country is currently preoccupied with the challenge of diversifying the structure of its economy. Like in many rich and poor countries, the issue of poverty and well-being has been of great concern.

Omonona, (2009) noted thatthe poverty situation in Nigeria has been deteriorating Since the 1980s although the country is rich in human and material resources that should translate into better living standards. Adeolu*e.t al*,(2004) noted thatincomes and productivity in rural areas are low; hence the rural population has continue to remain poor. Smallholder agriculture, the dominant occupation in rural Nigeria, is mainly characterized by inadequate capital and low productivity.USAID (2011),IFAD (2009) and Cadoni and Angelucci,(2013) reported thatmost rice farmers in Nigeria are smallholders (90 percent of total), applying low input strategy to agriculture, resulting in low output hence Nigeria rice productivity is among the lowest within neighbouring countries, with average yields of 1.51 tonne/ha. Although,Nigeria is the largest rice producing country in West Africa, it is also the Second largest importer of rice in the World.

There are evidences that several development initiatives have beeninitiated by past government; different policies and structural programmes have been implementedin a bid to overcome poverty in Nigeria between 1977 till date. Among questions often asked and for which answers are beginning sought are: If the various initiatives really work? And how much impact do they have? In spite of the fact that some past studies have tried to address these questions, their "evaluations" only provide qualitative insights and do not assess outcomes against explicit and policy relevant counterfactuals

which are now widely seen as unsatisfactory (Ravallion, 2005). Other studies carried out after the introduction of new varieties of rice such as NERICA, focus more generally on the rice sub-sector as a wholeAkande, 2001, Bello, 2004,Daramola, 2005, Okoruwa*et al* ., 2007 while Spencer *et al*., (2006) was NERICA varieties specific. However, there is still a dearth of impact assessment studies in the rice sector in general and specifically on the Rice development programmes in the study area. Whether the latter are contributing to increase income and reduce poverty are the empirical questions this study intends to address. In view of these, this research is poised to answer the following research questions;

i. what are the socio-economic characteristics of the respondents.
ii. whatare the factors that influenced beneficiaries' participation and intensity of use of package of practices?
iii. whatis the income level of rice farmers participants and non participants in the study area.
iv. doesagricultural transformation have any effect on the rice farmers' productivity?
v. doesagricultural transformation have any effect on the rice farmers' poverty status?

1.3.Objective of the study.

The broad objective of the study is to assess the impact of Agricultural Transformation Project on the productivity and poverty of rice farmers in the study area.

The specific objectives are to:

i. describe the socio-economic characteristics of the rice farmers in the study area.

ii. describe the factors that influenced beneficiaries' participation in the project and the intensity of use of package of practices.

iii. estimate the income level of participants rice farmers and non participants in the study area

iv. determinethe effect of agricultural transformation on the beneficiaries' productivity.

v. determinethe effect of agricultural transformationon the beneficiaries' poverty.

1.4. Justification

Nigeria economic growth and political stability is highly hinged on agricultural growth and development. This is because agriculture is still the largest employer of labour, employing about 75% of the Nigerian labour force, particularly the rural dwellers. The high rate of poverty in Nigeria is worrisome and the deplorable standard of living in the rural areas is of great concern. Worthy of note is the fact that poverty is prevalent among the rural dwellers majority of who are farmers. This high rate of poverty is has been attributed to low output, lack of access to market and low income Awotide*et,al,* (2015). Haggblade,(2004) noted that a significant reduction in poverty will not be possible without rapid development and growth in the agricultural sector. People in agricultural sector earns relatively lower incomes hence they are poor.

The challenge of reducing the level of poverty has become a major phenomenon in the Nigerian economy. Consequently, Nnadi*et,al* (2013) noted that the reduction of poverty is the most difficult challenge facing the any country in the developing world where on the average, majority of the population is considered poor. Evidences from Nigeria

show that the number of those in poverty has continue to increase, since majority of the poor are in agricultural sectorAwotide*etal;* (2015).

Among the various staple food crops cultivated by Nigerian farmers, rice is regarded as the most important staple food in Nigerian diets. Its importance in the attainment of national food security is enormous. For many decades successive governments have tried to avert food insecurity crisis that could be engendered by rice scarcity. In view of this several policies to improve rice production have been formulated and implemented among which is the recent Agricultural transformation Agenda (ATA). If effective policies are formulated and implemented, more knowledge about the determinants of target groups' participation decision and participation intensity is crucial for continued success and the sustainability of the projects. But little or nothing has been done to best of my knowledge in the study area about these determinants.

In addition,empirical studies show that gains from new agricultural projects influenced the poor directly, by raising incomes of farm households, and indirectly, by raising employment and wage rates of functionally landless laborers, and by lowering the price of food staples (Pinstrup-Andersenet*et al*., 1976; Hossain*et al*.,1994; Winters et al., 1998; de Janvry and Sadoulet, 1992, 2002; Irz*et al*., 2002; Bellon*et al*., 2006; Binswanger and von Braun,1991, 2003; Just and Zilberman, 1988; Diagne*et. al.*, 2009). To the best of my knowledge no empirical studies have been carried out to quantify the impact of the agricultural transformation project on rice farmers' productivity and welfare in the study area.

Also, Scientists, research administrators and policy makers face increasing pressure to justify continued public investment in agricultural projects. As demands proliferate for scarce government funds, better evidence is needed to show that agricultural projects generates attractive rates of return compared to alternative investment opportunities.

The result has been an upsurge in studies, seeking credible ex ante estimates of the expected benefits of current and proposed programs of research and ex post estimates of benefits from previously performed projects. Ex ante or ex post estimates of the impact of increased agricultural productivity on poverty are not easy to quantify as they depend on many factors. There may be effects on labor if increased productivity affects labor demand, which in turn may affect both on-farm and off-farm wages.Considering these factors as a whole, there is a general consensus within agricultural economics that agricultural productivity growth drives pro-poor growth, benefiting poor farmers and landless laborers by increasing both production and employment.This study is justified because it does not only attempt to quantify empirically the impact of the project on rice farmers but it will also give an insight to the government, Non- governmental donor agencies of how much effect the project had on target farmers.

1.5.Statement of Hypotheses.

H_{01}: Agricultural transformation project has no significant effect on the productivity of the participants.

H_{02}: Poverty status of the participants and non participants in agricultural transformation project are not significantly different from each other.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1Review of Rice Production in Nigeria

Rice is grown in approximately on 3.7 million hectares of land in Nigeria, covering 10.6 percent of the 35million hectares of land under cultivation, out ofa total arable land area of 70 million hectares. 77 percent of the farmed area of rice is rain-fed, of which 47 percent is lowland and 30 percent upland. The range of grown varieties is diverse and includes both local (such as Dias, Santana, Ashawa, Yarsawaba, and Yarkuwa) and enhanced varieties of traditional African rice (such as NERICA) (Bayou 2009). Paddy rice production has been increasing between 2001 and 2006, followed by a decline in 2007 and a positive peak in 2008. From 2008 to 2010 production statistics show a decreasing trend in production, associated with a decline in area harvested between 2006 and 2010. This trend resulted into higher yields between 2008 and 2010, despite declining production.Cadoni and Angelucci, (2013) opined that increasing production between 2002 and 2006 can attributed to the implementation of the Presidential Initiative on increased Rice Production, although decreasing production between 2008 and 2010 is not in line with policies aimed at the development of the rice sector during those years.

Cadoni and Angelucci, (2013), also noted that despite the relative increase in yields between 2002 and 2006, yielding performance remains below potential. Compared to those of neighboring countries in the region (Benin, Cameroon, Chad, Ghana and Niger), rice yields in Nigerian are among the lowest, superseded by yieldsin Benin, Ghana and Niger.Rice yields are between 46 percent and 56 percent below their potential for different production systems. Rain-fed agriculture is the main production systems used, while irrigated rice are said to be the best performingin terms of yields

(3.5tonne/ha), followed by rain-fed lowland(2.2 tonne/ha) and mangrove swamp (2tonne/ha). Rice production in low land with wet soil zone is favoured within the country, given its resistance to drought.Some of the inefficient agricultural practices are low input application, and poor plant husbandry and post-harvest handling. The main areas of rice cultivation in the country include the middle belt and Northern states of Benue, Kano, Niger and Taraba, as well as the South Eastern states of Enugu, Cross River and Ebonyi. Kano is the main producing state, followed by Niger, Benue, Ebonyi, Taraba, and Borno. The latter seven states account for over 67 percent of total rice production in the country.

2.2. Concepts inImpact Assessment of Agricultural Technology and Programmes.

The term ‘impact assessment’ or ‘evaluation’ is used in different ways by different people. Impact refers to the broad, long-term economic, social and environmental effects resulting from project while evaluation /assessment is judging, appraising or determining the worth, value or quality of project, in terms of its relevance, effectiveness, efficiency and impact (IAEG, 1999). Impact assessment is an established practice in public goods investment project and programmes such as infrastructure, health, education, transportation, and urban development.Omoto(2003) and Rover and Dixon (2007) see impact assessment as a process of systematic and objectiveidentification of the short and long-term effects–positive and negative, direct or indirect effectof intervention on economic, social, institutional and environments. Such effects may beanticipated or unanticipated, and positive or negative, at the level of the individual, householdor the organization caused by on-going or completed development activities such as a projector program an impact evaluation assesses the extent to which a project has caused desired/undesiredchanges in the intended users. It

is concerned with the net impact of an intervention onindividuals, households or institutions, attributable only and exclusively to that interventions(Baker, 2000).

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

According to FAO (2000), impact assessment is done for several practical reasons: (1)accountability – to evaluate how well we have done in the past, to report to stakeholders onthe return to their investment, and to underpin political support for continued investment; (2)improving project design and implementation - to learn lessons from past that can be appliedin improving efficiency of research projects; and (3) planning and prioritizing - to assesslikely future impacts of institutional actions and investment of resources, with results beingused in resource allocation and prioritizing future projects and activities, and designingpolicies.

2.3. Types and Approachesto Impact Assessment

Based on the time continuum, there are two types of impact assessment studies. *Ex ante* typeis about assessing the impact of the likely future environments and of expected impacts frominterventions. It is applied to assist in decisions on approval and funding of any project whereas *ex-post* (which this study meant for) evaluates performance, achievements and impacts ofthe past activities of the project or program (FAO, 2000). The resulting information is used inaccounting for the past use of resources, and as a useful input for future planning. According to Ponniah*et al.* (1996), comprehensive impact evaluation can be undertaken attwo levels viz. people (household) and community.

2.3.1. People level impact

People level impact refers to the effect of the intervention on the ultimate users or targetgroup for which the technology is developed and adopted. Impact begins to occur when thereis a behavioral change among the potential users. The people level impact deals with theactual adoption of the appropriate technologies and subsequent effects on production, income,environment and/or whatever the development objective may be (Omoto, 2003). The peoplelevel impact can be economic, socio-economic, socio-cultural, and/or environmental.

2.3.2 Economic impact assessment.

Economic impact measures the combined production and income effects associated with a setof research and development activities (Ponniah and Martella, 1999). The economic impactassessment studies range in scope and depth of evaluation from partial impact studies(adoption studies) to comprehensive assessment of economic impacts (FAO,

2000). Onepopular type of partial impact assessment is adoption studies that look at the effects of newtechnologies such as the spread of modern crop varieties on farm productivity and farmers'welfare. Economic impact assessments of the more comprehensive types look beyond mereyield and crop intensities to the wider economic effects of the adoption of new technology.

2.3.3 Social impact assessment.

Social impacts areimportant and need to be considered along with the economic andenvironmental impacts. Social impacts assessment include the effects of intervention of theproject on the attitude, beliefs, resource distribution, status of women, income distribution,nutritional implications, institutional implications etc of the community. These can beassessed through socio-economic surveys and careful monitoring. Social impact has thepotential to contribute greatly to the planning process of other types of development projects(FAO, 2000). It can assist in the process of evaluation of alternatives, and to help in theirunderstanding and management of the process of social change.In many impact assessment studies these impact evaluations is rarely applied or overlookedespecially in agricultural research and development programs and focusing usually oneconomic and environmental impacts. Only few economic studies have included social impactanalysis through qualitative assessments (FAO, 2000).

2.3.4 Environmental impact assessment.

The importance of environment impact assessment is increasing in agricultural research anddevelopment interventions due to the growing concerns of land degradation, deforestation andloss of biodiversity around the world. However, there are few

countries and researchinstitutions that have formally assessed the environmental impacts associated with agriculturalresearch projects (FAO, 2000).

2.4Community Level

2.4.1 Institutional impact assessment.

According to North (1996), institutions are rules of game and organizations and theirentrepreneurs are players. Increasing agricultural productivity, whilst strengthening localinstitutions, has long been an important goal of agricultural research and development.Organizations play an important role in meeting this goal by improving technologies andknowledge base of the biological, social, economic and political factors that govern theperformance of an agricultural system, and by strengthening local institutions' capacity andperformance. Most impact evaluation studies are often subjected to rigorous appraisals fromeconomic and environmental perspectives, without giving due attention to the institutionalaspect of the interventions (Ponniah*et al.*, 1996).

While economic ,environmental and social impact focuses on the impact evaluation of thetechnological outputs of research and development organizations in the form of newtechniques, methods, information and practices of agricultural systems, institutional impactassessment involves the evaluation of the performance of an intervention in non-technicalactivities such as training, networking, facilitation, development of methodologies, andadvisory services in the areas of research and other policies, organization and management.The concrete results and impacts of institutional development can be difficult to see and maytake time to emerge. However, information, generated from institutional impact assessmenthas the great potential to lead to better, more effective actions and institutional performance ofa research and development

system (FAO, 2000). Institutional and organizational impact ismeasured in terms of changes in policy, institutional structure, networking, arrangements andachievements in human capacity buildings (Omoto, 2003).

2.5Approaches to Impact Assessment Study.

