

**IMPACT OF ADOPTION OF IMPROVED OIL PALM
TECHNOLOGIES ON SMALLHOLDER FARMERS'
LIVELIHOOD IN SOUTH-SOUTH, NIGERIA.**

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CERTIFICATION

I certify that this work entitled “Impact of Adoption of Improved Oil palm Technologies on Smallholder Farmers’ Livelihood in South-South, Nigeria” was carried out by Gere, Solomon. Ogheneochuko (Reg.No: 20104739178) in partial fulfillment for the award of the degree of Doctor of Philosophy (Ph.D) in Agricultural Extension in the Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria.



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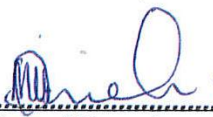


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DEDICATION

This PhD thesis is dedicated to the Glory of the LORD God Almighty, JEHOVAH, in whom my life depends and to the entire immediate Gere's family for their love and support.

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ABSTRACT

The study assessed the “Impact of adoption of improved oil palm technologies on smallholder farmers’ livelihood in south-south, Nigeria.” The objectives were to:- describe farmers socio-economic characteristics, sources of information, identify farmers awareness, livelihood activities, level of adoption of the oil palm technologies; assess impact of smallholder farmers’ adoption; and identify constraints to technologies adoption. The Null hypotheses tested were:- relationship between farmers socio-economic characteristics and adoption of oil palm technologies; farmers perceived impact on livelihood and adoption of technologies; socio-economic characteristics and farmers perceived impact of adoption; and whether there was difference in farmers perceived impact among adopters in three selected states. A multistage random sampling method was used to select a total of 322 oil palm farmers from three states of Edo, Bayelsa and Akwa Ibom in south-south, Nigeria. Structured questionnaire, interview schedule and focus group discussion were used for data collection. Data were analyzed using descriptive and inferential statistics of frequency counts, percentages, means, rank order; Ordinary least square regression analysis; Pearson product moment correlation and Analysis of variance. The results showed that the oil palm farmers were dominated by males (79.5%). While 77.3% of the farmers were married, 57% had household size of 5-8 persons; while 31.1% of the farmers have 11-15 years farming experience. The age distribution of farmers were within age bracket of 41-50 years; about 53.1% of the farmers belong to farmers’ social organization, and only 20% of the farmers had no formal education. The mean monthly income of the farmers was N30,800.00. The result also revealed the following characteristics of oil palm farms, where 62.1% of the farmers had oil palm plantation farm size of 1-3ha; 55.3% of the farmers operated on sole planted oil palm farms; while 45.0% of the farmers had oil palm plantation aged between 11-20 years old, 51.6% of the farmers operated on selfowned oil palm plantation; and about 46.6% of them had their oil palm plantation farms located between 1-2km distance from home. Sources of information on oil palm technologies used by greater proportion farmers were friend / neighbours, extension agents and agricultural development programs (ADPs) ranked 1st, 2nd and 3rd respectively. The farmers had very high awareness of the oil palm technologies and hence high level of Adoption of improved oil palm technologies recorded among the farmers. The study revealed among the oil palm livelihood activities that marketing of palm produce $\bar{x} = 3.65$, transport of palm produce $\bar{x} = 3.58$, harvesting of palm fruits $\bar{x} = 3.58$ and palm oil processing $\bar{x} = 3$ were rated as very important activities by larger proportion of the farmers. Impact of farmers’ adoption of improved oil palm technologies perceived at household and farm levels on farmers’ social life (before and after), and at community level, had positive impact on the smallholder farmers livelihood at household and farm levels; impact on farmers and where perceived farmers’ impact indicated increases in farm income, increase farm yields, improved food security, oil palm plantation expansion; improvement on the farmers social life of the material benefits and well-being. The study developed and described in perspective the “Impact Pathway” framework for the adoption of improved oil palm technologies generated by Nigerian Institute for Oil palm Research (NIFOR), to demonstrate how oil palm technologies adoption could create impact in the lives of farmers/non-farmers in the study area. Major constraints affecting farmers’ adoption of oil palm technologies were lack of capital/fund, lack or no access to land, high cost of inputs, high cost of labour and insecurity to life and properties. Regression analysis result showed that co-efficient determination of farmers’ characteristics t-ratios of:- sex= 0.042, marital status=1.570, household size =3.52, and farm size = 0.170 had significant positive relationship on adoption of oil palm technologies while t-ratios of:- age= -2.880, educational level = -3.74 and farming experience = - 0.24 had negative relationship on adoption. Pearson product moment correlation analysis showed that significant and positive relationship existed between farmers’ perceived impact of improved oil palm technologies on farmers’ livelihood and adoption of oil palm technologies. Regression analysis results had p-values of :- age= 0.004, household size<0.001, farming experience = 0.008 and education level <0.001) had significant positive relationship between socio-economic and farmers perceived of impact at household level. ANOVA result showed that no significant difference existed between farmers perceived impact of adoption on farmers livelihood among farmers’ adopters across the three selected states. Based on results of the study, recommendations were made:- provision of farm inputs subsidies to farmers; review of land use policy to make more land available for large scale oil palm expansion; among other recommendations.

Keywords: Impact, Adoption, Oil palm, Technologies, Livelihood, South-South, Nigeria.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

There has been growing concern for the assessment of impact of agricultural technologies at farmers' level particularly by stakeholders, development experts, and donor agencies, to determine who benefit from technological change and in what specific ways at both small-scale and societal level (Maredia, *et.al.*, 2013). More importantly in this regard, there is increasing need to assess the potential impact of agricultural technologies on farmers' livelihoods and to demonstrate the actual impact of research interventions/benefits on rural poor smallholder farmers with a view to reducing poverty and setting priorities for research (Alwang and Siegel, 2003; Sarah Morton, 2015; Kurosh and Somayeh, 2019).

In sub-Saharan Africa and particularly Nigeria, it has been reported that three quarters of its population living in rural areas are extremely poor and where the rate of poverty is twice that of the global average and highest in the world (AfDB, 2012; World Bank, 2015; Beegle, *et.al.*, 2016). More so, majority of the resource-poor smallholder farmers living in those rural areas depend largely on agriculture as their major source of livelihood for food and incomes (Biru, *et.al.*, 2020). Also most of these sub-Saharan countries including Nigeria are presently experiencing slow agricultural development (Dawd Gashu,*et.al.*,2019). This is due to problems ranging from the use of traditional farming methods leading to poor production, inappropriate agricultural policies, low adoption of agricultural technologies and inadequate information; other constraint factors including decline in farm size due to increase population, traditional land tenure systems, urbanization, issue of climate change, among others constraints (Awotide,*et.al.*,2016; Dawd Gashu,*et.al.*,2019).

Consequently, research and adoption of new technologies are crucial to increasing agricultural productivity of the resource-poor smallholder farmers and which is key to raising household income, food security, improve farmers livelihood and fight against poverty (Kassie, *et.al.*,2018). Against this background, several low income sub-Saharan Africa countries including Nigeria have adopted agricultural programs and strategies that could induce necessary impact on farmers' livelihood and to achieve sustainable increase in food production. In this direction, Nigeria has in its national agricultural research system (NARS) over 18 different agricultural research institutes with various mandates, have generated substantial technologies especially in area of crop production through the development of improved seed varieties with better adaptation to specific ecological zones, resistance to classified pests and diseases, and with better responsiveness to fertilizer application. These technologies have potential to increase agricultural productivity, generate income and enhance the livelihoods of rural smallholder farmers who constitute over 70% of the rural population. Of particular note in this regard, in the generation of research technologies, is the Nigerian Institute for Oil palm Research (NIFOR) since 1939. This was based on the identification of the oil palm industry as one of the effective avenue to enhance farmers' livelihood for income generation especially among women who process and sell palm oil in both local and national markets, employment generation along the oil palm production chain, food security and economic growth and stability.

The oil palm *Eleais guineensis (Jacq)*. is one of the important economic tree crops in the tropic and a major cash crop of Nigeria which has greatly contributed to the growth of the national economy. The oil palm produce, palm oil and palm kernel oil are used as food for human consumption and livestock as well as raw materials for local food processing, soap and cosmetics industries. Nigeria's export trade of palm oil and palm kernel oil in 20th

century accounted for about 88- 90% of its foreign earnings. Nigeria lost her foremost position in export temporarily to Zaire in 1964 – 1965 and remain world largest producer until 1966 after which Malaysia and Indonesia took over due to their commitment to oil palm plantation production (Merem,*et.al.*, 2020). Nevertheless, in 2021 Nigeria was ranked the world's fifth (5th) largest producer of palm oil but only accounted for 1.8% of total world production (USDA, 2022). However, there is a big gap between domestic production and consumption. And for Nigeria to fill the existing gaps in its palm oil production, there is need to expand production by cultivation of more oil palm.