If one could observe the same individual at the same point in time, with and without theproject, this would effectively account for any observed or unobserved intervening factors orevents and the problem of endogeneity do not arise (Ravallion,2005;Gilligan *et al.*,2008). Since this is not happening in practice, something similar is done byidentifying non-participating comparator groups identical in every way to the group thatreceives the intervention, except that comparator groups do not receive the intervention.To know the effect of a project on a participating individual, we must compare the observedoutcome with the outcome that would have resulted had that individual not participated in theproject. However, as stated earlier two outcomes cannot be observed for the same individual.In other words, only the factual outcome can be observed. Thus, the fundamental problem inany social project evaluation is the missing missing data problem (Bryson *et al*., 2002; Ravallion,2005).

Estimating the impact of a project requires separating its effect from intervening factors whichMay be correlated with the outcomes, but not caused by the project. To ensure methodologicalrigor, an impact evaluation must estimate the counterfactual, that is, what would havehappened had the project never taken place (Baker, 2000).This task of "netting out" the effect of the project from other factors is facilitated if controlgroups are introduced or constructed form non-beneficiaries. Control groups consist of acomparator group of individuals or households who did not receive the treatment, but

havesimilar characteristics as those receiving the intervention called the treatment groups, the onlydifference between groups is being project participation. The comparison group should beidentical to the treatment group except that the treated group receives the intervention and thenon treated ones do not. They make it possible to control for other factors that affect theoutcome(confounding factor).Identifying these groups correctly is a key to identifying whatwould have occurred in the absence of the intervention (Ezemenari*et al*., 1999; Gilligan *etal.,* 2008).However, this is difficult to achieve for two reasons. First, beneficiaries of the interventionmay be selected on the basis of certain characteristics (purposive targeting) based. If thesecharacteristics are observed then a comparison group with the same characteristics can beselected. But if they are unobserved then in principle only a randomized approach caneliminate selection bias. Second, the comparison group may be contaminated either byspillover effects from the intervention or a similar intervention being undertaken in thecomparison area by another agency.If these differences that could arise from the non-random placement of the program and/orfrom the voluntary nature of participation in program (self-selection) is not properlyaccounted for, comparison of outcomes between program participants and non-participants islikely to yield biased estimates of program impact(Gilligan *et al.*,2008).

In theory, evaluators could follow two main quantitative methods in establishing control andtreatment groups namely randomization/pure experimental design and non-experimental/quasi-experimental design. In practice, in the social sciences, the choice of a particularapproach depends, among other things, on agricultural transformation availability, cost, and ethics to experiment.

2.5.1 Experimental method

Experimental designs, also known as randomization, are generally considered as the mostrobust of the evaluation methodologies (Baker, 2000). By randomly allocating theintervention among eligible beneficiaries, the assignment process itself creates comparabletreatment and control groups that are statistically equivalent to one another, given appropriatesample sizes.In a randomized experiment, the treatment and control samples are randomly drawn from thesame population. In other words, in a randomized experiment, individuals are randomlyplaced into two groups, namely, those that receive treatment and those that do not. In this caseobservable and unobservable characteristics get uncorrelated thus no selection bias problemarises. This allows the researcher to determine project impact by comparing means ofoutcome variable for the two groups which yields an unbiased estimate of impact (Nssah,2006).

According to Ezemenari*et al*. (1999), a random assignment of individuals to treatment andnon-treatment groups ensures that on average any difference in outcomes of the two groupsafter the intervention can be attributed to the intervention (i.e. both observed and unobservedcharacteristics is the same for both the treated and the control group).Random assignment ensures the two groups are statistically similar (drawn from samedistribution) in both observable and unobservable characteristics, thus avoiding programplacement and self-selection biases (Bernard *et al.,* 2010). If implemented appropriately, thisdesign ensures that potential confounders are balanced across program (intervention) andcontrol units and therefore any differences in the outcomes between the two can be attributedto the program.

2.5.2 Quasi-experimental method

Quasi-experimental (nonrandom) methods can be used to carry out an evaluation when it isnot possible to construct treatment and comparison groups through experimental design. Forprojects that are often setup intentionally, it is common to only have access to a single cross-sectionalsurvey done after the project is introduced (Jalan and Ravallion, 2003). Thesetechniques generate comparison groups that resemble the treatment group, at least in observedcharacteristics, through econometric methodologies which include matching methods, doubledifference methods and reflexive comparisons.When these techniques are used, the treatment and comparison groups are usually selectedafter the intervention by using nonrandom methods. In some cases a comparison group is alsochosen before treatment, though the selection is not randomized. Therefore, statistical controlsmust be applied to address differences between the treatment and comparison groups andsophisticated matching techniques must be used to construct a comparison group that is assimilar as possible to the treatment group (Gilligan *et al.,* 2008).

A quasi-experimental method is the only alternative when neither a baseline survey norrandomizations are feasible options (Jalan and Ravallion, 2003). The main benefit of quasiexperimental designs are that they can draw on existing Agricultural transformation sources and are thus oftenquicker and cheaper to implement, and they can be performed after a project has beenimplemented, given sufficient existing agricultural transformation. The principal disadvantages of quasi-experimentaltechniques are that (a) the reliability of the results is often reduced as themethodology is less robust statistically; (b) the methods can be statistically complex and data demanding; and (c) there is a problem of selection bias. This study employed this method asthere is no base line for the project.The central methodological challenge

in non-experimental evaluation method is thatexamining outcome response of an intervention involves distilling the effect of interventionper se from that of the factors that affect individuals (Foster, 2003). There are differenteconometric approach that has been used to avoid or reduce this problem.

2.5.3 Double difference or difference-in-differences (DID):

Method in which one compares atreatment and comparison group (first difference) before and after a project (seconddifference). Comparators should be dropped when propensity scores are used and if they havescores outside the range observed for the treatment group. In this case potential participantsare identified and data are collected from them. However, only a random sub-sample of theseindividuals is actually allowed to participate in the project. The identified participants who donot actually participate in the project form the counterfactual (Jalan and Ravallion, 1999;Baker, 2000).With this method program impacts are estimated by calculating the difference in outcomesbetween treatment and control groups after program implementation minus the difference inoutcomes between treatment and control groups prior to the implementation. Often, we referto this double difference or this simple comparison-in-means as the difference-indifference(DID) estimator.The strength of the panel-based-DID estimator comes from its intuitive appeal and simplicity.It can derive an estimate of the impact by comparing the treatment and control groups usingthe post treatment data (second difference), after we use the pre-treatment data to equatetreatment and control groups (first difference). In addition to this, DID estimates are knownto be less subject to selection bias because they remove the effect of any unobserved timeinvariantdifferences between the treatment and comparison groups.

However, there are at least two disadvantages that relate to the very simplicity of such a panelbased impact assessment. First, constructing panel data sets can be expensive, timeconsuming, and logistically challenging particularly because we need to collect baseline andfollow-up data that straddle the implementation of a program. Second, the design assumes thatthe potential selection bias (i.e., due to administrative targeting or volunteering) is linear andtime invariant such that it can be subtracted off in the first differencing (Jalan and Ravallion,1999). However, these assumptions might be violated if the time period between two panelagricultural transformation sets is long enough so that the unobservable variables of subjects are altered. In addition,the unobservable variables can be changed as the subjects participate in the program whichleads the estimate to be biased.

2.6A Reflexive Comparison.

Methods in which a baseline survey of participants is done beforethe intervention and a follow-up survey, is done after. Here, Participants who receive theintervention are compared to themselves before and after receiving the intervention. Thecounterfactual group is the set of participating individuals themselves (Jalan and Ravallion,1999; Baker, 2000).

2.7Propensity Score Matching.

Among quasi-experimental design techniques, matchedcomparisontechniques are generally considered a second-best alternative to experimentaldesign (Baker, 2000). Intuitively, PSM tries to create the observational analogue of anexperiment in which everyone has the same probability of participation. The difference is thatin PSM it is the conditional probability (P(X)) that is intended to be uniform betweenparticipants and

matched comparators, while randomization assures that the participant andcomparison groups are identical in terms of the distribution of all characteristics whetherobserved or not. Hence there are always concerns about remaining selection bias in PSMestimates (Ravallion, 2005).

On the other hand researchers also usually applied ordinary regression in adjusting preexistingdifferences treated and comparison households. Although common, such an approach hassome limitations. The first is that regression generally assumes a set of linear relationshipsbetween the covariates and the outcome of interest. A second, more subtle problem involvesthe so called common support or distribution of the covariates (Ravallion, 2005). Not onlyhigh- and low-treatment groups differ in terms of the means of those variables, but thedistribution of those variables could overlap relatively little. In that case, regressionessentially projects the behavior of individuals in one group outside the observed range toform a comparison for the other at common values of the covariate. Such projections can behighly sensitive to functional form (Foster, 2003).

An alternative to econometric regression is statistical matching methods. With this methodmeaningful counterfactual (control) group is selected among a large group of nonparticipants,which is identical to the participating group (Bryson *et al.,* 2002; Caliendo andKopeinig, 2008) to match the characteristics of the project population (causality of potentialoutcomes) as closely as possible. It matches control groups to treatment groups on the basis ofobserved characteristics or by a propensity (to participate) score; the closer this score, thebetter the match. A good control group is from the same economic environment and is askedthe same questions by similar interviewers as the treatment group. In recent years there havebeen substantial advances

in PSM technique applications (Rosenbaum and Rubin, 1985; Jalanand Ravallion, 1999).

Unlike econometric regression methods, PSM compares only comparable observations anddoes not rely on parametric assumptions to identify the impacts of projects and it does notimpose a functional form of the outcome, thereby avoiding assumptions on functional formand error term distributions, e.g., linearity imposition, multicollinearity and heteroscedasticityissues. In addition, the matching method emphasizes the problem of common support, therebyavoiding the bias due to extrapolation. Results from the matching methodare easy to explain to policy makers, since the idea of comparison of similar group is quiteintuitive.Matching the treated and the control subjects becomes difficult when there is a multidimensionalvector of characteristics (Rosenbaum and Rubin, 1983). The PSM solves thistype of problem by summarizing the pre-treatment characteristics of each subject into a singleindex variable, and then using the propensity score (PS) to match similar individuals. Thisconstitutes the probability of assignment to treatment conditional on pre-treatment variables(Rosenbaum and Rubin, 1983).

Matching estimates is more reliable if: (i) participants and controls have the same distributionof unobserved characteristics; (ii) they have the same distribution of observed characteristics;(iii) the same questionnaire is administered to both groups; and (iv) treated and controlhouseholds are from the same economic environment. In the absence of these features, thedifference between the mean impact of the participants and the matched non-participants isbiased estimate of the mean impact of the project (Jalan and Ravallion, 1999).PSM is not without its potentially problematic assumptions and implementation challenges.First, PSM requires large amounts of data both on the

universe of variables that couldpotentially confound the relationship between outcome and intervention, and on largenumbers of observations to maximize efficiency (Bernard *et al.*, 2010) .Second, related to theprevious point we can never be entirely sure that we have actually included all relevantcovariates in the first stage of the matching model and effectively satisfied the conditionalindependence assumption (CIA). Furthermore, PSM is non-parametric: we do not make anyfunctional form assumptions regarding the average differences in the outcome. Although thefirst stage involves specification choices - e.g., functional form like logit and probit, empiricalanalyses tend to find impact estimates that are reasonably robust to different functional forms.Moreover, if unobservable characteristics also affect the outcomes, PSM approach is unableto address this bias (Ravallion, 2005).Irrespective of its shortcomings, PSM is extensively used in the recent literature on economicimpact evaluation (Jalan and Ravallion 2003). It is very appealing to evaluators with timeconstraints and working without the benefit of baseline data given that it can be used with asingle cross-section of data, where this study envisaged to employ.

2.8 A Review of Studies on Application of PSM Methods.

A number of researchers have applied this semi parametric model to evaluate social programsboth in Ethiopia and elsewhere in the other parts of the world. Below are some of the recent studies who haveapplied PSM in program evaluations particularly in Ethiopia.Fitsum*et al,* (2006), used PSM in order to analyze the impact of small scale water harvestingon household poverty in Tigray .The main objective here was to assess whether householdswith ponds and wells are better off compared to those without. Results show that householdswith ponds and wells are not significantly better off compared to households without, eventhough they are comparable in essential

household characteristics.Yebeltal (2008), applied the model to assess the impact of Integrated Food Security Programin Ibant district of Amahara region. The study found that the program has increasedparticipating households' calorie intake by 30% (i.e., 698 calories) compared to that of nonparticipatinghouseholds.In assessing the impact of the Productive Safety Net Program (PSNP) in Ethiopia on livestockand tree holdings of rural households, Anderssonet *al.* (2009), have applied PSM model.They found that there was no indication that participation in PSNP leads households todisinvest in livestock or trees. In fact, the number of trees increased for households thatparticipated in the program. It could be the case that participation in PSNP (where treeplanting and subsequent forest management work on public lands are usual activities) leads tohouseholds becoming more skilled in forestry, and that they switch to increased forestplanting as a result.

In analyzing the impact of social protection on food security and coping mechanisms inEthiopia's productive safety nets program, Gilligan *et al.* (2008), used PSM methods and theyfound that participation in the public works component of the PSNP (defined as receipt of atleast 100 Birr) in payments over the first five months has modest effects. It improves foodsecurity by 0.40 months and increases growth in livestock holdings by 0.28 TropicalLivestock Units (TLU). It leads to an increase of 4.4 percentage points in the likelihood that ahousehold is forced to make a distress asset sale.Bernard *et al.* (2010), applied PSM in assessing the impact of cooperatives on smallholders'commercialization of staple crops using the output price offered and proportion of output soldas indicators. They found that cooperatives deliver, on average, 7 percent price premium fortheir members' output, relative to what these farmers would have received had they decided tomarket their output individually. On the other hand,

the quantity of grain coming to marketfrom this smallholder farmer is less than it would be without the cooperative's services.