The main challenges to the oil palm production sector in Nigeria, is the low rate of planting and problem of land acquisition in the oil palm growing areas. Moreover, the wild palms and older plantations must also be replaced with improved planting materials to boost productivity. However, it must be noted that the Nigeria oil palm industry is largely dominated by smallholder farmers who operate at subsistence level. They contributed over 80% of the national palm oil and palm kernel output; and employing inefficient production and processing techniques which production could not meet the growing population food need and rising demand for industrial raw materials. These smallholder farmers are constrained by factors such as inadequate inputs, land tenure problem, high cost of planting materials, high cost labour, poor adoption of improved oil palm technologies, and insufficient capital, to boost farming activities. (Owolarafe, *et.al.*, 2002; Ikuenobe, 2010; Sani Shehu,*et.al.*, 2021).

To address these challenges, the Nigeria government over the years has initiated various oil palm cultivation programs to boost the yields of the crop; thus a number of improved oil palm production technologies released through NIFOR research efforts, made significant contributions to the development and growth of the oil palm agricultural

subsector. The introduction of these improved oil palm technologies such as improved packaged agronomic practices which comprise improved oil palm planting materials, fertilizer management methods, plantation establishment techniques, pests and disease control measures, weed management practices, etc, are particularly tailored and aimed at the smallholder farmers to boosting yields and productivity of oil palm (NIFOR,2009). However, the dissemination/transfer of these oil palm technologies is to encourage an estimated 1.8 million smallholder farmers and out growers involved in oil palm production in the 24 oil palm growing states of Nigeria (Ayodele, 2010), to move away from their traditional oil palm production system towards the adoption of these improved technologies to increase productivity of the palms. The adoption of improved oil palm technologies will not only lead to increase crop yields and income of rural households, it can also induce the required livelihood impact of the smallholder farmers.

Drucker (1998) stated that Nigeria has the needed potentials to increase her production of palm oil and palm kernel through the application of improved technologies. The adoption of these oil palm technologies can appreciably induce the necessary impact on the national palm oil output thereby increasing the smallholder farmers' livelihood outcomes of:- increased income, improve farmers healthcare, employment generation, households nutrition, etc., and or reduce poverty and food insecurity in the country. Several studies have shown that there is significant positive impact of improved agricultural practices on the welfare/livelihood of smallholder farmers (Abebe and Sewnet, 2014; Kassie, *et.al.*,2018; Bedru, *et.al.*, 2022). These technologies, if adopted could lead to improved livelihood impact for smallholder farmers. The farmers can further use these livelihood assets to improve their well-being and undertake other livelihood strategies in non-farm activities.

In the agricultural sector, research generated technologies are considered the major instrument that have the potential to affect poor people lives positive or negatively through causal impact pathways. These include the direct impact through increase of incomes of resource-poor farming households and indirect impact through changes in food prices, labour market effect and economic growth (Kerr and Kolavallio, 1999; De Jenvry, *et.al.*,2011). Impact on the lives of resource poor smallholder farmers is probably being recognized as the most functional benefit of agricultural technologies and now the dominant preoccupation of various stakeholders (Jahnke, *et.al*, 1987; Collinson and Tollen, 1994; Sarah Morton, 2015; Biru, *et.al.*,2020;). The farmers livelihood implications of oil palm improved technologies adoption is now a major concern to stakeholders and social scientists; the impact of these oil palm technologies have also received considerable attention. The study therefore assessed the social impact of the adoption of improved oil palm technologies on smallholder farmers' livelihood in south-south, Nigeria.

1.2 Statement of the Problem

The study location is situated in the south-south agro-ecological zone of the oil palm growing belt of Nigeria. The zone was delineated from the south-west and south-east oil palm growing belt of Nigeria and which consist of Edo, Delta, Bayelsa, Rivers, Akwa Ibom, and Cross-river States. The zone has a long history of oil palm cultivation and where oil palm production remains the driving force of rural agro-business; and a major source of livelihood for many rural smallholder farmers. According to Ayodele (2010), these rural smallholders account for more than 80% of the total palm oil and palm kernel production. The Nigeria oil palm industry over the years has been an effective avenue to enhance farmers' income generation, food security and economic growth. Despite the importance of oil palm

agricultural subsector, productivity among these farmers is low; it is constrained by various factors of imperfect inputs, input and output market as well as lack access to information and improved technologies (Akhaine, 2017). However, to boost the yields and productivity of the rural smallholder farmers, a number of oil palm research base improved production technologies were introduced and disseminated for farmers adoption (NIFOR, 2006). Studies have shown that improved technologies adoption are crucial for productivity gains, increase income, reduction of poverty, improved farmers livelihood (Anaglo,*et.al.*,2014; Mekonnem,2017; Yiriyibim,*et.al.*, 2022). Moreover, farmers livelihood has implications and are now a major concern to stakeholders; Impact of improved technologies adoption also has received more attention (Onwuka, 2019). Also there are evidences that adoption of improved technologies increase yields and which in turn improve upon the livelihood of farmers (IFPRI,2002; Rahman,2002; Keba, 2019.). Therefore, there is need to investigate the actual social/socio-economic impact of the oil palm technologies ie, the impact the technologies had on the lives of the people, their livelihood, their gender relationship and social process in the different oil palm growing communities. According to De Janvry,*et.al.*, 2017 and White and Raitzer, 2018, this will help to determine how far the technology has been successful in meeting social and economic objectives and how well such technologies satisfy the needs and aspiration of households or other larger units in the target population.

Adoption of technologies is also considered a necessary condition for it to have an impact. Impact assessment adoption survey is often conducted with its main objectives of estimating the level of adoption and for contributing information to estimating benefits (Bellon,2001; Diagne,2006; Ayenew,*et.al.*, 2020.). To generate information on the level and extent of adoption and its livelihood impact on the resource-poor smallholder farmers who

use these oil palm technologies therefore, there is need to investigate the level of adoption of these technologies among those oil palm smallholder farmers.

Awareness of technology has been identified in studies (van den Ban and Hankins, 1996.; Adekoya and Ajayi, 2000; Asiabaka *et.al.*, 2001; Rogers, 2003; and Ironkwe, *et.al.*, 2008.) as important determinant to adoption of technologies. This study assessed the farmers awareness of available oil palm technologies in the study area.

The adoption of technology has outcomes on the livelihoods of adopters. According to Chikwendu (2009), that the impact of adoption of these technologies on the farmers' livelihood outcomes – income, poverty reduction, nutrition, health care, etc, is now a widely asked question among development experts, donor- agencies and stakeholders. There is the need to also investigate these outcomes.

There is also increasing threats of constraints/vulnerability of the rural poor as well as unequal distribution of benefits among oil palm technologies' adopters (McCarthy, 2010; Cramb and Curry, 2012). It was reported also that certain constraints faced by farmers in Nigeria does not allow them to fully adopt improved technologies. Some of the constraints include socio-economic characteristics of the farmers themselves, high cost of inputs and low extension coverage; such as changes in human health, animal health, economic indicators as prices, governance, natural disaster - low land flooding, drought condition and among other factors of gender, politics, conflicts, belief, etc, (Ejembi, *et.al.*,2002; Adato, *et.al.*, 2007; Awotide,*et.al.*, 2016). Adoption studies have shown that these constraints and negative environmental influences including vulnerability factors are associated with adoption of modern technologies (IFPRI, 2002). These need to be investigated.

It was against this backdrop therefore, that the study carried out an *ex-post* social impact assessment on the adoption of improved oil palm technologies on smallholder farmers' livelihood in the study area.

The study therefore sought answers to the following research questions:-

- i. what are the socio-economic characteristics of the oil palm farmers?
- ii. are the farmers aware of the oil palm technologies ?
- iii. what are farmers sources of information on the oil palm technologies?
- iv. what are the oil palm farmers' livelihood activities?
- v. did the farmers adopt and utilize these technologies and what is the level of adoption?
- vi. what are the farmers' perceived impact on their livelihood and/or benefits derived from the adoption of improved oil palm technologies?
- vii. what are the impact pathways of these oil palm technologies?
- viii. what are the constraints to adoption of the oil palm technologies and in what magnitude.

1.3 Objective of the Study

The broad objective of the study was to analyze the impact of adoption of improved oil palm technologies on smallholder farmers' livelihood in South-South, Nigeria.

The specific objectives of the study were to:-

1. describe the socio-economic characteristics of the oil palm farmers.
2. identify the farmers awareness of the improved oil palm technologies in the study area.
3. ascertain the farmers' sources of information on improved oil palm technologies.
4. examine the level of adoption of improved oil palm technologies among

the smallholder farmers.

5. identify the farmers' oil palm livelihood activities in the study area.
6. assess the farmers perceived impact of adoption of improved oil palm technologies on farmers' livelihood.
7. describe the 'impact pathways' of the oil palm technologies in the study area.
8. identify the constraints to adoption of the improved oil palm technologies among the farmers

1.4 Hypotheses of the study

The hypotheses of the study were stated in Null form (H_0) as follows:

1. There is no significant relationship between the socio-economic characteristics of farmers and level of adoption of improved oil palm technologies.
2. There is no significant relationship between farmers' perceived impact on livelihood and adoption of improved oil palm technologies.
3. There is no significant relationship between the farmers socio-economic characteristics and perceived impact of adoption on the farmers livelihood.
4. There is no significant difference in farmers perceived impact of adoption on farmers' livelihood among adopters of oil palm technologies across the three selected states of South-South, Nigeria.

1.5 Justification of the study

Rutzer and Winkle, (2005) affirmed that among the motive of conducting impact evaluation on publicly funded agricultural research system is to meet donor's demand for more direct evidence that their large investment in agricultural research are positively

affecting the Millennium Development Goals (MDGs) and/or just recently re-named Sustainable Development Goals (SDGs) (Guillaume-Gentil, 2015), related to farmers' livelihood impact, poverty alleviation, food security, environmental sustainability, improving health, and generating employment. Manyong *et.al.*, (2001), noted however, that impact assessment of technologies generated from public agricultural research has always been viewed as an important activity to ensuring: accountability, maintain credibility, and improve internal decision making process and capacity to learn from past experience. They reported that impact evaluation is a critical component of agricultural research which helps to define priorities of research, facilitate resource allocation among programmes, guide researchers and those involved in technology transfer. This will enable them to have a better understanding of the way new agricultural technologies are assimilated and diffused into farming communities and to show evidence that the farmers' (end-users) benefit from research products.

Phillip (2009) however, gave several reasons in support of the need to conduct agricultural technology impact studies. That:-

- It serves as a source of information for policy makers and provider of agricultural fund.
- The transfer of research induced technology to farmers is the only way to know and measure research benefits to society. It has been affirmed that benefits from new technology on commodity depend linearly on technology adoption. Therefore, impact studies must measure it with some level of accuracy as adoption rate is the key parameter result of technological transfer process.
- Impact assessments provide feedback to scientists on which technology components are successful at farm-level or what adjustments to technologies are required.

Chikwendu (2009) also pointed out that impact evaluation are needed to measure benefits and compare them with cost of research; Scientists can target their work to achieve the greatest possible pay off; documentation of research impact assessment results are also needed to ensure appropriate level of public support. Therefore conducting impact evaluation amount to an attempt to measure the effects of research outputs on research object or target end-users.

According to the CGD (2006), conducting impact evaluation stems from the fact that impact assessment enhance positive and sustainable outcomes associated with project implementation; they support the integration of social and environmental aspects associated with numerous sub-projects into the decision making process. Impact evaluation helps us to answer key questions for evidence based policy making of what works; what doesn't, where, why and for how much? Impact evaluation for this reason, has received increasing attention in policy making in recent years in both western and developing countries context (Briceno and Gearder, 2010).

Muaz (2003) however, observed in his studies that impact assessment is an important component of the armory of evaluation tools and approaches and that it is integrated to global effort to improve the effectiveness of aid delivery and public spending; more generally in improving living standards. He further noted that though Impact evaluation was originally more oriented toward evaluation of social sector programmes, and in other areas such as agriculture, energy and transport.

Impact assessment of agricultural research and technological changes have implications for increase in knowledge of researchers and development experts including policy makers in the field of agricultural research and dissemination of innovations and particularly as it relates to oil palm tree crop research and development . In addition to addressing other

issues affecting smallholder resource – poor rural farmers that constituted the majority producers in the oil palm agricultural subsector in Nigeria, disentangling the livelihood implications of oil palm production on the smallholder farmers is of immense importance not only to understand how the diffusion/adoption of better oil palm production technologies affect smallholders, but also of how these others factors of cultural, vulnerability, including institutional/government policies among other factors influencing oil palm farmers to expand their farming activities that may result to social challenges.

The study will also give understanding of the link between agricultural productivity and poverty reduction, and the direct / relative impact of improved agricultural performance and rural income. The study, it is hoped will contribute to the literature by quantifying the implications of oil palm cultivation on the rural smallholder resource-poor famers' livelihood using field data from agro-ecological oil palm growing areas of Nigeria. Impact assessment of oil palm technologies at farm-level could also stimulate research activities aimed at solving farmers problems through feed back information and which could assist in the design and redesign of appropriate research intervention and its dissemination. Moreover, findings from this study could provide the required base line data information for future evaluation studies for the oilpalm agricultural research subsector and other related crops. Information on the pathways in which new technologies generate impacts are considered important in making current and future research efforts more effective in reaching resource-poor farmers which is now the main goals of stakeholders and research.

1.6 Scope of the study

The study focused on the impact of adoption of improved oil palm technologies and how it affected the livelihood activities of oil palm farmers in the south-south agro-

ecological zone of Nigeria. This study is imperative to provide the necessary base line information and data that will be helpful in the design of programmes of interest to other disciplines and people and thereby contributing to fast track agricultural transformation, enhance farmers' livelihood and poverty alleviation in Nigeria.

CHAPTER TWO

LITERATURE REVIEW

2.1 Empirical literature

2.1.1 Concepts: Impact, Evaluation, and Impact Evaluation

According to Impact Assessment and Evaluation Group (IAEG) (2000), of the Consultative Group on International Agricultural Research (CGIAR), that: ‘**Impact**’ refers to the broad long-term economic, social and environmental effects resulting from research. But a common definition of ‘impact’ used in evaluation refers to it as ‘the totality of a longer-term consequences associated with an intervention on quality-of-life outcomes’ (Impact Evaluation Group (IEG), nd).

The Organization for Economic Co-operation and Development’s – Development Assistance Committee (OECD’s – DAC) (2002), defines impact as the positive and negative, primary and secondary long term effects produced by a development intervention directly or indirectly, intended or unintended at the level of the individual or an organization. The IAEG (2000) however, explained that the effects so resulting from impact may be anticipated or unanticipated and positive or negative, at the level of the individual or organization. These effects generally involve changes in both cognition and behaviour.

Evaluation on the other hand, is the judging, appraising or determining the worth, value or quality of research, in terms of its relevance, effectiveness, efficiency and impact (IAEG, 2000). Evaluation is the study of the effects and efficiency of a project which are made during and after the project implementation and operation. Evaluation in agriculture focus mainly on judging the programme merit or worth (Nwachukwu, 2008; Nwakwasi, *et. al.*, 2019).

Consequently, Impact Evaluation Group (IEG) (nd) of the World Bank stated that **‘Impact Evaluation’** is an assessment of impact of intervention on final welfare outcomes. According to the Impact Evaluation Group (IEG) however, that the meaning of impact evaluation has taken different meanings over time and there are continued debates as to how it has been done. Thus, they define impact evaluation as a counterfactual analysis of the impact of an intervention on the final (human) livelihood outcomes (IEG, (nd); DFID, 2006) The Consultative Group of International Agricultural Research (CGIAR) (2006), defines impact as ultimate social, environmental or economic benefits that are consistent with the objectives of an activity (e.g. a research activity).

Different definitions of impact evaluation*

White (2009), in his report noted that while there is agreement on the importance of impact evaluation, a consensus is emerging around the use of counterfactual evaluation methods. There is also a wide spread debate in recent years on both the definition of impact evaluation and the use of appropriate methods.

The IEG however observed that impact evaluation has taken different meanings during the last twenty years. Various definitions including those of United Nations International Children Educational Fund (UNICEF) (2004); United States of America International Development Agency (USAID) (2011); United States Environmental Protection Agency program Evaluation glossary, (2008); Wikipedia, EvaluationWiki (2014); World Bank-Development Impact Evaluation (DIME); OECD-DAC (2002), among others define impact evaluation differently but all tend to mean the same. However, the following definitions have been the most common:

* The terms impact evaluation and impact assessment which mean the same are used interchangeably in this study.

- An evaluation which looks at impact of an intervention on final livelihood outcomes, rather than only at project output, or a process evaluation which focuses on implementation;
- An evaluation concerned with establishing a counterfactual i.e. the difference the project made (how indicators behaved with the project compared to how they would have been without it);
- An evaluation carried out some time (five to ten years or more) after completion of the intervention so as to allow time for impact to appear;
- An evaluation considering all interventions within a given sector or geographical areas.

However, these definitions are not mutually exclusive. According to the IEG(nd), many evaluations since the 1990s were carried out above ten years or more after the intervention closed and also tried to establish a counterfactual. The IEG's current approach definition of impact evaluation, combine the first two definitions above, that is a counterfactual analysis of the impact of an intervention on final livelihood (welfare) outcomes. Impact assessment however, can be distinguished on the basis of disciplinary lines according to International Institute for Environment and Development (IIED), (1998) as follows:

- Environmental Impact Assessment (EIA), (IAIA, 2021).
- Social Impact Assessment (SIA) (Burdge and Vanclay, 2009).
- Environmental Health Impact Assessment (EHIA).
- Risk Impact Assessment (RIA).
- Strategic Environmental Assessment (SEA).
- Economic Impact Evaluation (EIE).

- Beneficiary Impact Assessment (BIA) (Asiabaka, *et. al.*, 2008).

It is important to note here however, that there are three broad categories of impact that form part of a comprehensive impact assessment (Anandajayasekaram *et.al.*, 1996; Nkamlue *et.al.*, 2006). (See Figure 1):

(i). the first is the **Direct product (outcome) of research** activities (research results). The most commonly used approach for assessing the direct product of research is known as effectiveness analyses. A useful starting point for effectiveness analysis is the Logical framework (Log frame) of the project. The Logical framework permits the assessment of the degree to which the research activities have made changes in the desired direction.