2.9.0 Methodological issues and Approach toAgriculturalProjectImpact Assessment.

2.9.1 Participation decision and intensity of use of package of practices.

A major methodological issue in a technology impact studies is how to address thesimultaneity of decision making regarding the sequencing of the technology components (package of technology improvements) and the intensity of the useof the new technologies programme. A variety of approaches have beenapplied by different researchers. ByerleeanddePolanco (1986) demonstrated that farmers in the Mexican *altiplano* participated in improved varieties, fertilizer, and herbicide in a step-wisemanner, rather than as a package.Smale*et al,* (1995) modeled participation as three simultaneouschoices: the choice of whether to participate in the components of therecommended package, the decision of how to allocate different technologies across the land area, and the decision of how much of some inputs, such as fertilizer, to use. Khanna (2001)used a double selectivity model to look at two site-specific technologies soil testing, and variable rate technology. The modelwas designed to compensate for sample selection bias. Dimaraand Skuras (2003) modeled the adoption decision as a partialobservability process, which allows adoption to be modeledas a two-stage process, even if only one stage is observed.

Teklewold, *et al.*, (2006) examine the factors influencing the rate and intensity of participation in poultry technology using the Double-hurdle Model. The model was applied to a sample of 200 small holder farmers in Ethiopia and found that the Farmers' decision on adoption of poultry technology was positively affected by the sex of the

household head, family size, availability of supplementary feed, credit and extension service and the extent of expected benefit from poultry, and negatively affected by market problem. On the other hand, farmers' decision on the extent of participation in exotic poultry breed was positively influenced by age of the household head, however, experience in adoption of poultry technology and expected benefit from poultry breed was found to negatively influenced participation.

Beltran *et al*., (2011) applied random-effects Double-Hurdle Model to a survey data to identify the farm-level factors affecting the participation and intensity of herbicide use in rice production in the Philippines. Results broadly indicate apparent differences in the degree to which important explanatory variables affect the intensity and participatory decisions. The age of the farmer, household size, and irrigation are the significant predictors of farmers' decision to use herbicides, while economic variables such as the price of herbicides, total income of farmers, and the use of bank loans or credit are the highly significant factors determining the intensity of herbicide use. Significant determinants of both the adoption and intensity decisions are land ownership, farm area, and the method of crop establishment used. Asfaw et al., (2011) applied augmented Double-Hurdle Model to analyse the determinants of the intensity of a variety adoption conditional on overcoming seed access constraints. They found out that knowledge of existing varieties, perception about the attributes of improved varieties, household wealth (livestock and land) and availability of active labour force are major determinants for participation of improved technologies.

2.9.2 A Review of Cragg'sDouble-Hurdle Model

Modeling farmers decision making about whether to participate or not to participate in a programme constitutes a discrete (whether or not to take up the programme) and continuous (the intensity of use of the technology) in the programme (Wale and Yallew, 2007). Most adoption models are based on the assumption that farmers are faced with a choice between two alternatives and the choices they make depend on identifiable characteristics of the technologies or project' expected benefits and the available incentives (Pindyck and Rubinfeld, 1997). In this study, participation decision was measured as a binary (1, participants and 0, otherwise) while level of participation or use intensity of project package of practices (dependent variable) was measured as the proportion of package of practice applied by the project participants. A feature of many models of this nature, for example straightforward binary or censored models, is that the process which results in non-participation is assumed to be the same as that which determines the intensity or level of participation. Thus, for example, if a given farmer's characteristic is known to have a positive effect on the extent of participation, then a very high value of this characteristic would inevitably lead to the prediction of participation for such farmer. While such assumptions may turn out to hold, there is no reason to expect this apriori. One reason why such an assumption might fail is that there may exist a proportion of the population of farmers who would, out of principle, never participate under any circumstances

Accordingly, the double-hurdle statistical model, originally formulated by Cragg (1971) in the context of household demand for products, was applied to estimate the probability of participation and the intensity of use. This method has many benefits in the context of this study. First, the sets of factors that affect the participation and intensity of input use can be dissimilar (Teklewold, et al., 2006). Second, this procedure allows the definition

of different types of dependent variables for participation decision and intensity (level of participation) decisions. This is important since the participation decision will often be described by a binary variable or censored variable (one that has a lower limit, an upper limit, or both (Greene, 2003)), while the intensity decision is better described using continuous values.

2.10 ImpactAssessment

Although there are many theoretical reasons why improved agricultural technologies should enhance farm households' welfare, it is difficult to assess welfare effects from technology participation based on non-experimental observations. This is because the counterfactual outcome of what the crop income and poverty status would be like if the participant in the technology had not been is not observed. In experimental studies, this problem is addressed by randomly assigning households to treatment and controlled groups, which assure that the outcomes observed with the control groups without agricultural technology, are statistically representative of what would have occurred without adoption by the treatment households. However, in cases where the non-random allocation of the treatment is either determined by the policymaker or self-selected by households, selection bias may cloud the impact estimation results.

A pressing challenge in agricultural project impact assessment studies, therefore, is how to conceptualize an appropriate counterfactual framework of impact assessment that will minimize the effects of overt and hidden biases and deal with the problem of non-compliance. It isdifficult to compare outcome gains (welfare and productivity) between participants andnon-participants of technologies, because the adoption decisionis correlated with other factors affecting the gains. Impact evaluation measures the

changes in individual, household or community income and well-being that result from a particular project or program. Barrettet al., (2004) take advantage of the fact that many farmers inMadagascar have introduced an improved rice management technology on some, but not all of their plots. Thus, they cancontrol for productivity differences across plots while holdingconstant farmers' characteristics, including unobserved farmer characteristics. Resent literature has emphasized that a distinctive feature of an impact evaluation is the use of a counterfactual, which identifies what would have happened to the beneficiaries in the absence of the program. This counterfactual is critical to understanding the improvements in people's lives that are directly caused by the program. The predominant literature on the poverty linkage effects of agricultural growth during the 1970s tend to show that technical change in agriculture leads to more production, which in turn leads to increased incomes for households with land.

Most recent studies indicate that agricultural technology may reduce poverty through direct effects on output levels, employment, food security, food prices, incomes, and overall socioeconomic welfare (Omiloa, 2009). Because of the assumption that agricultural technology automatically reduces poverty, antipoverty impacts have often been developed mostly for participants and focused exclusively on them. This approach fails to spell out an adequate counterfactual situation and obscures the significance of agricultural technology on poverty without comparing participants with non-participants. The question that arises is: how cans an agricultural technology–poverty linkage properly conceptualized within the context of both participants and non-participants? Or, better still, can the conceptualization of agricultural technology–poverty linkage be structured in such a way as to allow comparability between

participants and non-participants? Several methods of evaluating a counterfactual analysis of antipoverty development programs abound in the evaluation literature.

According to Ravallion (2005), Adeoti (2007) and Omilola (2010), common methods includes single difference methods which compare outcomes between a sample of participants and non participants, the double difference or "difference in difference'' method which compares outcome indicators with-and –without the project, before and after adoption by using a preintervention baseline survey and post intervention data. Omilola (2009) pointed out that although the use of single difference methods is prevalent in the evaluation literature; these methods generally tend to furnish impact analysis with inadequate information on whether the control group is similar to the treatment group in terms of all characteristics with the exception of adoption of new technology.

Scholars like Miguel and Kremer (2004) who have tried to use the single difference method have in some ways encountered complications using it in their evaluation of treatments for intestinal worms in children. They then mention that the omission of externalities between children who received treatments and those who did not tend to lower the measured impacts of the intervention. Adeoti*et al*., (2005) noted that, one of the problems with "before and after'' comparisons is that it fails to account for changes in production that will occur without the project and therefore can lead to erroneous estimates of the quantified impacts.

Ravallion (2005) and Omilola, (2009) pointed out that, three problems are associated with the methods, the first is selection bias, which is related to how one can deduce the

counterfactuals for participants with regards to non-adoption who have different characteristics. This problem can be resolved by ensuring comparability between participants and non-participants in terms of their pre-intervention characteristics. Failure to implement the later implies that observed differences in outcome indicators between participants and non participants cannot be taken to be valid. For instance, Glewwe*et al.* (2004) show that selection bias resulted in higher test scores of school children in Kenya. Also, VandeWalle (2002) reports that selection biases for the evaluation of the impact of rural roads on poverty attributed longer income gains to project beneficiaries when in fact there are no income gains.

Mendola (2006) employed the propensity matching score to shed light on the potential impact of agricultural technology on poverty alleviation strategies in two rural Bangladeshi regions. As technology adoption is not randomly assigned but there is 'self-selection into treatment', she tackled methodological issue in assessing the causal effect of technology on farm-household wellbeing through the non-parametric-score matching analyses. It pursues 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. It finds 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 propensity score matching method is one of the modern non-parametric estimation techniques that do not depend on functional form and distributional assumptions. The method is intuitively attractive as it helps in comparing the observed outcomes of

technology participants with the outcomes of counterfactual non-participants (Heckman *et al*., 1998). Despite its heavy data requirements, the matching method can produce experimental treatment effect results when such data are not feasible and/or available. It also helps to evaluate programs that require longitudinal data sets using single cross-sectional data set where the former does not exist. However, Junning*et al*. (2008), observed that while p-score comparisons can be used to compare the welfare performance of participants and non-participants farmers with similar intrinsic characteristics, they cannot correct for hidden bias because p-score comparison only controls for observed variables (to the extent that they are perfectly measured).

Asfaw (2010), evaluated the potential impact of adoption of modern agricultural technologies on rural household welfare in rural Ethiopia and Tanzania from a radom selection of 1313 households using parametric (propensity score matching) and non parametric (endogenious switching regression) to control for selection problem. He observed that improved agricultural technologies had positive impact on crop income. Although the impact on consumption income is mixed, his findings shows that technology adoption had direct role of improving rural household welfare and that hiher income translate into lower income poverty.

Also, Menale*et al*,(2010), used PSM, poverty dominance analysis test and switching regression model to estimate the welfare effect of technology adoption by controlling for the role of selection bias, problem. He noted that the adoption of improved groundnut technologies has a significant positive impact on crop income and poverty reduction.

Menale*et al*,(2010) submitted that only a few methods deal appropriately with selection problem. The PSM for example only removes part of the selection bias called ‘’overt’’ bias Lee (2005). PSM cannot remove what is called hidden bias which is caused by unobservable covariates that may also affect the farmers’ selection in to the participation state and the outcome indicators. Furthermore when we are faced with non compliance problem ATE parameter estimated with PSM score does not identify the causal effect. The impact parameter that identifies the causal effect of adoption in the presence of non-compliance is the Local average treatment effect (LATE).

Dontsop, (2010) employed both propensity score matching and the LATE methods to control for overt, hidden and non-compliance biases in his assessment of the impact of NERICA rice adoption on the welfare of rice farmers in Nigeria. He however observed that adoption of NERICA had significant impact on the welfare of the farmers. In this study we propose to use LATE framework to estimate the causal effect of technology on productivity, and poverty status of participants of Agricultural Transformationamong rice based farmers in the study area.

2.11 A Review of the LATE model

2.11.1 The Local Average Treatment Effect (LATE) Model

Most of the methods employed by researchers in agricultural technology impact analysisare prone to estimation problems resulting from selection bias. The methods proposed to minimize the effects of overt and hidden biases and deal with the problem of *non-compliance* can be classified under two broad categories. First, there are the methods designed to remove overt bias only and which are based on the conditional independence assumption (Rubin, 1974 and Rosenbaum and Rubin, 1983) which postulatesthe existence of a set of observed covariates ***x*,** which, when controlled for, renders the treatment status d independent of the two potential outcomes $y_1$and y_0 The estimators using the conditionalindependence assumption are either a pure parametric

regression-based method where the covariates are possibly interacted with treatment status variable to account for heterogeneous responses, or they are based on a two-stage estimation procedure where the conditional probability of treatment $P(d = 1|\, x) \equiv P(x)$, called the *propensity score*, is estimated in the first stage and ATE, ATE1 and ATE0 are estimated in the second stage by parametric regression-based methods or by non parametric methods, which include various matching method estimators that include the ones used by Mendola (2007).

Following the framework adopted by Adekambi*et a*l. (2009), and Diagne*et al.*(2010); Dontsop, 2010), each farm household has ex-ante two potential outcomes: an outcome when participating in a project that is denoted by $y_1$and an outcome when not participating that is denoted by y_0. Letting the binary outcome variable *d* stand project participation status with $d = 1$ meaning participation and $d = 0$ non- participation, we can write the *observed* outcome *y* of any farm household as a function of the two potential outcomes: $y = dy_0 + (1 - d)y_0$. For any household, the causal effect of the participation on its observed outcome *y* is simply the difference of its two potential outcomes:$y_1 - y_0$. But, because the realizations of the two potential outcomes are mutually exclusive for any household (i.e. only one of the two can be observed ex-post), it is impossible to measure the individual effect of participation in the project on any given household. However, one can estimate the mean effect of participation in the project on a population of households: $E(y_1 - y_0)$, where E is the mathematical expectation operator. Such a population parameter is called the Average Treatment Effect (ATE) in the literature. One can also estimate the mean effect of adoption on the subpopulation of participants: $E(y_1 - y_0 \mid d = 1)$, which is called the Average Treatment Effect on the treated and is usually denoted by ATE1 (or ATT). The average treatment effect on the *untreated*: $E(y_1 - y_0 \mid d = 0)$ denoted by ATE0 is also another population parameter that can be defined and estimated. According to Imbens, (2004); Lee (2005), the conditional independence based estimators of ATE, ATE1 and ATE0 called Inverse Propensity Score Weighing Estimators (IPSW), can be expressed by the following formulas.

$$\hat{ATE} = \frac{1}{n}\sum_{i=1}^{n} \frac{d_1 - \hat{p}(x_1))y_1}{\widehat{P(X_1)}\,(1-\hat{P}(X_1))} (1)$$

$$\hat{ATE1} = \frac{1}{n_1}\sum_{i=1}^{n} \frac{d_1 - \hat{p}\,(x_1))y_1}{(1-\hat{p}(x_1))} (2)$$

$$\hat{ATE0} = \frac{1}{1-n_1}\sum_{i=1}^{n} \frac{d_1 - \hat{p}\,(x_1))y_1}{\hat{p}(x_1))} (3)$$

Where$n$is the sample size, $n_1 = \sum_{i=1}^{n} d_1$is the number of treated (i.e. the number of project participants) and $p\hat{}\,(x)$ is a consistent estimate of the propensity score evaluated at $\boldsymbol{x}$. probit specification can be be used to estimate the propensity score.