(ii). the second is the **Intermediate impact**, it is concerned with the organizational strategies and methods used by researchers. The Impact of the Intermediate product(s) is ignored in most Impact assessment because the link between the Intermediate product and the ultimate economic benefit is not clear and not easy to quantify.

(iii). the third is the **People level impact**: The people level impact can be:

- Economic Impact;
- Social Impact: Socio-economic Impact/ Socio-Cultural Impact; and
- Environmental Impact.

The economic impact evaluation measures the combined production and income effects associated with Research and Development (R&D) activities. The economic impact can be evaluated through what is known as an “efficiency analysis” which compares the cost and the benefit of the project in a systematic manner and using econometric methods (Anandajayasekaram, *et.al.*,1997). However, several authors and organizations have highlighted the limitations using economic efficiency as principal criterion for assessing impact (Shexson, 1999).

Environmental Impact Assessment (EIA) is defined as the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effect of development proposal prior to major decisions being taken and commitment made (International Association for Impact Assessment (IAIA),1998; Morris,2019; and IAIA, 2021). Many countries require EIA for major development projects.

Social Impact Assessment (SIA) includes the effect of research on the attitude, benefits, resource distribution, status of women, income distribution, nutritional implications, institutional implication, vulnerability factors, etc. These can be evaluated through socio-economic surveys and careful monitoring (Burdge and Vanclay, 1996). The Social Impact Assessment framework as an instrument of user-oriented and people centered research has been developed using a more holistic and comprehensive approaches in response to the limitation of the traditional Economic Impact analysis.

Studies including Campbel (1990); Carnea (1991); Walker and Chrissman (1996); Becker and Vanclay, (2003); among others averred that the SIA represents an effort to analyze the real or potential impact of technologies upon specific group of people. And that SIA requires the analysis of changes that occur in the lives of people as a result of adopting innovation or new policy intervention. It helps to determine how far a technology has been successful in meeting Social and Economic objectives and how well such technologies satisfy the needs and aspiration of households and other larger Social units in the target population.

However, the focus of this study is on the Social Impact assessment. According to Burdge and Vanclay, (2009) and Vanclay, (2020) that the SIA as a process and methodology has potential to contribute greatly to planning process, to review of other effects of social infrastructure projects and other development interventions such as research

outputs and management of the process. For agricultural research, it can assist in the evaluation of alternatives and to help in the understanding of social change. SIA can enrich the Impact analysis as well as provide a clearer identification of issues for research planning and prioritization. However, it is evident that SIA has rarely been applied to agricultural research programmes. The estimates of Social Surplus in impact studies of agricultural research are based on costs and benefits that are measurable in monetary unit. (Burdge and Vanclay, 2009).

Omoto (nd), noted that agricultural research usually generates many types of outputs. These include technologies embodied in physical object (of improved seeds), management tools and practices, information and improved human resources. These outputs affect the environment of research institutes (through training and partnership building) and research clientele (through technologies and information generation) which ultimately impact the indicators of research.

However, the term impact in the context of R&D activities includes both, the Direct product of research as well as the People level impact. The People level impact refers to the effects of technologies' on the ultimate users or target group for which the technology was developed. Impact begins to occur when there is a behavioral change among potential users.

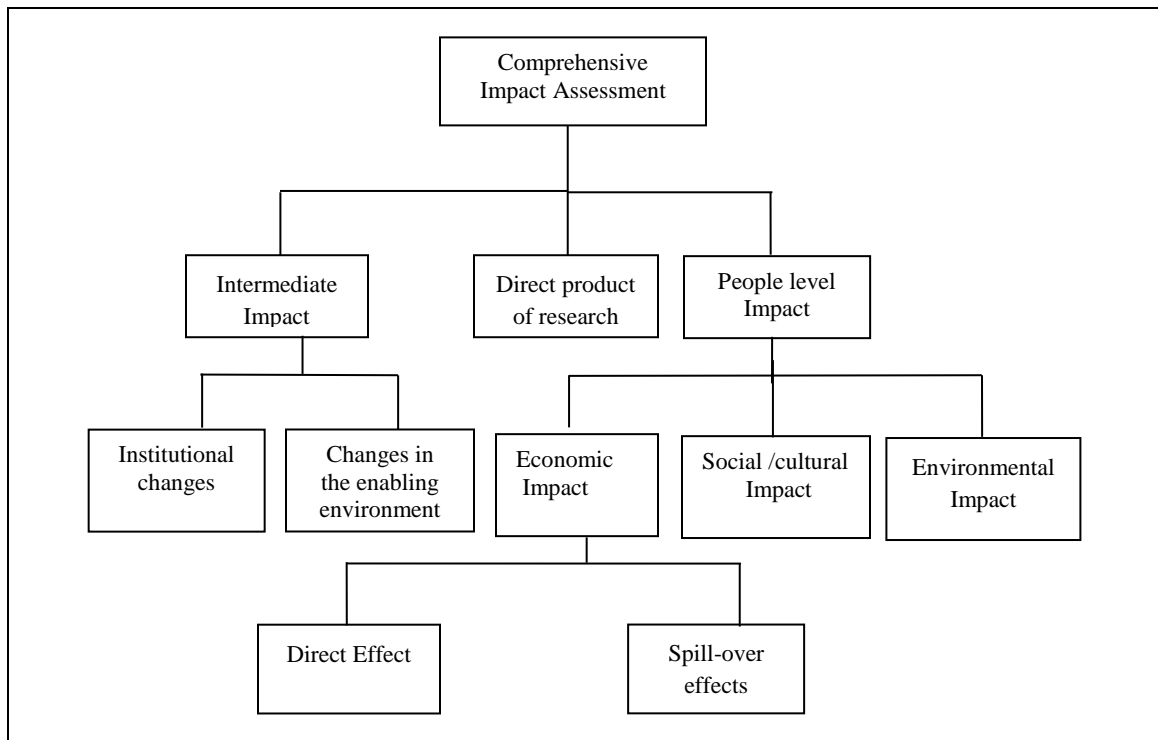
The People level impact deals with the actual adoption of research output and subsequent effect on production, income, environment, and/or whatever the development objective may be. The people level impact of any R&D programme cannot be achieved without accomplishing the intended direct product of research. Therefore in any comprehensive impact assessment, there is need to differentiate between research results and the contribution of the research results and the contribution of the research to development (Anandajayasekeram, *et.al.*, 1996). Impact assessment has to link outputs,

outcomes and eventual impacts, and to describe and prove how outputs have led to the final impact. This description is commonly called the *Impact pathway* (Steffen, 2007).

The purpose of impact assessment of agricultural research activities therefore, depend by and large on when the assessment is done: Impact assessment of agricultural technologies can be undertaken by using an *ex ante* or an *ex post* approach. *Ex ante* studies try to estimate the potential impact of the adoption and diffusion of the concerned technologies, whereas *Ex-post* studies evaluate the effects that actually occurred after its adoption/ diffusion. In other words impact assessment can be performed before initiating the research (*ex- ante*) or after the completion of the research activity (*ex- post*) including the technology transfer.

The methods used for an impact assessment depend on the types of technology as well as on the impact(s) to be evaluated, and on the scale and data availability.

Figure 1: Comprehensive Impact Assessment



Source: Anandajayaseketam *et.al.*, 1996.

Types of impact assessment in agricultural research

Manyong *et.al.*, (2001) in their study affirmed that Impact assessment of agricultural research is a continuous process. And being a process, it is conceptualized as a cycle involving different types of Impact at different stages. They noted that Impact studies essentially have the same process as technology development itself. And based on the technology development process therefore four stages of Impact Assessment would constitute the Impact cycle. These include:

- Ex-ante Impact Assessment – i.e. Impact for priority setting.
- On-farm technology evaluation
- Adoption stage Impact Assessment
- Ex-post Impact Assessment

They observed that these different types of impact studies are not mutually exclusive, though distinct in function. But at the same time serve a complementary function in the technology development and dissemination process. (Manyong, *et.al.*, 2001).

Ex-ante impact assessment

Ex-ante impact assessment also referred to as prospective evaluation, is carried out before the project or programme is initiated as to aid in priority setting. Ex-ante impact assessment is carried out during the design phase of the intervention, involving collection of baseline data from intervention beneficiaries (the treatment group) and non-treatment group (the comparison group). They may involve the selection of individuals or communities into treatment and comparison group.

Some notable examples of ex-ante impact assessment in Nigeria are Social Impact Assessment (SIA) of the Obigbo North facilities upgrade; and SIA of Gbaram-Ube Node integrated oil and gas projects in sixty-six communities in Rivers and Bayelsa states; all

funded by Shell Petroleum Development Company (SPDC) as part of its EIA projects to assess the impact on the livelihoods of the beneficiary communities, (Asiabaka, 2010); other example include the World Bank assisted projects of community assessment for micro-watershed management and environmental programme for Enugu and Imo states, Nigeria, (Asiabaka, 2010).

Ex-ante impact studies are conducted to estimate the expected returns from current alternative research efforts. Assessment of future impact includes: Measures of productivity impact, distribution of economic benefits and effect on environment quality.