2.11.2 The Instrumental Variable (IV).

The *instrumental variable* (IV) based methods (Heckman and Vytlacil, 2005;Imbens 2004; Abadie, 2003; Imbens and Angrist, 1994) are designed to remove both overtand hidden biases and deal with the problem of endogenous treatment. The IV based methodsassume the existence of at least one variable **z** called *instrument* that explains treatment status butis redundant in explaining the outcomes $y_1$and y_0, once the effects of the covariates $\boldsymbol{x}$ arecontrolled for. Different IV based estimators are available depending on functional form assumptions and assumptions regarding the instrument and the unobserved heterogeneities. According to Imbens andAngrist, (1994) the simple non-parametric Wald estimator requires only the observed outcome variable *y*, the treatment statusvariable *d* and an instrument *z*. Also, as proposed byAbadie's (2003), the generalization of theLATE estimator of Imbens and Angrist (1994) suggested that the instrument *z* is not totallyindependent of the potential outcomes $y_1$and y_0 but will become so conditional on some vector ofcovariates $\boldsymbol{x}$ that determine the observed outcome *y*.

Considering the expressions of the Imbens and Angrist (1994) LATE estimator and that of Abidie (2003), it can be noted that the project status variable is a "natural" instrument for the participation status variable (which is the treatment variable here). Indeed, firstly a farmer cannot participate without being exposed to it and we do observe some farmers participating in the project (i.e. exposure does cause adoption). Second, it is natural to assume that exposure to Improved Farafara affects overall household income only through adoption (i.e. the mere exposure to the project without participating in itdoes not affect the income of a farmer). Hence, the two requirements for the exposure status

variable to be a valid instrument must be met. Now, if *z* is a binary outcome variable taking the value 1 when a farmer is *exposed* to the the project and the value 0 otherwise. Let $d_1 \; and \; d_0$be the binary variables designating the two potential *participation*outcomes status of the farmer with and without exposure to the project respectively (with 1 indicating participation and 0 otherwise). Because one cannot participate in the project without being exposed to it, we have $d_0 = 0$ for all farmers and the *observed* adoption outcome is given by $d = zd_1$. Thus, the subpopulation of potential participants is described by the condition d_1=1 and that of actual participant is described by the condition d=1 (which is equivalent to the condition $z = 1 \; and \; d_1 = 1$). Now, if we assume that *z* is independent of the potential outcomes d_1, $y_1$and y_0 (an assumption equivalent to assuming that exposure to the project is random in the population), then the mean impact of the project on the average productivity, expenditure and income of the subpopulation of project potential participants (i.e. the LATE) is given by: (Imbens and Angrist, 1994; Imbens and Rubin 1997; Lee, 2005)

$$E\{y_1 - y_0 | d_1 = 1\} = \frac{E(y|z) - E(y|z=0)}{E(d|z=1) - E(d|z=0)} \quad (4)$$

The RTS of equation (11) can be estimated by its sample analogue given by

$$\left[\frac{\sum_{i=1}^{n} y_1 z_1}{\sum_{i=1}^{n} Z_1} - \frac{\sum_{i=1}^{n} Z_i(1-Z_1)}{\sum_{i=1}^{n}(1-Z_1)}\right] X \left[\frac{\sum_{i=1}^{n} d_1 Z_1}{\sum_{i=1}^{n} Z_1} - \frac{\sum_{i=1}^{n} d_1(1-Z_1)}{\sum_{i=1}^{n}(1-Z_1)}\right]^{-1} \quad (5)$$

Equation (5) is the well known Wald estimator.

The assumption that exposure to the project is random in the population is unrealistic and, therefore, it is preferable to use Abadie's LATE estimator which does not require the assumption but instead requires the much weaker conditional independence assumption: The instrument *z*is independent of the potential outcomes $d_1, y_1 \; and \; y_0$conditional on a vector of covariates $\boldsymbol{x}$ determining the observed outcome *y*. With these assumptions, the following results can be shown to hold for the conditional mean productivity, expenditure and income response function for potential participants.

$f(x,d) = E(y \mid x,d;\; d_1 = 1) \; and \; any \; function \; g \; of \; (y,x,d)$ (Abadie, 2003; Lee 2005):

$$f(X,1) - f(X,0) = E(y_1 - y_0 | X, d_1 = 1) \quad (6)$$

$E(g(y,d,x)|d_1 = 1) = \frac{1}{p(d_1=1)} E(K.g.x))$ (7)

Where (K = 1 - $\frac{Z}{p((Z-1|X)}(1-d)$) is a weight function that takes the value 1 for a potential participant and a negative value otherwise. The function *f*(*x*,*d*) is called a Local Average Response Function(LARF*)* by Abadie (2003). The LARF $f(\theta; x, d) = E(y|x, d;\ d_1 = 1)$**E(*y* |*x*, *d*; *d1*=1)** is estimated by parameterization. Then, using equation14 with *g*(*y*,*d*, *x*) = $\left(y - f(\theta; x, d)\right)^2$ the parameter $\theta$is estimated by a weighted least squares scheme that minimizes the sample analogue of $E\{K\left(y - f(\theta; x, d)\right)^2\}$. The conditional probability $P(z = 1|x)$ appearing in the weight K is estimated by a probit model in a first stage. Abadie (2003) proves that the resulting estimator of θis consistent and asymptotically normal. Once $\theta$is estimated, equation (13) is used to recover the conditional mean treatment effect$E(y_1 - y_0|x, d_1) = 1$as a function of *x*. The LATE is then obtained by averaging across *x* using equation (7).For example, with a simple linear function $f\ (\theta, d, x) = \alpha + \alpha d + \beta x\ where\ \theta = (\alpha, \alpha, \beta)$; then$(y_1 - y_0|X, d_1 = 1) = \alpha$. In this case, there is no need for averaging to obtain the LATE, which is equal to α. Hence, a simple linear functional form for the LARF with no interaction between *d* and *x*implies a constant treatment effect across the subpopulation of potential participants. In the estimation below, we postulate an exponential conditional mean (outcome) response function with and without interaction to guaranty both the positivity of predicted expenditure and heterogeneity of the treatment effect across the subpopulation of project potential participants. Because of the fact that exposure is a necessary condition for participation, it can be shown that the LATE for the subpopulation of potential participants (i.e. those with$d_1 = 1$) is the same as the LATE for the subpopulation of *actual* participants (i.e. those with $d = zd_1 = 1$)

2.12Theoretical Framework. Theory of Impact Evaluation

Impact evaluation is an assessment of how the intervention being evaluated affects outcomes, whether these effects are intended or unintended. The proper analysis of impact requires a counterfactual of what those outcomes would have been in the absence of the intervention. In most agricultural projects impact analysis, potential

participants are assumed to make decision in their own best interest. Considering adoption from the view point of constrains optimisation, rational households are expected to participate if actually a choice can be made that is, if supply exists and credit constraints do not prevent purchasing the technology. The programme is also expected to be profitable or otherwise advantageous. In adoption and agricultural programme models and its resulting outcomes where selection into "treatment'' (participation is made by farmers on the basis of expected profitability of participation by farmers at time t). If we denote the observable variable by the researcher known as (Z_{it}) and that which is not(U_{it}), then, the following rule characterizes participation;

$T_{it}(Z_{it}U_{it}\varepsilon_{it}) = \{1\ if E_{\pi}{}^{*}(Z_{it}U_{it}T_{it} = 1) - E_{\pi}{}^{*}(Z_{it}U_{it}T_{it} = 0) + \varepsilon_0 > 0$…….(8)

Where T is a binary indicator of participation, $E_{\pi}{}^{*}$ is the maximized value of restricted general expected function and ε_{it} is an iid error term when ε_{it} is 0, participation takes place if and only if maximized expected profit with the new technology exceeds maximized expected profit from non-participants. Unless ε_{it} is very important the farmers that are observed adopting are in large part those who expected the technology to be profitable.

The outcome variable (for example, household consumption, poverty status, or productivity) $Y_{it}$is a function of observed variables X_{it}, unobserved variables V_{it}, adoption status T_{it}, and an iid error term μ_{it}.

$Y^{T}{}_{it} = Y^{*}{}_{it}\ [X_{it}, V_{it}, T_{it}(Z_{it}, U_{it}, \varepsilon_{it})\mu_{it}]$……(9)

If technology was randomly assigned, as it would be with a random experiment, then the causal effect of technology/programme on households' wellbeing can be represented as the difference in average wellbeing between participants and non-participants of the technology. A reduced form of the model can be represented as follows:

$Y^{T}{}_{i} = F^{T}(X_i) + \varepsilon^{T}{}_{i} T = 0,1$ ……..…… (10)

$T_i = G(W_i) + \varepsilon_i$……..(11)

whereY^T denotes income of household i that participates in the new technology T. Thus, ${Y^1}_i and {Y^0}_i$ would denote income in household i in case the later participates or does not participate in the new technology respectively. Income depends on a vector of some observed variables X_i and on a vector of unobserved variable ${\varepsilon^T}_i$. $T_i$is a binary variable equal to 1, if household i participates in the programme (and 0, otherwise); W_i is a subset of X_i and includes observed variables influencing the choice to employ a new technology; other unobserved household specific factors are summarized by the random variable ε_i.

In a counterfactual form, the quantity of interest is the average treatment effect, defined by Rosembaum and Rubin (1983) as

$\alpha = E({Y^1}_i - {Y^0}_i)$ ……(12)

A fundamental problem in estimating the causal effect in (12) is that only ${Y^1}_i or {Y^0}_i$ is observed and not both for each household; therefore what we observe can be expressed as:

$T_i = T_i{Y^1}_i + (1 - T_i){Y^0}_i T = 0,1$ ……(13)

The expression for α can then be written as,

$\alpha = P.[E(Y^1|T = 1) – E(E(Y^0|T = 1) + (1\text{-}P).E(Y^1|T = 0) - E(Y^0|T = 1)]$ .....(14)

Where P is the probability of observing a household with T=1 in the sample. Eq (14) implies that the effect of participating in the programme for the whole sample is the weighted average of the effect of programme in the two groups of households.

If technology was randomly assigned to households, we could simply replace the unobserved counterfactuals, $E(Y^1|T = 0)$, with the actual income $E(Y^0|T = 1)$, as the two would be (close to) equal.

2.13 ReviewPoverty Incidence and Intervention of Poverty Programmes in Nigeria.

2.13.1 Pre-democracy era

In Nigeria, the earliest poverty alleviation programme was in 1972 during the GeneralYakubu Gowon's Administration named "National Accelerated Food Production Programme- NAFPP" and the Nigerian Agricultural and Cooperative Bank – NACB". These programmes were entirely devoted to funding agriculture. In 2004, the NAFPP turned out to be a colossal waste and nothing was achieved. Successive governments have tried to address some of these issues (poverty related) through the enunciation of poverty related programmes. Whether these programmes have succeeded in either alleviating poverty or not is a moot point. Suffice it to say however, after these first two was Operation Feed theNation (OFN).

In 1979 the OFN was lunched, the programmed was said to haveexpended a lot of money and efforts in getting ill-prepared University graduates to go to the rural areas to teach the peasant farmers how to farm. The irony of the programme is thatthe theoretical farming graduates were teaching farmers, who makes his/her living on farming; how to farm. The scheme succeeded in creating awareness on food shortages and the need to tackle the problem. The programme had the specific focus of increasing food production.

OFN lasted until 1979untill1983 – 1985 when the back to land programme was introduced. The regime was also noted for "go back to the land" programme, which was a poverty alleviation strategy. Also, Between(1985-1993) poverty alleviation programmes introduced among others include the Peoples bank, which sought to

provide loans to prospective entrepreneurs on soft terms and without stringent requirements of collaterals. It also regulated to an extent the activities of community banksthat also sprouted as adjuncts of the Peoples Bank and as sources of cheap funds for communities and their members. Also, the Directorate of Food Roads andRural Infrastructure (DFFRI) which sought to open up rural areas via construction offeeder roads and provision of basic amenities that would turn them into production centres forthe national economy established. The DFFRI was the most comprehensive programme onthe nation's war against povertyArogundade*et al*., (2003). Considering the truism that rural populations in Nigeria aresignificantly poorer than their urban counterparts, this programme targeted this core group.Its premise was just not to open the rural areas, and the hinterland, which ordinarily would nothave been accessible. It also aimed at promoting rural employment based on the assumptionthat if rural infrastructure, such as electricity, was available in the villages, many welders, forexample, would operate from there, instead of scrambling for spaces in congested urbancentres. On the other hand, DFRRI assumed that if the hinterland was linked by road, farmerswould transport their products to the markets easily and at cheaper rates, thereby reducing thecost of food production as a way out of poverty. Many Nigerians are however agreed thatthis, like other programmes by the regime, were good but their impacts on the populace andpoverty were minimal because of shortcomings in their implementationArogundade*et al*., (2013).

Another programme that tried to head-off the scourge of poverty by targeting theagricultural sector was the Nigerian Agricultural Land development Authority (NALDA).The Authority was intended to reduce the prevalence of subsistence agriculture in the countryand in its place infuse large scale commercial farming by

assisting farmers with inputs anddeveloping land for them to the point of planting, at subsidised rates. While all theseprogrammes collapsed at one point or the other, nonetheless, at least one of theseprogrammes 'the National Directorate of employment'(NDE) – has had some years of staying power up till date. By its mandate, NDE was todesign and implement programmes to combat mass unemployment and articulate policiesaimed at developing work programmes with labour intensive potentials. From its programmesand its staying power, this was a scheme that could be adjudged as one of the most successful ofpoverty alleviation policies. Unemployment was seen as one of the keyissues challenging the agenda of government since it posed a potential danger to the sociopolitical and economic system of the nationArogundade*et al*., (2013).

Until the 1980s, unemployment was not a serious problem in Nigeria. Globaleconomic recession however took its toll on the country, because as that decade progressed,inherent weaknesses were noticed in the nation's economy. The need for the creation of NDEwas traced to the drastic reduction in oil prices and the resultant economic policies at thetime. It is on record that hundreds of thousands of youths benefited from the NDEscheme through its four-pronged approach that includes Vocational Acquisition Training(673,000). However, the drawback on NDE'sschemes was seen in that there was no follow-up programme for beneficiaries. Many of themwho did not utilise the skills acquired; others did not properly invest the loans theyreceived, thus, found themselves in a worse state Arogundade*et al*., (2013).

Between 1993 – 1998 theFamily Economic Advancement Programme (FEAP) was lunched.This period marked Nigeria's relapse into the globalbracket of 25 poorest

nations. Significantly, FEAP existed for about two years (1998 – 2000)during which it received funding to the tune of N7 billion out of which about N3.3 billionwas disbursed as loans to about 21,000 cooperative societies nationwide that were productionoriented. Such projects targeted for assistance included poultry production, garri making,soap making and animal husbandry (Akintola 2001).

2.13.2Thedemocratisationera

By 1979- 1983,the government came up with a project named theGreen Revolution, which also emphasised food production. The objectives of the greenrevolution programme were: reduction in food importation, virile boosting of crops and fibreproduction in the country. Besides, the overall objective was mechanised farming.Meanwhile, various manipulations for selfish gain; particularly with respect to landacquisition, characterised this programme, most especially, by top civil service employees. Arogundade*et al*., (2013) noted that at the end of the programme, by 1983, a colossal amount of money was considered wasted.Taking cognisance of this, the present day democracy, which has its root from May 1999,poverty eradication was set out as one of the cardinal areas of focus, as revealed in theapproved blueprint for the establishment of the National Poverty Eradication Programme(NAPEP) – a central coordination point for all anti-poverty efforts from the local governmentlevel to the national level by which schemes was executed with the sole purpose oferadicating absolute poverty. This was the only government that embarked on eradication; a shift from the traditionalconcept of alleviation. Such schemes already identified include: Youth Empowerment Scheme (YES), Rural Infrastructures Development Scheme (RIDS), Social WelfareServices Scheme (SOWESS) and Natural Resource Development and ConservationScheme (NRDCS).

On the whole, these schemes were designed to spearhead government's questto eradicating absolute poverty – a condition where a person or group of personsare unable to satisfy their most basic requirements for survival in terms of food, clothing,shelter, health, transport, education and recreation – amongst Nigerians. With a take-off grantof N6 billion approved for it in 2001,NAPEP has established structures at all levels nationwide. Under its Capacity Acquisition Programme (CAP), it trained 100,000unemployed youths just as 5,000 others who received training as tailors and fashiondesigners, were resettled. A total of 50,000 unemployed graduates have also benefited fromNAPEP's Mandatory Attachment Programme, which is also an aspect of CAP (NAPEPclaimed).The programme has also established aAgricultural transformationbank of all unemployed youths in all the 36states of the federation and the Federal Capital territory (FCT).About 1.1 million youths haveso far been registered. Such Agricultural transformation could be used in targeting groups in any future povertyalleviation effort. The difference between NAPEP and past poverty reduction agencies is thatit is not a sector project implementation agency but a coordination facility that ensures thatthe core poverty eradication Ministries were effective.

2.14 A Review of Foster, Greer and Thorbecke (FCT) Weighted Poverty Index

This model has been used in several studies on impact of agricultural technologies adoption on poverty status of farming households (Dontsop-Nguezet et al., 2011;Asfawet al., 2010; Omilola, 2009 Mendola, 2007; Rahman, 1999). Usually there are three steps involved in the measurement of poverty. These are choosing a quantitative welfare indicator, choosing a means of discriminating between the poor and non-poor through the use of poverty line and aggregating this information into a poverty

measure for a particular population (Omonona, 2009). The three most widely used measures of income/consumption quantitative poverty analysis are the poverty headcount ratio, the poverty gap, and the squared poverty gap or poverty severity (Omilola, 2009). This is because these three poverty indexes satisfy many of the basic desirable properties of poverty measures, particularly the property of being additively decomposable with population share-weights. These three most widely used poverty indexes are usually expressed as members of a class of measures proposed by Foster, Greer, and Thorbecke (FGT, 1984). The general Foster, Greer and Thorbecke (FGT) poverty index (p_{ai}) can be expressed as:

$$P_{ai} = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-y}{z}\right)a \qquad \text{...............15}$$

Where:

n = number of households in group

q = the number of poor household

z = poverty line

y = the per capita expenditure (PCE) of the i^{th} household,

a = degree of poverty aversion (0, 1 and 2)

Poverty headcount index ($\alpha = 0$)

$$P_0 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-yi}{z}\right)^0 = \frac{q}{n} \qquad \text{...............16}$$

The poverty headcount index 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. The headcount ratio fails to account for the degree

of poverty by ignoring the extent of shortfall of incomes of the poor from the poverty line. For instance, the headcount ratio will be unaffected by a policy that makes the poor even poorer since it is not sensitive to distribution of income among the poor.

Poverty gap index (a = 1)

$$P_1 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-yi}{z}\right)^1 \dots\dots\dots\dots\dots\dots\dots\dots \quad 17$$

The poverty gap index provides information regarding how far 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. The poverty gap measure has an advantage over the headcount ratio in the sense that it will be increased when there is income transfer from poor to non-poor, or from poor to less poor who thereby become non-poor (Omilola, 2009). Although the poverty gap index takes both the incidence and depth of poverty into account, it is insensitive to inequality among the poor.

Poverty squared gap index (a=2)

$$P_2 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-yi}{z}\right)^2 \dots\dots\dots\dots\dots\dots\dots\dots \quad 18$$

The poverty gap index 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. This measure takes into account the incidence of poverty, depth of poverty and the inequality of poverty among the poor. It raises when the number of poor people increases, or when the poor get poorer. Poverty measures takes value between 0 and 1, with numbers close to 0 indicating little poverty and those closer to 1 suggesting high poverty

(Omilola,2009). The poverty line is the line that divides the poor from non-poor using the mean per capita household expenditure (NBS, 2012). One-third of it gives the extream core poor from the rest of the population.

2.15Conceptual Framework for the Study

The sustainable rural likelihood framework (SRLF) as presented in figure (1) was adopted for this study considering the objectives of agricultural transformation. The SRLF is primarily a conceptual framework for analysing the causes of poverty, people's access to resources and their diverse livelihood activities, the relationships at micro, intermediate and macro levels. The framework provides a means of thinking about the interactive influences on livelihood without overlooking the important explanatory factors (Ashley and Carney, 1999). Farmers are endowed with both natural and manmade asset resources in their farming environments. Their access to the available resources is constrained by many factors which consequently limits their livelihood outcomes under the natural state. Research and development institutions help to identify and develop programmes and technologies capable of helping the farmer's access livelihood resources at their disposal as well as provide better options of exploiting the resources with minimum damage to their environment, and enhance their productivity and output thereby bettering their livelihood outcomes.

Agricultural transformation programme has sharpened policies, institutions and processes that have direct effect of strengthening investment and agricultural production decision. This is expected to consequently impacts on farmers' consumption and market participation choices and eventually betters their livelihood outcomes. Livelihood outcome of interest in this study includes increased income, improved food, improved

productivity and sustainable use of resources and increased commercialization of produce.

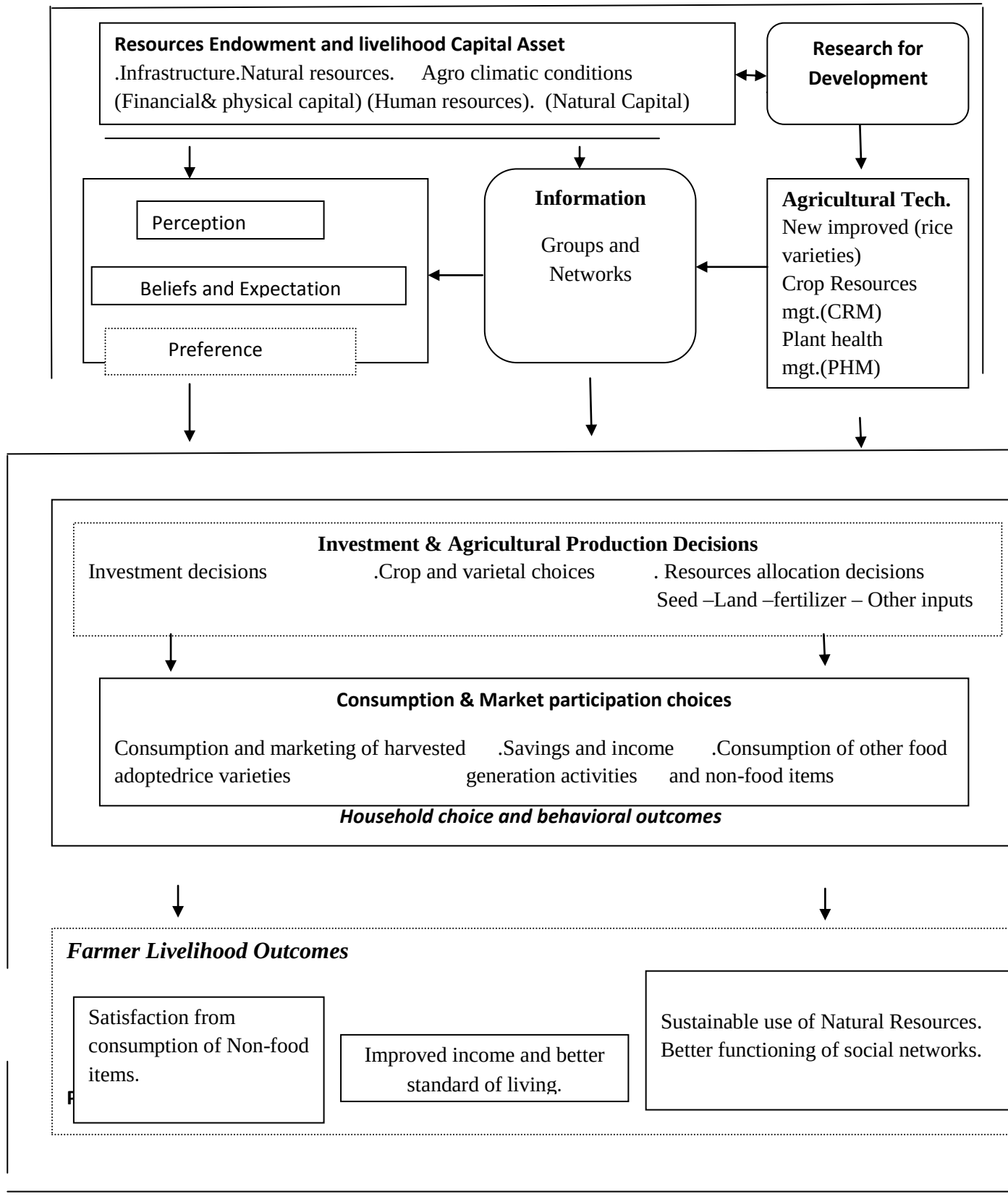

Figure 1 Agricultural Household Impact and Outcome pathwaySource: Asfaw et al., 2011

CHAPTER THREE

3.0 METHODOLOGY

3.1Study Area.

The study was carried out in Kano state. Kano state is located in north western Nigeria. It occupies an area approximately 20,131km^2. It is located on latitude 11^0 30^1N and longitude 8^0 30^1E with an average altitude of 484m above sea level,the state has a population of totaling 9,383,628 according to 2006 National Population Census (NPC, 2006). Kano statebordersKatsina State to the north-west and Jigawa state to the north-east, (figure 3.1). Farming is the main occupation of the people and it is characterized predominantly by mixed cropping. Kano state features savanna vegetation with a semi-arid climate. It witnesses an average precipitation of about 690mm per year, the bulk of which falls from June to September. The state is typically hot throughout the year, though noticeably cool from December February. The annual temperature ranges between 19.06^{0}c to 33.19^{0}c. It has a well drained ferruginous soil.

Subsistence and commercial agriculture is mostly practiced in the state. Among the food crops cultivated are millet, cowpeas, sorghum, maize and rice for local consumption while groundnuts and cotton are produced for export and industrial purposes.Presently, rice is particularly important to the economic activities in the study area, both upland and low land rice is cropped in the study area because of the availability of tube wells and the Hedejia-Jama'a irrigation scheme lying on both sides of Zaria Kano-Rano roads. The scheme was originally started by Kano state government, it is one of the largest irrigation scheme in West Africa (Sangari,2006). During the colonial period and several years after the country's independence, the groundnuts produced in the state constituted one of the major sources of revenue for the

country. Kano State is a major producer of hides and skins, it is also a major producer of sesame, soybean, cotton, garlic, gum Arabic and chili pepper.