On-Farm Technology Evaluation

After research priority setting, researchers embark on technology development. This involves on-station development of new crop varieties, crop and national resource management practices, or Integrated pest management (IPM) practices. These technologies will then undergo on-farm testing with the farmers. On-farm testing is useful for evaluating technologies in a wider range of condition than available on-station. They are carried out to test with farmers and on their plots, the acceptability and profitability of the technology developed or the technologies already available before they are promoted.

Examples of on-farm impact assessment on farmers' plot include Pilot IPM projects involving twenty villages in scaling up IPM technologies in four African countries – Cameroon, Chad, Niger and Nigeria, funded by Africa Development Bank (AfDB) who are part of the Lake Chad Basin Commission, (Asiabaka, 2010); and Beneficiary Impact Assessment (BIA) of parasitic pilot sites in cereal-legumes systems: SP-IPM parasitic weed IPM sites in Northern Guinea Savannah of Nigeria, (Asiabaka, *et. al.*, 2008).

On-farm trials are important for obtaining realistic input – output data for cost – benefit analysis.

Adoption Studies

Alene *et.al.*, (2007), reported that adoption studies are carried out to monitor the level and pathway of adoption and the impact of proven technologies on farm-level productivity during the technology promotion stage. Adoption studies measure the extent of use of the technology, the performance of the technology, (productivity changes, advantages and disadvantages), changes in farm management induced by the new technology, and characteristics of the diffusion process. Phillips (2009) however, in his report identified three types of technology adoption studies that are readily visible in literature, namely those that focus on the measurement of:

- Adoption rate
- Adoption level or intensity; and
- Studies concerned with adoption and non-adoption decision.

He explained that in all types of adoption rates studies, Adoption rate (Ar) is measured as:

$$\text{Adoption rate (Ar)} = \frac{\text{No. of Farmers adopting technology} \times 100\%}{\text{Total No. of farmers in sample (i)}}$$

But in crop-based adoption studies, Adoption level/Intensity (Ai) is defined or measured as:

$$\text{Adoption intensity (Ai)} = \frac{\text{Area of crop under technology (ha)}}{\text{Total area under the same crop (ha)}}$$

He noted that several studies have interchanged Ar and Ai as adoption rate but in principle they are not equal in value unless the whole or equal farm land of adopters is devoted to the technology under study. Philip (2009), explaining technology adoption decision, reported that there are adoption studies that focus on:

- Whether or not farmers adopt a given technology, and / or
- The level of use of the technology,
- Studies that measure adoption (i) and non-adoption (o),

- Identify those factors that might have influenced or contribute to observed adoption responses.

Statistical analysis of adoption: The statistical tools used for analysis of adoption include:

- ✚ Logit analysis; Probit, Tobit / censored Regression analysis.
- ✚ Adoption/Non - adoption studies use: Probit or logit regression models.
- ✚ Adoption level/intensity studies use: Tobit/truncated or censored regression (using non-zero responses).
- ✚ Goodness of fit model use: Pseudo R-Square; Likelihood ratio Chi-square; and t-values of independent variables.

Studies by Manyong *et.al.*, (2001); IAEG (1999); however, affirmed that the essential information required from Adoption studies includes:

- Levels and speed of adoption and reasons for non-adoption
- Farmers perceptions of desirable trait or features of the technology options;
- Farm-level productivity and income gains due to alleviation of constraints (biotic and abiotic)
- Impact on the livelihood outcomes of the farm households in terms of distribution of income, nutrition and health.
- Infrastructural, institutional and policy constraints hindering technology adoption.

Farmers' perceptions of important constraints, desirable traits, and management practices are also very useful. Adoption studies are usually conducted as case studies, which are chosen on the basis of scientist's view. (IAEG, 1999; and Pachico, 2001).

Ex-post impact assessment

Ex-post impact evaluations are usually retrospective evaluations conducted after a technology has been widely adopted by farmers in the target area. In other words ex-post

evaluations are conducted after the implementation phase and may exploit existing data. Ex-post impact assessment (EPIA) develops the confidence of scientists, researcher managers and stakeholders and makes case for enhance research support (Bantilan and Dar, 2001). In addition, information obtained during the process of impact evaluation is fed back into research prioritization. EPIA studies on adoption and impact are carried out following large – scale dissemination of the technology. In practice however, case studies on adoption and impact such as those conducted in technology demonstration villages, are considered as ex- post impact studies.

Alene *et.al.*, (2007) however, observed in their report that the impact assessment process as a cycle becomes complete when adoption and impact information obtained from ex-post impact studies is feedback to ex-ante impact studies and the process continues. They noted in their studies that impact assessment is a data – intensive activity and collecting appropriate data is perhaps the most time consuming and costly component of conducting impact assessment.

2.1.2 Improved agricultural technologies used in impact assessment:

Improved agricultural technologies

Anderson (1997), explained that the word '**Improved**' to embody any of the several desirable characteristics: They include, higher potential grain yield, responsiveness to other inputs such as fertilizer and /or irrigation, and greater tolerance to stresses such as droughts, pest or diseases; others are shorter duration (length of the growing period), longer storage capacity after harvest, higher nutrient content, better taste and high quantity or quality. The term '**Agricultural technologies**' describes the output of agricultural research but it is broadly defined to include not only physical technologies but also germplasm and management practices.

Improved agricultural technologies therefore, are usually the product of agricultural research. They are referred to as improved planting materials, improved breeds, agronomic packages and practices, production processes, improved methods and techniques.

Pinstrup–Anderson (1982), in his study divided improved agricultural technologies in four categories:- Biological, Chemical, Mechanical and Management:

- Biological technology includes improved crop varieties, livestock breeds and others technologies which incorporate materials of biological nature.
- Chemical technology includes inputs fertilizers, weeds and pest control materials.
- Mechanical technology includes farm machinery, processing equipment, and tools.
- Management is knowledge concern with decision making and use of the materials.

Alene *et.al.*, (2007), further grouped improved technology (crop based) in the following categories: Modern Varieties (MV); Crop and Resource Management (CRM); Plant Health Management (PHM) and Post-Harvest (PH).

Classification of agricultural technologies used for impact evaluation

De Jenvry *et.al.*, (2011), in their report on impact assessment considered the different kinds of agricultural technologies that are likely to be evaluated. They observed that each of the technology has unique limitation that must be kept in mind when setting expectations about what we can learn from impact analysis and their challenges. These include:

(a). Yield – increasing and cost serving technologies

Examples are new seed varieties (main advantages are in output per hectare), fertilizers and certain new cultivation practices. Cost saving technologies also include new seed varieties (advantages are require fewer complementary inputs as well as cultivation practices that produce equal results with less effort). These technologies are often presented or

recommended to producers as a package including seed varieties and the associated best management practices (De Jenvry, *et.al.*, 2011).

(b) Risk mitigating technologies

These technologies might not raise yield in time where conditions are favourable, but they reduce risk of very bad outcomes when negative shock occur. Drought and pest / disease resistant seed varieties and livestock vaccines are good examples. Evaluating Risk – mitigating technologies is difficult while adoption may impact expected outcomes their effects may not always be observed.

(c) Quality-Improving Technologies

These technologies result in output that is of higher quality in some respect, even if yield does not improve. Best example is Quality Protein Maize (QPM); improved sweet potatoes (Low, *et.al.*, 2007). The impact of quality – improving technology is difficult to evaluate in part because the channel of transmission from availability of the new variety to the manifestation of benefits involve several actors. ‘Adoption’ by consumers requires that producers have already adopted and produce the variety so that it is available to consumers, and that consumers have chosen to consume it.

(d) Technologies that alter environmental externalities

New cultivation and livestock management techniques may fall into this category. These technologies are differentiated from those that improve or maintain plot-level soil quality in that they prevent negative externalities on neighbouring property or public resources. Example through groundwater contamination, very little of the effect of this technology can be observed at the level of the adopter. The impacts on public resources can be hard to measure and such impact take a long time to manifest.

2.1.3 Improved oil palm technologies and oil palm Tenera hybrid seed development in Nigeria:

Oil palm origin and its distribution in Nigeria

The oil palm *Elaeis guineensis*.(Jacq). is of great economic importance to many countries of Africa. It is known to be native to the countries bordering the Gulf of Guinea-present West Africa sub-region. While the oil palm was earlier believed to have been introduced from Brazil by the American botanist, O.F. Cook, a well-known authority on palms, the oil palm in its natural state find its greatest dispersion in the countries of West Africa. However, while it is generally agreed that the oil palm originated in the tropical rainforest region of West Africa, during the 14th to 17th centuries some palm fruits were taken to Americas and from there to the Far East (FAO, Bulletin 148). The oil palm appears to have thrived better in the Far East thus providing the largest commercial production as an economic crop far removed from its center of origin.

Hartley (1977), affirmed that the oil palm originates from the West Coast of Africa where it is thought to have appeared in the Tertiary period. Interestingly and indeed puzzling, the oil palm, occurs so commonly throughout West Africa. It is not known anywhere in its true wild state (Zeven, 1967; WIFOR, (1967); NIFOR, 2005).

In Africa, the main oil palm belt runs through the southern latitudes of Cameroon, Cote d Ivoire, Ghana, Liberia, Sierra Leone, Togo, and into the equatorial region of Angola and the Congo. The oil palm appears to have thrived better in the Far East thus providing the largest commercial production of an economic crop far removed from its center of origin due mainly to climatic factors (monsoon climate) and deliberate policies.

Oil palm occurs with particular abundance in Nigeria where there is what is known as the 'Oil palm Belt' especially in the Eastern region of the country and stretching from Calabar in the east to banks of the River Niger and to the west. Morgan (1955), defined the

‘Oil palm belt’ as the area which covers almost the whole of the Southern provinces of Nigeria and extending northwards along the, chief river valleys and with a northern limit of the Oil palm-marginal areas of the Oil palm belt and which appears to coincide with the rainforest/areas having high dry-season humidity. It is a region of highly acid and often very sandy soils. Morgan pointed out that there is a distinction between palm growth in the east and west, and that palm growth in the east is denser than palm growth in west and is paralleled by greater concentration of population. However, based on observed distinction of the oil palm growth density between the east and the west, climate suitability, soil types and / or ecological conditions prevailing, the “Oil palm belt” was classified into three agro-ecological growing zones as the Southwest oil palm zone, Southeast oilpalm zone and the Marginal area/zone of the oil palm belt (see Map 1, Appendix 1).

Importance of the oil palm

The Oil palm *Elaeis guineensis* (Jacq). described as a ‘golden plant’ is regarded as a stabilizing crop to global food security especially in the developing and major producing countries of South-east Asia, and Central and West Africa where the oil palm has become increasingly important driver of economic development and poverty reduction (IFC, 2011; Oyinde, *et.al.*, 2012). The major reasons for the oil palm importance are: its dominance in the global vegetable oil market and due to its inherent productivity in yield of more oil per hectare compared with any other major oil seed crops such as Rapeseed, Soybean, Sunflower, Groundnut, and Cotton seed and it is cultivated in about 43 developing countries (Teoh, 2010; Oyinde, *et. al.*, 2012; Oil World, 2013).

In terms of land utilization, of the total land area dedicated to oil crops of 258.9 million hacters (ha) globally in 2012, oil palm required about 12.2 million ha (5.5%) for its production while soybean only required 98.0 million ha (40.1%) of the total land area.

Other advantages of oil palm over other oil seeds include energy efficiency through the utilization of its own biomass as fuel for power and steam generation in palm oil mills and its lowest requirement for inputs of fertilizer and pesticides (Teoh, 2004).

Oil palm has a tremendous potential as an important agricultural crop and sources of food. Its main products – the palm oil, palm kernel and palm kernel cake are important raw materials for many foods and industrial products. Originally, palm oil was used in its crude form for cooking. It has evolved into an international commodity with many biofuels production. Also, about 80% of current world palm oil production is consumed in form of food as cooking oil and as ingredient in packaged food such as margarine, ice cream, cookies and chocolates. Others include bakery products and shortenings, vitamin A and animal feeds (NIFOR, 2009; Basiron, 2010;). The non-food uses of palm oil include soaps, cosmetics, detergents and surfactants, pharmaceuticals, nutra-ceuticals, some households and industrial products (IFC, 2011). Besides, palm wine, palm kernel shell, the fronds and trunk fibers provide others industrial and domestic applications (Gere and Gwaram, 2004). The oil palm as a source of edible oil, contributes to food security, health and well-being of the citizenry (Ikuenobe, 2010). The fruits of the oil palm contain 45 to 55% oil compared to other vegetable oils and it contains high level of Beta carotene and Tocotrienols which has been found to help protect against Cancer (Azizan, 2006).

Nigeria was once a leading producer and exporter of palm oil and palm kernel in the world and accounting for about 43% of world market trade. The export of palm oil and kernel from Nigeria dwindled between 1961 and 1965 as palm oil producer. The export of palm produce has since 1975 stagnated and Nigeria has reversed to be a net importer of palm oil (Omoti,2004; NIFOR, 2005). Presently, world palm oil production amount to over 14.4 million metric tons with Nigeria accounting for less than 7% (Olagunju, 2008). Omoti

(2003), reported that the low level of palm oil production in Nigeria was attributable to a number of factors ranging from poor quality palm oil production, near absence and limited establishment of large scale oil palm plantations; reliance on wild and semi-wild oilpalm groves production, coupled with the traditional production practices, and insufficient use of improved oil palm production technologies among majority of farmers and players in the oil palm industry (Omoti, 2003).

Oil palm production system in Nigeria

Until recently, the oil palm is not cultivated but harvested in its wild state. This situation had weakened the development of the oil palm industry particularly for export trade and domestic food demand. The production system was usually by exploiting the wild palms (absence of plantation development) and inefficient processing. It is important to note that Nigeria has an estimated 2.5 million hectares (ha) of oil palm and out of this about 350,000 ha is under Large, Medium, and Small scale plantation system. The remaining is under natural wild groves or semi-wild groves production system and dominated largely by unimproved Dura oil palm variety plantings. See Table 2.1 (Omoti, 2004; NIFOR, 2005). Under these conditions, it is not possible to achieve efficiency in production. Efficient production is obtained when crops are well cultivated with better varieties and this demand knowledge only through research.

As opposed to the improved oil palm production system which recommended use of improved Tenera hybrid variety and better agronomic practices, the traditional oil palm production method found the oil palm trees growing wild, uncultivated, irregular growth / spacing – sometimes densely packed together or widely dispersed depending on soils condition; The palms' groves are dominated with unimproved Dura oil palm variety,

uncultivated and no conscientious effort to maintain them. Palms are harvested in their wild state and fruits processed by traditional methods.

Table 2.1: Oil palm production system in Nigeria

Production system	Estimated area(ha)
Wild / Semi wild groves	2,500,000
Estates (medium and large scale)	150,000
Small holders	200,000
Total	2,850,000

Source: Omoti, 2004 and NIFOR, 2005.

Oil palm technologies and Tenera hybrid seed varietal development:

(i) Oil palm Tenera hybrid seed attributes

Over the past three decades, the Nigerian Institute for Oil palm Research (NIFOR), has made substantial effort to improve the productivity of the crop – the oil palm by developing high yielding early maturing oil palm Tenera hybrid variety capable of producing 15 – 18 tons of Fresh Fruit bunches (ffb) per ha per year and 20 – 25 tonnes of ffb per ha per year in its 1st and 2nd circle breeding programs respectively and released between 1960 to 1975 and 1980 – 2008; with its associated agronomic husbandry practices including improved palm oil processing mills. (Omoti, 2003 and NIFOR, 2009). By comparison with Oil palm Dura variety, the Tenera hybrid variety has high disease resistance, relatively slow growth among other attributes (see Table 2.2). The development of these oil palm technologies is to encourage farmers in the 24 oil palm growing states of Nigeria, to move away from the traditional oil palm production system towards utilization of improved technologies for increase productivity of the crop (See Map 2, Appendix 2.)

The oil palm (Tenera) hybrid planting material also known as Extension Work Seed (EWS) is a cross between the Dura x Pesifera using advance plant breeding technique of modified Reciprocal Recurrent Selection (RRS) breeding programme. The EWS variety has

the ability to bear fruits in 3 years after field planting establishment and produces an optimal yield of 15 – 18 tons of ffb per ha per year as from the 8 years of planting. It is adapted to highly variable soils and seasonal growing conditions in Nigeria.

Table 2.2: Quality attributes of oil palm planting materials and performance in farmer’s fields

Attributes	Unimproved Oil palm, Dura Variety	Improved NIFOR Tenera Hybrid variety	Performance of NIFOR Tenera in farmers’ fields
Maturity/Time of Fruiting (years)	5 – 7	2 1/2 – 3	2 1/2 – 3
Yield (ffb) Tonnes/ha/year	3 – 5	15 – 18	15 – 25
Oil extraction (%)	8 – 10	20 – 26	18 – 2
Oil Yield tonnes/ha	0.5 - 1	3 – 3.5	3 – 3.6
Tolerance/Resistance to <i>Fuseruim Oxyporium</i> wilt disease	No	Yes	Yes
Slow stem height Increment	No	Yes	Yes

Source: NIFOR, 2005

(ii) Research developed Oil palm Technologies

NIFOR a leading research centre for oil palm research and development in Nigeria since early 1960, developed a comprehensive package of technologies for the cultivation and production of the oil palm. These technologies comprises of improved oil palm hybrid seeds and its associated agronomic and management techniques are offered as a package technology to teeming smallholders’ farmers and the large estate farmers (medium and large scale plantation).(NIFOR, 2009). These packaged technologies include:

- Improved oil palm hybrid planting materials:(Oil palm Tenera seeds and seedlings)
- Oil palm Nursery establishment and management techniques:
 - Nursery site selection;
 - land preparation methods
 - Polyethene bags nursery practices;(Single and Double stage nursery methods).
 - Fertilizer application technique;
 - Mulching of seedlings

- Watering of nursery palm (Irrigation and manual watering).
- Pruning of nursery seedling leaves
 - Nursery weed control methods,
 - Pests and disease control methods.
- Oil palm Plantation/field establishment techniques:
 - Land preparation method,
 - Pegging and marking out planting spaces 9m x 9m Triangular spacing
 - Transplanting/ field planting of palm seedlings
 - Fixing/use of Wire collars to protect newly planted seedlings from rodents.
 - Planting of cover crops.
- Plantation/ Field Management Techniques:

Weed control practices (Mechanical-use of tractor drawn Slasher; Chemical-herbicides spray and Manual slashing of weed in the inter-row (interline) spaces for plantation/ field maintenance)

 - Ring weeding of palm base.(manually by hand)
 - Mulching of palms in the field
 - Pruning of palm leaves.
 - Pests and Disease control
- Fertilizer application methods for plantation palms.
- Pests and diseases control practices.
- Harvesting techniques of palm fruit bunches:
 - Use of Harvesting Chisel for short palms,
 - Hook knife(Malaysian knife) with long pole; ladders; Climbing ropes.
- Palm oil/ Palm kernel Processing techniques:
 - Using NIFOR Small Scale Processing Equipment(SSPE) with automated digester screw press mill graded into Small, Medium and Large Scales for different plantation sizes;
 - Nutcrackers/nutcracker separator equipment for palm kernel recovery; Palm kernel oil expeller.
- Palmwine tapping, Palmwine preservation and bottling techniques:
 - Use of crown corks on glass bottles, and use of plastic bottles.