Figure 3.1: Map of Nigeria showing Kano State

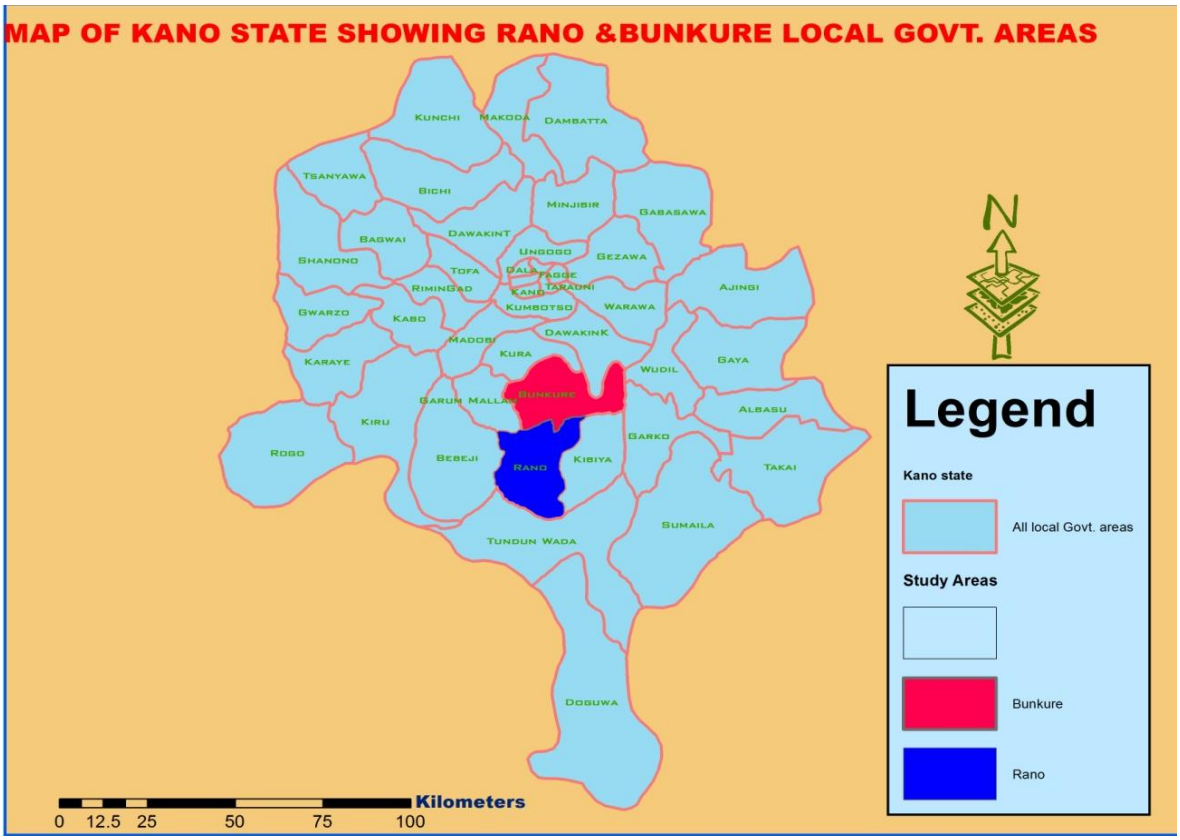

Figure 3.2: Map of Kano State showing Bunkure and Rano Local Government Areas

3.2. Sampling Technique.

Multi-stage sampling technique was employed to select the respondents for this study. The first stage involved random selection of two local governments from the three local governments that participated in agricultural transformation programme in the state. This was followed by purposive selection of seven villages from the local government areas. The selection of the villages was due to the implementation of agricultural transformation programmes and intensity of rice farming activities in the areas.Next, was the random selection of the respondents as presented in table 3.1 below.

Table 3.1: Description of sampled farmers according to villages

L.G.A	Village	Participants	Non-Participants
Rano	Rano	32	57
	Rarun	30	43
	Kaurara	25	45
	Kazaurarawa	23	56
Bunkure	Bunkure	35	61
	Kuruma	35	48
	Shiye	21	60
Total		**201**	**370**

Source: Field survey, 2015.

Method of data collection

Primary data was used for the study. This was obtained by administering structured questionnaire to participants and non-participants rice farming households in the study area by trained enumerators. A total of 571 farmers were used for the study consisting of 201 and 370 participants and non-participants. Data were collected on socio-economic variables (age, educational level, farm size, farming experience, and non-

farming activities of the respondents). Information's was also collected on the input-output level, income and expenditure of the respondents.

3.3 Analytical Technique

Descriptive statistics (including frequencies and percentages) and inferential statistics (Z-test, t-stat). Foster-Greer-Thorbecke (1984) class of poverty measures was employed to determine the poverty status of the respondents. Craggs Model was used to examine participation determinants and thelevel of participation in the programm. Propensity score matching and the LATE model were used to determine the project impact on the farmers' productivity and welfare.

3.3.1 Determinants of participation decisionand input use intensity

3.3.2The Cragg's model

The double-hurdle model is a parametric generalization of the Tobit model, in which two separate stochastic processes determine the decision to participate and the intensity of participation in the project. In the model, both hurdles have equations associated with them, incorporating the effects of farmer's characteristics and circumstances. Such explanatory variables may appear in both equations or in one. Most importantly, a variable appearing in both equations may have opposite effects in the two equations. The double-hurdle model has an adoption (D) equation as specified below:

$$\begin{cases} D_i = 1 \; if D_i^* > 0 \; and \; 0 \; if D_i^* \\ \qquad D_i = \alpha' Z_i + U_i \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (19)$$

Where D is a latent variable which takes the value 1 if the farmer participates in the programme and zero otherwise. Z is a vector of household characteristics and α is a vector of parameters and an intensity equation defined by:

$$\begin{cases} Y_i = Y_i^* if Y_i^* > 0 \; and D_i^* > 0 \\ \qquad Y_i = 0 \; otherwise \\ \qquad Y_i^* = \beta' X_i + V_i \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (20)$$

Where $Y_i$the observed intensity of participation is given by:

$$Y_{i} = \sum(\frac{AT_i}{RT_i})/S_i \quad \text{..... (21)}$$

whereY_i is participation index of ith farmer, AT_i is the level or quantity of input the farmer actually applied, , RT_i is the exposure or quantity of an input he ought to apply, and S_i is the proportion of score attributable to a particular input (as given by percentage for each innovation).

$X_i$is a vector of the individual's characteristics and β is a vector of parameters.

X_1 = Farm size devoted to Rice production (ha).

X_2= Age of household head (years)

X_3= Gender

X_4= household size

X_5= Level of Education (years)

X_6 = Own radio or TV set or mobile phone (yes = 1)

X_7 = Own Oxen for transportation/ traction (yes =1)

X_8 = Number of improved varieties known in previous cropping year

X_9 = Member of cooperative (yes =1)

X_{10} = Member of farmers association (yes= 1)

X_{11} = Contact with government extension agent

X_{12} = Access to credit (D=1 for access, 0 otherwise)

X_{14} = Experience in farmer-farmer seed exchange (yes = 1)

X_{15} = Farmers' perception of the varieties (ranked above average = 1)

X16= Access to fertilizer (yes =1)

X17= Market distance (Km)

The log-likelihood function for the double-hurdle model is given by

$$\log L = \sum_0 \ell_n [\, 1 - \Phi\left(\alpha Z_i'\right)\left(\frac{X_i'\beta}{\sigma}\right)] \; +$$

$$\sum_0 \ell_n [\Phi\left(\alpha Z_i'\right)\frac{1}{\sigma}\phi\,(\frac{Y_i - X_i'\beta}{\sigma})] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (22)$$

3.3.3 Determination of productivity index model

Key and Mcbride (2003) approach to the determination of total factor productivity was adopted to evaluate the impact of the programme on the farmers. This is expressed as:

$$TFP_i = Y_i \,/\, \sum P_i X_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (23)$$

Where,

TFP_i = Index of total factor productivity for ith farmer).

Y_i = Quantity of rice produced (Kg) by ith farmer.

P_i = Unit price of ith variable input (₦)

X_i = Quantity of ith variable input used.

$\sum$ = Summation

Where X_i includes the following,

X_i = Quantity of Rice seeds used (Kg)

X_{18} = Quantity of fertilizer (Kg)

X_{19} = Quantity of herbicides (liters)

X_{20} = Quantity of Labour input (man-days)

3.3.4Poverty Measure

The FGT (Foster-Greer-Thorbecke 1984) class of poverty measures was be used since it is decomposable across subgroups such as participants and non-participants. The FGT class of poverty measure is given generally as:

$$P_{\propto} = \frac{1}{n}\sum_{1=1}^{n}\left[\frac{z-y_i}{z}\right]^{\propto} \quad \text{.....(24)}$$

where $n$is the total number of individuals in the population, $z$is the poverty line y_i is he value of per capita income of the ith person, and α is the poverty aversion parameter. When $\alpha = 0$, $P_\alpha$is simply the head count ratio, the proportion of people at and below the poverty line. When $\alpha = 1$, $P_1$is the poverty gap index (or depth of the poverty), defined by the mean distance to the poverty line, where the mean is formed over the entire population with the non-poor counted as having a zero poverty gap. When $\alpha = 2$, P_3(the squared poverty gap) is called the severity of poverty index because it is sensitive to inequality among the poor.

3.3.5The Local Average Treatment Effect Estimation (LATE)

The LATE model was also used to achieve objective 4 and 5. Being a combination of methods, it addressed the problem of overt, hidden and non compliance bias. The implicit form of the model is represented as shown below;

$$Y_{iLATE} = f(participation\ status, S_i, V_i, Z_i) \text{.....(25)}$$

Where Y_{iLATE} is the ith outcome component, (Productivity and Poverty status) participation status of respondents

S_i = vector of covariates for propensity score model

V_i = vector of covariates for Instrumental model

Z_i = vector of covariates for impacted outcome model (LARF)

Covariates for the propensity score model.

X_{21} = Years of formal education (years)

X_{22} = Vocational training (yes = 1, 0 otherwise)

X_{23} = Migrant status of household head (yes 1, 0 otherwise)

X_{24} = Years of experience of household head (years)

X_{25} = Household size

Covariates for impacted outcome (Poverty status and income)

X_{26} = Age of household head (years)

X_{27} = Gender of Household head (Male 1, 0 otherwise)

X_{28} = Level of Education (years)

X_{29} = Number of years of experience in rice farming

X_{30} = Household size.

Covariates for poverty impact assessment

X_{31} = Farm size (ha)

X_{32} = Family size

X_{32} = Gender of household head (Male =1)

X_{33} = Consumption expenditure (₦)

X_{34} = Off-farm income (₦)

X_{35} = Livestock income (₦)

X_{36}= Total rent from land (₦)

X_{37} = Distance to nearest agricultural office (Km)

X_{38} = distance to the main market (km)

X_{39} = Membership of cooperative or community group

X_{40} = Access to credit ((D=1 if yes, 0 if otherwise)

X_{41} = Access to seed ((D=1 if yes, 0 if otherwise)

X_{42} = Access to media ((D=1 if yes, 0 if otherwise

Covariates for the Instrument model

X_{43} = Years of formal Education (years)

X_{44} = Number of years spent in traditional variety of rice cultivation

X_{45} = Household location (1 if urban,0 otherwise)

X_{46} = Number of years resident in the village/town (years)

X_{47} = Household size

X_{48} = Farmers nativity (dummy 1 if yes, 0 otherwise)

X_{49} = Primary occupation (dummy 1 if farming, 0 otherwise)

X_{50} = Age of household head (years)

X_{51} = Number of improved and local varieties known

Definitions and apriori signs of the included variable

Marital status of household head (D = 1 if married, 0 if otherwise)

Household type (D =l if monogamous, 0 if otherwise)

Gender of household head (D=l if male, 0 if otherwise)

Age of the household head in years. It is hypothesized as inversely related to participationdecisions.**Age of household head square** to capture the life cycle of household welfare.

Farm size. The total area of farm land cultivated by household head in the 'previous' season in hectares (2.471) acre= 1 hectares), hypothesized as positively related to participation.

Rice farming experience: Number of years the household head had spent as a rice farmer, hypothesized as positively related to participation decisions.

Dependency Ratio: This will be expressed as a ratio of the dependants' to the working household members.This is hypothesized as inversely related to household participation decision because the higher the dependency ratio the less likely the household head will

want to devote resources to new discoveries as he is expected to be pre-occupied by how to meet the immediate needs of the home.

Primary occupation of household head (D=l if farming, 0 if otherwise)

It is expected that the more commercialized and market-driven the crop is, the more will the farmer's need to grow it for cash purposes. It is hypothesized as directly related to adoption decisions.

Yield: Refers to physical yield of rice (tons/ha), hypothesized as positively related to household participation decisions.

Market distance: distance (km) to the nearest major grains market, an index for market access is hypotheised as inversely related to adoption decisions.

Transport cost: Transport cost (₦) to the nearest main city, source of seed, hypothesized as inversely related to participation decisions.

Extension contact: Exposure of household head to extension services, on farm trials, workshops on improved sorghum (dummy; 1= expose, 0; otherwise) hypothesized as positively related to participation decision.

Credit: Households heads access to credit facilities (dummy 1= access, 0; otherwise)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents the results of the study and the relevant discussions. It includes socioeconomic and farm characteristics, factors that influenced participation and the level of use of the package of practices in the project, impact of the project on the farmers' productivity, expenditure, and income and poverty status.

4.1. Socio-Economic Characteristics of the Farmers

4.1.1 Age of Household Head

Table 1 presents the age distribution of the respondents; the result revealed that the mean age of the sampled respondents was 41.2 year. About 8.75% of the participants were less than 30 years old however, most (46.77%) were aged between 30 – 40 years. Also the age distributions of the non participants follow the same trend, an average farmer among the non-participant falls within the range of 31-50 years. Age is hypothesized to assume a quadratic function in farming activities, most times, very young famers are considered immature to be able to undertake larger scale farming, on the other hand, very old farmers (who might have out grown their economically active age) will find it difficult to undertake rigorous farming activities. Nnadi and Akwiwu (2008), Muhammad-Lawal*et al.* (2009) similar studies found age to influence participation in Youth in agricultural on-farm or off-farm activities. Based on the age distribution obtained in this study, it can be asserted that the rice farming population is economically active and agriculturally viable.

However, the role of age in explaining participation in agricultural projects is somewhat controversial inthe literature. Older people are sometimes thought to be less amenable to change andhence reluctant to change their old ways of doing things. In this case, age

Table 4.1. Distribution of respondents according to Socio-economic characteristics

Variables	Participants frequency	Percentage (%)	Non-Participants Frequency	Percentage (%)
AGE				
< 30	18	8.75	41	11.08
30-50	94	46.77	182	49.19
41-50	69	34.33	106	28.65
> 51	20	9.95	41	11.08
Mean	41.9		40.5	
Gender				
Male	155	77.11	289	78.10
Female	46	22.89	81	21.89
Educational Status				
No formal Education	48	23.88	88	28.71
Quranic	54	26	91	24.59
Primary	61	30.34	84	22.27
Secondary	28	13.93	66	17.85
Tatiary	10	2.48	41	11.08
Family Size				
< 5	20	9.95	84	22.70
5-10	105	52.23	188	50.81
11-15	46	22.88	56	15.13
> 16	30	14.93	42	11.35
Mean	10		9	
Farming Experience				
< 5	41	20.40	16	4.32
6-10	33	16.42	79	21.35
11-15	43	21.39	59	15.96
16-20	43	21.39	87	23.51
>21	50	24.88	129	34.86
Mean	15		17	
Rice Farming experience				
< 5	37	18.41	95	25.67
6-10	102	50.7	159	42.97
11-15	32	15.9	52	14.05
16-20	22	10.95	44	11.89
>21	8	3.98	20	5.45
Mean	9.6		9.5	
Total	**201**	**100**	**370**	**100**

Source: Field Survey, 2015

will have a negative effect on participation. On the other hand, older people may have higheraccumulated capital, more contacts with extension, better preferred by credit institutions,larger family sizes, etc all of which may make them more prepared to

participate in a technologythan younger ones. Whatever the condition, age is an important factor thatwould help explain participation in new projects.