These technologies are usually offered to the farmers and producers as packages recommendation (NIFOR, 2009).

2.1.4 Diffusion of improved oil palm technologies in Nigeria

Over the last three decades, NIFOR has made substantial efforts to improve the productivity of the oil palm by developing high yielding and early maturing oil palm hybrid Tenera (EWS) through elaborate breeding programmes. The cultivation of the oil palm was enhanced through the introduction and dissemination of the Oil palm EWS distribution and alongside agronomic and management practices to farmers across the oil palm growing belts of Nigeria. (See Table 2.3).

Table 2.3: Performance of NIFOR oil palm EWS planting materials released to farmers from 1930s to date.

Period	Type of Planting Materials	Yield in tones /ha/Year	
		FFB	Palm oil
1930s – 1950s	Open and controlled pollinated D x D; D x T and D x P crosses of selected grove palms	2.5 – 5	0.5 – 1.0
1960s – 1970s	DxP controlled production EWS planting materials from 1 st stage Oil palm breeding programme.	5 – 10.0	1.0 – 2.0
Late 1970s – late 1980	DxP controlled reproduction of elite Tenera hybrid progenies from 1 st cycle of modified Reciprocal Recurrent Selection (RRS) breeding programme.	15 – 18	3.0 – 3.6
Late 1980s – present	DxP controlled reproduction of elite Tenera progenies from the 2 nd cycle of modified RRS breeding programme.	20 – 25	4.0 – 5.0

Sources: Okwuagwu, *et. al.*, 2002; and NIFOR, 2005

Earlier attempt to disseminate the Oil palm EWS started in the late 1970s by formal government public sector extension and diffused through various extension channels of the Department of Agriculture – presently Federal Ministry of Agriculture and Natural Resource; the state ministries of Agriculture and including such states Agricultural agencies as Tree crops Unit (TCU) in Edo and Delta States, Small Scale Oil palm Management Units (SMUs) in eastern states, particularly Imo State; and more recently the diffusion channels of

the Oil palm EWS were through the Unified Extension system made up of the various states Agricultural Development Programmes (ADPs) – the state’s agricultural extension services. Besides these extension agencies, NIFOR also directly transfer research results of the palms to farmers to enhance diffusion and utilization of new developed technologies through various extension activities of On-farm Adaptive Research, Model villages demonstration programmes in Edo and Akwa Ibom States; Farmers’ specialized programme such as ‘Farmers outreach programme’ - a novel extension method designed by NIFOR, to directly catalyzed and mobilize farmers in 105 communities from 3 local government areas (Oredo, Ovia north-east and Ovia south-west).of Edo State, who owned land to cultivate oil palm and / or introduced Tenera EWS into their holdings (Gere, 2004). Other agricultural extension diffusion channels include: Organized agricultural farmers’ field days, exhibitions and training of farmers and staff of specialized agricultural extension agencies across the oil palm growing belt of Nigeria.

However, there has been a rising trend in oil palm cultivation by farmers in the 24 oil palm growing states of Nigeria where the oil palm is presently grown; and leading to a rising demand for oil palm EWS mainly by the various state governments as assistance to small-scale oil palm farmers, and many oil palm private estates. It is important to note that the oil palm EWS had been introduced and disseminated to farmers in the growing areas over a long range of time through different diffusion extension channels. This time lag made it possible to study the process, pattern, and extent of the oil palm EWS adoption by farmers. Moreover, the long time lag is important for adoption of oil palm technologies to have effects and or Impact on the farmers livelihood. Thus, long time lag is often required for Ex-post impact assessment and in line with recommendation / precondition for studies

on Ex-post evaluation and estimation of adoption (Hazel and Ramasamy, (1991) and Adato, *et.al.*, 2007).

2.1.5 Livelihood and livelihood activities:

The concept of 'Livelihood' according to Carney *et.al.*, (1999) has become increasingly popular in development studies as a way of conceptualizing the economic activities poor (non-poor) people undertake in their totalities. Livelihood by way of definition refers to the 'means' of earning income in order to live (Hornby, 2010). Livelihoods are the ways in which people satisfy their needs or gain a living (Chambers and Conway, 1992).

According to Ismail and Lipton (1997), that Livelihood is a set of flows of income from hired employment, self-employment, remittances or (usually in developing rural areas) from a seasonally and annually variable combination of all these. They said that a Livelihood should be sufficient to avoid poverty and preferably increase well-being (consumption of goods and services, health, status, achievement, and security) for a typical worker and their dependants. Livelihood implies a system of how rural people make a living and whether their livelihoods are secured or vulnerable over time. Chambers (1997) however, pointed out that the poor people maintain a portfolio of livelihood activities. Different members of the family seek and find different sources of food, fuel, animal fodder, cash, and support in different ways in different places at different times of the year. And that their living is improvised and sustained through their livelihood capabilities, through tangible assets in the form of stores and resources and through intangible assets in the form of future claims and access to income from private sources and or from property.

(a) Livelihood strategies

Livelihoods come from a variety of sources and activities and variable over time. Chambers (1987), observed that flexibility of households' livelihood determines the type

of livelihood strategies that rural household adopt and on how they respond to changes. Livelihood strategies therefore refer to the choices people adopt in pursuit of income, security, well-being and other productive and reproductive goals. Chambers (1987), noted that although some households adopt livelihood strategies that rely on few activities, most others adopt strategies that are complex, diverse, and versatile. What is important in the livelihood strategies is that it recognizes that households and individuals may pursue multiple livelihood activities sequentially or simultaneously.

Adato *et.al.*, (2007), in their report cautioned that in the context of agricultural research, we should not assume that the target individual is solely a farmer or that people with other businesses are not involved in farming. Nor should we overlook even minor livelihood strategies because they can be very important, especially for the poor who often pursue many livelihood strategies either to makeup enough income or to provide a measure for security. They observed that the pursuit of multiple livelihood activities can have important implications for cash and labour availability at different times of the year .

(b) Livelihood activities

According to Chambers (1989), livelihoods come from a variety of sources and activities and variable over time. Livelihood activities may include year-round or seasonal formal-sector employment, informal trading or sale of labour, home gardens, and food processing, livestock production, cultivation or use of natural or common property resources, labour exchange among family or neighbours, contracted ‘home work’, borrowing, scavenging, stealing, and begging. The activities may be on-farm or off-farm, including local or international migration involving elderly household members or children, be it legal or illegal (Adato, *et.al.*, 2007). They noted that for the effective analysis of these livelihood benefits, it is important to understand how these multiple livelihood activities are

related to factors faced by the poor such as vulnerability, and the ways in which their lives are affected by structures and institutions and how the development interventions may strengthen or weaken these livelihoods.

(c) Livelihood outcomes

Livelihood outcomes are the potential outcomes of research and technologies or intervention. The livelihood outcomes may include conventional outcomes indicators such as incomes, food security, and sustainable use of natural resources; Outcome indicators can also include a strengthened asset base, reduced vulnerability, and improvements in other aspects of well-being such as health, nutrition, self-esteem, sense of control, and even maintenance of cultural assets (Adato, *et.al.*, 2007). They noted however that outcome indicators arising from new technologies, practices, and institutional context are assessed in a number of ways: Thus indicators such as: Process indicators assess whether the new intervention is being used and used as intended; Intermediate outcome indicators assess such outcomes of the intervention as change in crop yields, post- harvest losses, soil fertility, improved forest management, etc.; Livelihood (welfare) outcome indicators assess the well-being of adopters and non-adopters of the intervention.

Adato *et.al.*, (2007), posited that livelihood outcomes can be measured in a number of ways (for example income, expenditure, food consumption, nutrition status, decision ability, social support, control of resources, etc.,) at a number of different levels (household level, farm level, individual level, community, regional, national,) and for different types of individuals (adopters, non-adopters, rural and urban individuals, women, men,).