4.1.2. Sex of Household Head

As presented in Table 1, the data revealed that for both participants and non-participants, males constitute more than 70% of the respondents implying that women constitute about 30% of the rice farming population. Gender of farmersoften affects their decision to participatein projects. In the past, in most parts of the developing world including Nigeria, most extension workers aremen and are usually biased towards men in their extension activities. In recent times however as the relative benefits to be gained in redirecting extension efforts by gender is been realized this bias has been corrected and women are involved in extension activities. Women play a significant role in agriculture especially widows.

4.1.3. Status of Education of Household Head

Table 1 shows the structure of education of the households head educational status. The study shows that a good number of the participants 48 (23.88%) and 88 (28.71%) had no formal education. Although, about 46% of the participants had primary and secondary education, only about 2.5% and 11.08 of the participants and non-participants respectively had tertiary education. Education is believed to increase the adoption or participation in innovative projects and new programmes. It is also believed to improve household per capita income.(Sanchez, 2005; Nnadi and Akwiwu, 2008).Aikaeli (2010) posits that investment in education is income improving. It is measured as the number of years spent in formal schooling/education (in years) This assertion conforms to similar studies by Nnadi and Akwiwu (2008), Muhammad-Lawal*et al.,* (2009).

4.1.4. Household Size

Table 1 shows that the respondents have an average household size of about 10 individuals, about 105 (52.23%) of the participants have household sizes ranging between 5-10 persons. Forty seven 47 (22%) of the respondents had 11-15 family members. Families with larger household sizes are likely to have greater responsibilities of meeting the family's income and social needs but large families to a rice farmer may be considered an incentive because of labour requirement. This finding imply that for both participants and non-participants in the study area, more than 90% of the farming households were made up of large families This is consistent with similar studies by Muhammad-Lawal*et al.* (2009), Aikaeli (2010) and Abdul-Hakim and Che-Mat (2011).

4.1.5. Farming Experience of Household Head

The results presented in table 1 revealed that the sampled farmers had an average of 16 years of farming experience. That majority (24.88%) of the participants in the project had over 20 years of farming experience, also about (42.79 %) of the participants had between 6-20 years of farming experience while majority the non participants (64.18 %) had over 20 years of farming experience. Furthermore, about 37% of the participants had acquired less than 10years of farming experience.

While farming experience helps a farmer to gain enough knowledge and expertise in undertaking certain farming activities, it takes quite a long period of farming to be able to gather this experience. Changes in climatic and weather conditions such as rainfall and temperature patterns take several years (sometimes up to thirty years) to occur. In this regard, very experience farmers are assumed to be above thirty-five (35) years of age. Invariably, the effect of longyears of experience in farming or main decision making is that with increased farming experience, farmers are generally better able to

assess the relevance of new projects and programmes. This ultimately informs their decision to participate or nt as they their interactions with their neighbors and the outside world. Also,experienced farmers, tend to be better placed in a position to accumulate skills needed for use in new innovation and projects compared with younger ones. Also farmers who have acquired some knowledge in school put this knowledge into practice when they go into farming. Hence the effect of farm experience will depend on the individual farmer and the kind of knowledge and experience he/she has acquired over the years.

4.1.6. Rice Farming Experience of Household Head

Table 1 presents the distributions of the sampled farmers according to their years of experience in farming.The data shows that the respondents have a mean of about 9.5 years of rice farming experience. About (50.7 %) of the participants in the project had between 6-10 years of rice farming experience, this constitute about 102 participants. About 42.97% of the non-participants had been into rice farming for about 6-10 years. The study also revealed that more than 60 % of the non- participants had more than 6years of rice farming experience. This can be considered as advantage to the respondents in terms of having prerequisite knowledge in farming. It is important to note that long years of general farming experience is not the same as experience acquired through the years in rice farming. While farming experience helps a farmer to gain enough knowledge and expertise in undertaking certain farming activities, it takes quite a long period of farming to gather this experience'' However, when a respondent has been involved in cropping rice year in year out over a long period of time, this could add to his understanding ability when introduced to new programmes that has to do with rice farming.

4.2 Factors Affecting farmers' participation in Rice Farming transformation Project and the Intensity of use of package of Practices.

The parameter estimates of the models employed to identifyfactors influencing farmers' participationdecision in the project are presented in Table2. The likelihood ratio test statistics suggest the statistical significance of thefitted regression. Results of the analyses also indicate that rate of participation and intensity of use of package of practices were influenced by different factors which includes farm size, gender, level of education, household size, ownership of assets such as radio/ television sets and phones. Other variables includes, ownership of Oxen/bull, extension contacts and market distance.

4.2.1 Farm size

Farm size influenced positively the probability of participation in the project at 5%probability also; it positively influenced the intensity of using of package of practices at 5% probabilitylevel. This implies that farm size is an indicator of wealth and a proxy for social status andinfluence within the study area. The result is similar with the finding of Teklewold*et,al* (2006).

4.2.2 Age

Age of the farm household head was positively related to the probability of participating in Agricultural transformation project at 10 percent probability level. The justification for this is that olderfarmers might have gained knowledge. The result is consistent with the findings of Teklewold*et,al*(2006) and Hassen (2013). The result indicates that as the age of the household increases head by one year, theprobability of participation in agricultural transformation increases by 0.17 percent. Also the intensity of use of package of practice in the project increases by 2 percent.

Table 4.2.Determinants of Farmers Participation decision and Intensity of use.

	Decision to participate			**level of use of package of practices**		
Variables	**Coeff**	**Robust std. Error**	**Marginal effect**	**Coeff**	**Robust Std. Error**	**Marginal effect.**
Constant	-0981	1.0132		3.43	6.34	
Farm size	0.71*	0.324	0.0668	4.70***	1.50	.76
Age	0.019	0.014	0.0017	0.03	0.065	0.02
Gender	0.386**	0.423	0.0440	0.03	0.07	0.01
Level of Education	0.018	0.039	0.0016	-0.15	0.76	-0.12
Household size	-0.166	0.219	-0.0169	-3.41***	0.86	-2.38
Comunication Asset	0.127*	0.138	0.122	2.13**	0.68	1.61
Own oxen	0.19**	0.075	0.0203	-0.33	0.32	-0.42
Knowledge of improved variety	0.35	0.266	0.0336	0.61	2.56	4.02
Extension agent	0.734**	0.290	0.0772	3.22	2.52	2.29
Credit access	0.462	0.275	0.0617	-1.15	1.33	0.82
Seed recycle						
Experience seed exchange	-0.008	0.003	-0.0008	-0.01	0.02	0.003
Market distance	0.02***	0.012	.0.0662	-0.2	0.01	0.01
Fertilizer access	-0.011	0.005	-0.0012	-0.01	0.02	-0.008
Landowner	-0.001	0.05	-0.0001	.21	0.28	0.151
Chi square	53.56***					147.34***
Log-likelihood	-63					-52

*Source Field survey 2015. Significant *at 10%, probability level*

4.2.3 Household size.

Household size negatively influenced participation in agricultural transformation Aikaieli J., (2010) Determinants of rural income in Tanzania; An Empirical Approach. Research Report 104, REPOAproject at 10 % probability level with a marginal effect of 1 percent implying that higher household size reduces participation by one percent. Furthermore, the intensity of participation is consequently reduced by 3 percent This

finding may be explained by the fact that farmers with larger households may require more expenditure to keep their households hence little is probably left to try new programmes. The negative and significant effect of household size on intensity of use might also be related more to the land allocated for other food crops to which the farmer is sure to keep food requirement of the household member than putting much resources into new programs.

4.2.4 Asset /radio/Television/Phone

Ownership of asset such as radio, television, radio or phone positively influenced participation at 1 percent and the intensity of useof package of practice at 5 percent probability level with a marginal effect of about 12 and 16.1 percent respectively. The probable reason for this finding is that improved practices are information sensitive and hence the household with ready sources of information uses the technologies ontheir farm plots more than others. This result implies that an average respondents' decision to participate was greatly influenced by access to communication assets. Similar results were found for other technologies Hailu (2006).

4.2.5. Own Livestock.

Livestock is considered as an asset that could be used either in the production process or in exchange. This variable was found to have impacted positively on the decision to participate in agricultural transformation program in the study area at 5% level of probability and with a marginal effect of 2%. This shows that ownership of Oxen/bulls in the study area increases the probability of participation by 2%. This is because these animals are not only used for traction purposes but also to transport the farm produce.

Abay and Assefa (2004) found similar signs for other technologies in studies carried out in Ethiopia.

4.2.6 Agricultural Extension

Access to extensionservices had the expected positive (0.734) and significant at 5% level of probability participation decision in transformation programme probably due to access to information from the agents. Similar signs found for other technologiesTeklewold*et,al* (2006).Agricultural extension services are the major sources of information for farmersto be familiar with improved agricultural technologies. Farmers can get access to informationabout new technologies through contacting agricultural development project/programme agent (ADP).

4.2.7 Market Access

The coefficient (0.02) of distance to allweather roads and markets was significant at 1%, had the expected positive signand was significant at 1% level for participationbut not for intensity of use of package of practice. Access to market is one other important variable for the adoption of improved technologies.This is due to the fact that a relatively closer distance of farmers' home to the marketenables and facilitates marketing of inputs and outputs. Proximity of farmers toall weather roads and markets are essential for timely input delivery and output disposal andresults in less transport cost of inputs and outputs.

4.3. Poverty Status of Rice Farmers in the Study Area.

The results of the poverty status of the respondents were presented in table 3. The World Bank standard of daily income of $1.95/day (₦378.14/day) was adopted for the study. Empirical findings from the study show that about 48.62% constituting about 274 sampled farmers spends less than (₦378.14/day). This imply that a sizable number of the farmers were not able to meet up with the daily minimum standard requirements for living. Furthermore, the poverty gap index (PGI) which define the average short fall in income measure i.e the severity of the poverty (P1) among the poor sub population was found to be 0.27878 (27.8%).This imply that it will require about 99.36/day per famer to come up to the poverty line. Also, the depth of poverty (0.2347) obtained revealed that an addition₦143.7 will be needed to take an average poor farmer out of poverty.

Table 4.3 Respondents distribution according to poverty status

Class	Frequency	Percentage (%)
1-50	58	10.15
51-100	52	9.10
101-150	71	12.43
151-200	40	7.00
201-250	61	10.68
251-300	54	9.45
301-350	74	12.95
351-400	43	7.53
451-500	48	8.41
501-550	44	7.71
551-600	26	4.55
Total		
Poverty index based on 378.14/day		
Number of poor	278	48.64%
Total number of respondents	571	
Poverty incidence (Po)	0.4864	
Poverty Severity (P1)	0.2788	₦99.36
Poverty Depth (P2)	0.2347	₦143.67

Source Field survey 2015

4.4. Effect of Agricultural Transformation Participation on Rice Participants' Impacted Outcomes.

Table 4 presents the descriptive analysis of the impact of agricultural transformation project on income from rice production, income from other crops, total agricultural expenditure, per capita consumption expenditure, and the incidence of poverty among the farmers. The average participant was better-off in terms of household income. For instance, the participants had a significantly higher income from both the production of rice and other crops than the non-participants; consequently the participants were also able to spend more (₦98324.60) on agricultural production than the non-participants (₦85800.90).

The Per capita expenditure was used to examine the impact of the project on therespondent's welfare because it reflects the effective consumption of households and therefore provides information on the food security status of households. Therefore, a comparison was made between the consumption expenditure of participants and non-participants. The result revealed that the consumption expenditure of the participants (₦11321.4) was higher than that of the non-participants (₦ 9980.60). This implies that the participants had a better welfare than the non-participants.

Analysis of the incidence of poverty showed that about 48% of the farmers were poor. The incidence of analysis of the incidence of poverty showed that about 48% of the farmers were poor. The incidence of poverty was however higher among the non-participants (52%) than the participants (46%). These results are consistent with other related studies on the impact of agricultural technologies on poverty (Mendola, 2007; Diagne*et.al*. 2009; Javier, *et.al*. 2010). With this revelations it appears the

participantswere better-off than the non- participants. However, theses comparisons did not account for the effects of other characteristics of the farmers that could influence these outcomes. Hence, these observed differences cannot be attributed entirely to the project due to the problem of selection bias and non-compliance and thus have a causal interpretation (Heckman and Vytlacil, 2005; Imbens and Angrist, 1994). Therefore, other statistical methods were employed to assess the impact of agricultural transformation on rice productivity and welfare.

Table 4.4:Effect of the participationon .

Variable	Pooled	Participants	Non participants	Mean Difference
Income from rice production	18246.30	103475.43	97404	6071.43***
Income from other crops	94359.55	102443.67	98732.78	3710.89
Non- Agricultural Income	96123.30	82432.40	85560.32	3127.92
Total agricultural expenditure	85800.90	98324.60	86413.20	11911.4***
Per Capita Consumption expenditure	10554.20	11321.40	9980.60	1340.8
Average farm size	0.96	1.18	1.05	0.13^{NS}
% of Poor households	48.00	47.00	52.00	5.00

Source: Field Survey, 2015
NS = Not significant*** = Significant at 1% level of probability

4.5Effectof Project on rice farmers' productivity

Due to the problem of selection bias and particularly non-compliance or problem of endogeneitythis study employed a combination of methods to assess the effects. The effect of agricultural transformation on rice productivity and welfare was estimated using the Local Average Treatment Effect (LATE) model. Meanwhile, for the purpose of comparison, model based on other techniques such as the Average Treatment Effect (ATE) using Inverse Propensity Score Weighting (IPSW) techniques was estimated.

The LATE estimate was carried out for each of the two outcomes of interest (rice productivity and welfare) using the two different estimation methods proposed by Imbens and Angrist (1994) and Abadie (2003). The LARF estimation that is required in Abadie's method used as explanatory variables in addition to the participation status, a set of other household characteristics to account for heterogeneity in the impact. The LARF was also estimated using the weighted least squares procedure, in order to avoid outcome in the predictions Abadie, (2003).

The result of the impact of the project is presented in Table 5. The result of the mean difference showed that there was a significant difference of 127.69kg/ha in rice productivity between the participants and non-participants. The Average Treatment Effect (ATE) in the entire population was 259.53kg/ha the ATT on the sub-population of participants was 289.22kg/ha. The estimated ATE0 implies that the participants had an increase of 222.98kg/ha in rice productivity. Precisely, the LATE estimates suggested that participation in agricultural transformation project significantly increase rice productivity by 347.60kg/ha. This could be interpreted as the change in rice productivity that is attributed to the project. Furthermore, the impact was also higher among the poor farming households (660.82kg/ha) than the non-poor farming households (470.66kg/ha). This implies that participation in agricultural transformationimpacted more on the life of the poor.

Table 4.5 Effect of participation on Participants productivity.

Estimation	Parameter	Robust standard error	Z-Value
Estimation by mean Difference			
Observed Difference	127.69**	29.19	2.76
Participants	286.45***	72.76	10.94
Non-participants	158.76***	56.50	5.81
Inverse Propensity Score			
Weighting Estimation			
ATE	259.53**	120.00	3.89
ATE1	289.22**	125.30	5.69
ATE0	222.98**	102,40	4.18
Local Average Treatment Effect			
Estimation			
LATE by WALD estimators	206.78**	115.02	2.80
LATE by LARF	347.60***	134.43	6.58
Impact by Poverty Status			
Poor	660.82***	191.00	5.84
Non-poor	470.78***	213.68	3.89

Legend: Significant level **p<0.05, * p<0.10, *** p<0.01. Source: Field survey, 2015

4.6Effect of theProject on Total Household Expenditure

The quantitativeoutcomes of the impact of agricultural transformation on welfare proxy by total household expenditure are presented in Table 6. The agricultural transformation revealed that agricultural transformationparticipation exerted a positive and significant impact on household expenditure in the study area. Precisely, the LATE estimate showed that participation in agricultural transformation significantly increased the total household expenditure by ₦34780.40. This represents the average change in total household expenditure brought about by the project. Also, comparison by poverty status further revealed that the impact was pro-poor in nature as it had a significant higher impact on the poor farming households (₦13498.52) than the non-poor (₦21460.50). The ATE estimates also showed a positive impact just like the LATE estimates. However, the ATE estimates of the impact of improved rice varieties adoption on rice productivity and welfare do not have a causal interpretation due to the problem of non-compliance.

Agricultural transformation was also pro-poor in nature as it had a higher positive impact on the poor households than the non-poor households in all the outcome s of interest considered in this study. It can be concluded that, the project can lead to the much desired increase in productivity, ensure national and households' food security. It can also be away out of the menace of rural poverty in Nigeria with proper and consistent implementation. Based on the findings from the study, access to communication gadgets such as Television set, telephone and radio as well as extension agents and availability of market for the produce was major determinants of participation in the project Also decision on package of practice use intensity was significantly influenced by farm size, family size and awareness. It is therefore important to note that to achieve Nigeria's goal of self-sufficiency in rice production

could be achieved through properly organized implementation of projects with particular attention to information and good extension services.

Table 4.6: Effect of the Project on Total Household Expenditure

Estimation	**Parameter**	**Robust standard error**	**Z-Value**
Observed Difference	18909***	3840.26	6.40
Participants	105123***	3521.39	5.23
Non-participants	86214***	a2848.62	9.87
Inverse Propensity Score			
Weighting Estimation			
ATE	36523**	233.46	2.67
ATE1	9123***	168.76	3.45
ATE0	6732.60**	145.87	2.58
LATE by WALD estimator	28320.56**	1123.14	2.74
LATE by LARF	34780.40***	3945.20	9.78
Impact by Poverty Status			
Poor	13498.52***	1372.14	4.8
Non-poor	21460.50***	6754.26	3.98

Source: Field survey 2015. Legend: * significant at 10%; *

CHAPTER FIVE

SUMMARY, CONCLUSION,CONTRIBUTION TO KNOWLEGDE ANDRECOMMENDATIONS

5.1 Summary

The study assessed the effect of agricultural transformation programme on the productivity and poverty status of rice farmers in Kano state Nigeria. Primary data were obtained through the use of well structured questionnaire administered to 571 rice based farming households. The data were analysed using descriptive statistics, inferential statistics, Craggs model, Fosrter Greer- Thobek's (FGT) weighted poverty index and LATE models.

The results show that a number of socio-economic characteristics impacted positively on the farmer's decision to participate in the project. Farm size (0.71), communication asset(0.127) impacted farmers decision positively at 10% level of significance. Sex (0.386), ownership of Oxen (0.19) and extension contact (0.734) influenced participation decision at 5% level. Also, level of education (0.018) and market distance (0.02) had positive effect on participation at 1% level. Furthermore, only farm size (4.70) and asset (2.13) jointly had positive significant effect on participation and level of use intensity. Although household size (2.13) has positive effect on participation, the effect on the use intensity was found to be negative at 5% level of probability.

The analysis of socio-economic characteristics of the farmers revealed that, the average age of the sampled farmers was about 39.6years. The respondents (70%) were mostly males. About 48% of the respondents had no formal education. An average farmer in the study area has rice farm size of about (0.91ha) and (0.99ha) for participants and non-participants respectively. Over 50% participants have been cultivating rice for between 6-10 years. The poverty status obtained from the study revealed that about 274

(48.64%) respondents were poor. The severity and depth of poverty were found to be (0.27878) and (0.2347) respectively. This means that it will require about ₦99.36 to move farmers under this category out of poverty. It will also require about ₦143.67 to move the poor in these area out of deep poverty. The impact of agricultural transformation program on impacted outcomes shows that although there was no statistical significant difference between the area cultivated by the participant and non-participants, the participants were better off in terms of income. The estimated income from rice of participants (₦103475.43) was statistically different from that of the non-participants (₦9704). The program also impacted positively on the respondent's welfare (table 4.6) revealed a consumption expenditure of (₦105123) and (₦86214) for the participants and non-participants respectively.

On the productivity, a significant mean difference of about (127kg/ha) was recorded between the participants and non-participants. Moreover, an average treatment effect of about 287.22 and 222.98kg/ha was obtained. This impact was also higher among the poor (660kg/ha) than the non-poor (470.66kg/ha). The program exerted a significant positive effect on the participant's total household expenditure with an observed difference of about (₦18909). The LATE estimate shows that participants in the program were able to increase their household total expenditure by ₦34780.

5.2. Conclusion

The study concludes the project is pro poor with an effect of 660.82kg/ha on the poor poverty status compared to the non-poor (470kg/ha). The LATE estimates also indicated increased in productivity with an observed mean of about(222.98kg/ha) increase by participants.The poverty status of respondents had also been positively impacted by the program by an observed increase of about 9.88% in welfare.

5.3. Contribution to Knowledge.

i. farm size, household size and communication assets contributed 52% to the determinants of participants' decision on the level of use of package of practices.

ii. there was an observed 9.98% improvement in welfare status of the participants than the non-participants.

iii. 48% (278) of the respondents were shown to have been living below the poverty line (₦378.14/day), the poor farmer will need an extra ₦143.7/day income in addition to their total income to come out of poverty.

iv. The Participants in the program had improved their productivity by about 127kg/ha translating into 28.68%.

5.4 Recommendations.

Based on the empirical findings from this study, the following recommendations were made.

i. Prompt information and farmers sensitization on developmental projects is very crucial to their participation and use of the package of practices; this was clearly shown by the statistical significance of the variables (assets such as radio, television and phones). It is therefore important to include proper information dissemination into agricultural projects.

ii. The project should ensure that priorities be given to formidable redemption centers and marketing access and outlets for the inputs and produce of the participants. In other words, farmers cooperatives can be formed to pool the outputs of participants together for better market bargain, also, moreaccess to

both the input should be made available by creating more redemption centers to further facilitate the participation in the project.

iii. Incentives can also be given to the participants at the point of sales by by buying up their products during gluts when prices are low as a measure to stabilize market prices so as to keep farmers in production.

iv. The project should give more attention to well organized extension visits for the participants.

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Appendix

Department of Agricultural Economics, Ahmadu Bello University Zaria, Nigeria.

Questionnaire on Effect of Agricultural Transformationon productivity and povertyof rice farmers in Kano State. Nigeria

Sir/ ma,

I am a research student of the Ahmadu Bello University Zaria 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= Agricultural transformation participant, 2= NONE Participant.

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 = Divorced
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.	Position in the household		1=male head, 2= female head, 3=wife of the household head 4= member
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 =Processing, 7 = 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 = processing,7=0thers (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= lease, 5= encroachment, 6= gifts , 7= others (specify)
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 group
25	Farm implements		1= manual, 2= mechanical
26	Means of transportation		1= bicycle, 2= motorcycle, 3= car, 4= pick up, 5= animals 6= others (specify) …….
27	Communication equipment		1= radio, 2= television, 3= video 4= GSM
28	Ownership of accommodation		1= yes, 0= No
29	Type of housing materials		1= mud/ thatched, 2= mud/zinc 3= brick/ zinc, 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= borehole , 4= public tap water , 5= others
32	Bank account		1= Yes, 0 =No

SECTION B: HOUSEHOLD EXPENDITURE

33. How much do you spend on food items per month (in Naira)……

34. How much do you spend on the following non-food items per month?

ITEMS	AMOUNT SPENT WEEKLY	MONTHLY	ANNUALLY
Clothing / shoes			
Education (school fees, books)			
Health care/ medicine			
Paid transportation / travel expenses			
GSM recharge cards			
Furniture			
House repair/maintenance			
House rent			
Water bill ,electricity			
Taxes / levies			
Alcoholic drinks, tobacco,cigarette/kolanut			
Kerosene/ charcoal/ firewood			
Remittances(money sent to household members not living in the household)			
Petrol for non productive machines(generators, cars etc)			
Contributions to association/group			
Contributions/ offerings to religious activities			
Other expenses(specify)			

SECTION C:Rice Production.

35.	Crops cultivated	
36.	Area of land available to farmer	
37.	Average area cultivated in the last planting season	
38.	Average area cultivated to rice	
39.	Average area cultivated to AGRICULTURAL TRANSFORMATION rice varieties	
40.	Average area cultivated to other varieties.	
41.	Years of experience in rice production	

42	**Cost of production per ha.(Naira)**	**Agric transformation Varieties**	**Other Varieties**		
	Cost of land				
	Planting materials				
	Equipment				
	Herbicide				
	Pesticide				
	Fertilizer				
	Labour land preparation				
	Weeding				
	Fertilizer and pesticide application				
	Harvesting				
	Transportation				
	Total				

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

52. 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: AGRICULTURAL TRANSFORMATION PROGRAMME PARTICIPATION.

53. Are you a beneficiary of AGRICULTURAL TRANSFORMATION (a) yes (b)No

54. Which improved varieties under AGRICULTURAL TRANSFORMATION are you aware of and have tried (tick if yes)

Rice	**Aware**	**Tried**

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

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

59. 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)……

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

61. What are your reasons for adopting the varieties above? (please state) ----------
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62. Since when have you been cultivating agricultural transformationrecommendedvarieties?(a) last 1 year (b) last 2 years (c) last 3 years (d) above 4 years

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

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

65. How readily do you access agricultural transformationroved varieties (a) very readily (b) fairly readily (c) not easy

66. Did you adopt other improved varieties of rice not published under agricultural transformation? (a) Yes (b) No

67. If yes, name the varieties……

68. Which of the following Agricultural transformation agronomic practices have you been exposed to, adopted and still using

Agric transformation rice Agronomic practices	**Exposed to**	**Adopted (level/qty applied)**	**Since when (years)**	**Still using**
Recommended spacing				
Timely maintenance (Times of weeding)				
Herbicide application(type)				
Fertilizer application(type & quantity)				
Pesticide application (type & quantity)				
Others (specify)				

69. If you have not adopted these agronomic practices, what are your reasons?(a) high cost (b) not available (c) not superior to my practice (d) not a member of farmer's group (e) others (specify)

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

SECTION E: PRODUCTION TECHNOLOGY.

71. Are you aware of any production technology? (a) Yes ☐ (b) No ☐

72. If yes, have you tried it? (a) Yes ☐ (b) No ☐

73. Have you adopted the technologies? (a) Yes ☐ (b) No ☐

74. If yes, which of these?

Improved varieties (name them) ……..

(a) Recommended spacing (please tick if yes)

(b)Timely maintenance, (c) Application of fertilizer, (d) Application of herbicides (e) Pesticide application (f) others (specify)

75. What are your reasons forparticipate? (a) profitability (b) easy access to cuttings (c) short duration of maturity (d) high viability of cuttings (e) others (specify)

76. What are your reasons for not participating? (a) difficult to produce (b) requires two cycles to produce (c) too expensive (d) others (specify)

SECTION F: PEST/ DISEASE CONTROL

77. Which of these diseases/ pests do you frequently encounter? (List them) ----------
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78. Which pest/ disease control measures are you exposed to? (list them) ----------
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79. Which control measure have you adopted ?(List them) ----------

IMPUTS QUANTITY

Please specify the quantity of inputs used in the last production season.

Inputs Type	**Quantity Used**
1. Seeds	
2. Labour	
Clearing	
Ridging	
Planting	
Fertilizer/manure application	
Weeding	
Chemical application	
harvesting	
Others	
3. Fertilizer	
4. Chemicals and pesticides	