George (2007), also affirmed that impact assessment for agricultural research involves impacts at many levels (plot, field, household, farm-level, community, national and

international) and also on many outcomes (level and variability of productivity, income, poverty, nutrition, health, well-being/welfare and various aspects of environment).

Livelihood outcome indicators can be captured both on direct and indirect effects of the intervention. The direct effects of outcome indicators are captured on-farm at household level and farm-level while indirect effects/benefits(outcome) indicators are captured at the community level to regional level and within the adopting areas. To capture these different effects of outcome indicators requires research designs that operate at different scales of analysis; and different research methods are required that are appropriate to each scale. However, Impacts are assessed in terms of selected livelihood outcomes including incomes, vulnerability, assets and well-being.

2.1.6 Oil palm impact pathways and livelihood activities:

(a) Oil palm potential impact pathways

Beside the continuous exploitation of wild/semi wild oil palm grove in Nigeria by the rural poor for processing and sales for cash and food, the oil palm positive impact on employment and income generation for the teeming population is considerable. The livelihoods impact benefits it brings to bear on the smallholder farmers and rural poor resulting from activities in its production and products value chain have brought improvement in their socioeconomic status and quality of life.

Oil palm livelihood activities are especially important on the lives of rural poor in Nigeria through three identified impact pathways (IFC, 2011):

- Firstly, it is largely a subsistence crop produced through harvesting wild palm fruits in intercropped fields, and processed into palm oil on-farm for households' consumption and sale for small cash largely by women.
- Secondly, commercial plantation is important. In Nigeria, commercial productions

are carried out by medium and large estates and producing incomes to rural households through smallholders out grower's scheme and through plantation employment. It is estimated that 1.8 million people in Nigeria are involved in oil palm production (Ayodele, 2010).

- Thirdly, its importance in industrial production for foods and non-food products had impacted greatly on the consumption, expenditures and prices of palm oil and its derivatives can be especially important to the livelihood of the urban poor.

Von Braun (2007), in his report noted that the identification of impact pathways through which impacts occur and the early attention to these impact pathways in the development of agricultural research programmes, can help ensure:

- that technologies meet the needs of women and men;
- that there is appropriate means of disseminating the technologies to them; and
- that lack of assets will not prevent adoption by the resource poor producers.

It has been observed that the development of the oil palm agricultural sector in Nigeria and including other African oil palm producing countries, are only producing a bit more than 10 per cent of the world average. Despite the availability oil palm technologies and large areas of land for oil palm cultivation, yields of the oil palm have continued to stagnate around 0.5 tons of palm oil per hectare (IFC, 2011). The low yields partly reflected the reliance on the wild/semi wild grove palms, inefficient processing methods, coupled with the lack luster government policies and lack of investment in the industry.

However, over the years, improved oil palm production technologies have been successfully disseminated into the oil palm growing areas with the smallholder farmers as the major target. The smallholders' adoption of these technologies represent a major opportunity to develop the industry and increase output.

(b) Oil palm livelihood activities

In Nigeria, the oil palm as a novel crop has a lot of potential livelihood options. The oil palm provides different livelihood activities in the various growing communities due to the different ways it can be used and to generate employment and income. Thus, the oil palm as a major vocation enables the rural poor to be part of the solution to poverty reduction problems through employment generation and means of livelihoods for millions of families. The livelihood activities derivable from various oil palm production operations involve the improvement through increase income, rural development, and poverty reduction. These oil palm Livelihood activities include:

- Oil palm plantations establishment and cultivation activities,
- Oil palm nursery operations,
- Palm oil milling and processing,
- Palm kernel cracking and milling operations,
- Palm fruits harvesting operations,

Other livelihood activities are:

- Broom making,
- basket weaving, Rope making,
- palm wine tapping, and palm wine bottling,
- Local gin 'ogogoro' distilling.

Other oil palm livelihood associated activities from non-farm operations:

- local fabrications of palm kernel processing/ palm oil milling equipment,
- transportation of palm produce (palmoil, palm fruits, kernels);
- marketing of palm produce.

2.2 Theoretical Literature:

This section highlights the theories supporting the study and methodologies and approaches used in impact evaluation. Briefs on issues and challenges to impact assessment were also reviewed.

2.2.1 Adoption and Diffusion of Innovations Theory

Theory in English, is used as a concept or scheme. For Psychologists, it is about human thought and behavior. While for Scientists, it is a tested and testable concept explaining an occurrence.

Rogers (2003), in his work of *Adoption and Diffusion of innovations theory*, defined adoption as “the first or minimal level of behavioural utilization” while diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003).

It has been reported that Rogers’ diffusion of innovation theory is the most appropriate for investigating the adoption of technology in higher education and educational environment (Parisot, 1995; Medlin, 2001). According to Dooley (1999) and Stuart (2000), that many researchers from a broad variety of disciplines have used the Rogers’ Diffusion Innovations model as a framework. They mentioned several of these disciplines as political science, public health, communications, history, economics, technology, and education and defined Rogers’ theory as a widely used theoretical framework in the area of technology diffusion and adoption. According to Rogers (2003), that most diffusion research involves technological innovations and usually the word ‘technology’ and ‘innovation’ are used synonymously. As defined by Rogers (2003), “a technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desire outcome”. He explained that a technology composed of two parts: hardware and

software. While the hardware is the ‘tool that embodies the technology in the form of a material or physical object’; software is ‘the information base for the tool’ (Rogers, 2003).

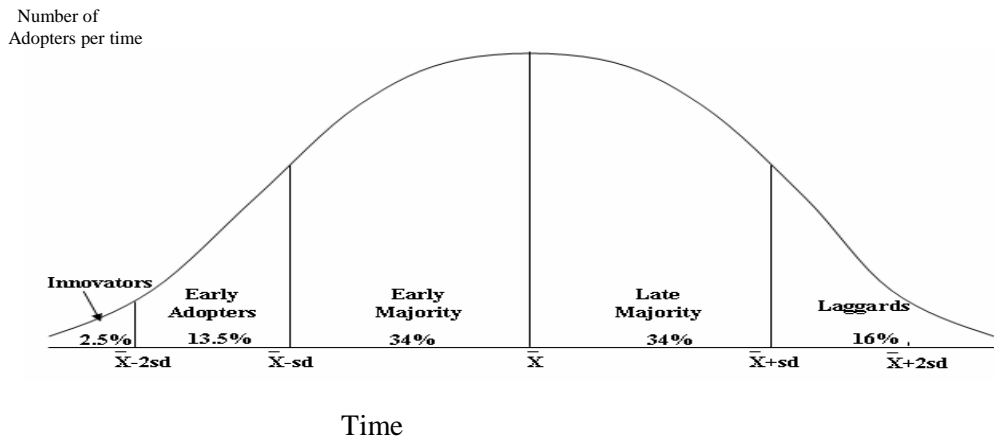
He further explained that adoption is a decision of “full use of an innovation as the best course of action available” and rejection is a decision ” not to adopt an innovation”. Thus he defines diffusion as “the process in which an innovation is communicated through certain channels over time among members of a social system”. Thus Innovation, Communication channels, Time, and Social system are the four key components or main elements in the diffusion of innovations theory.

The Diffusion of innovations model by Rogers is audience segmented which involve a number of adopters per unit of time as summarized in Figure 2. Below.

It was noted that incomplete adoption and non-adoption do not form part of this adopters classification. Only adopters of successful innovation generate this curve over time. In the normal distribution, each category is defined using a standard percentage of respondent. There is however, a striking difference between adoption and diffusion, while adoption is an individual affair, diffusion involve a large number of people. Diffusion itself refers to the spreading of information, while adoption is the decision to use a new idea and practice on a continuous basis (Akubuilu, 2008).

There are several definition of theories of innovation (Popa, *et.al.*, 2008). However, innovation in its modern meaning is a new idea, creative thought or new imaginations in form of devices or methods. Innovation in recent time is taken as the application of better solution that meet new requirements, unarticulated needs or existing market place requirements or needs as well as items that could be easily commercialized (Eze, *et.al.*, 2020).

Figure 2: Diffusion of Innovations Theory
 (Rogers,2003)
 “audience segmentation”



(Rogers, 2003)

- (1) *Innovators- Venturesome, Educated*
- (2) *Early adopters- Social leader, popular, educated.*
- (3) *Early majority- deliberate, informal social contact*
- (4) *Late majority- skeptical,*
- (5) *Laggards- traditional, lower Social economic class*

Adekoya and Tolobonse (2005), explained Diffusion as a process of information exchange or flow between dyads or other units among a group of people. The Diffusion process contain four essential stages:- the innovation, its communication from individual or groups to another, the social system where the process occurs and the time lag over which the process is affected. Rogers, (2003), represented the Diffusion process as:- S – M – C – R – E

Where: S = Source (an inventor, scientist, change agent, or opinion leader)

M = Message (the idea, skill, or information,)

C = Channels (mass media, interpersonal, friends, neighbours, opinion leader,)

R = Receiver (Target audience, opinion leader in the social system)

E = Adoption

In agricultural technology transfer (Extension), this process is represented as:

Research - Technology - Extension - Farmer
 (Source) ===== (Message) ===== (Channel) ===== (Receiver)

Adoption of new technologies :

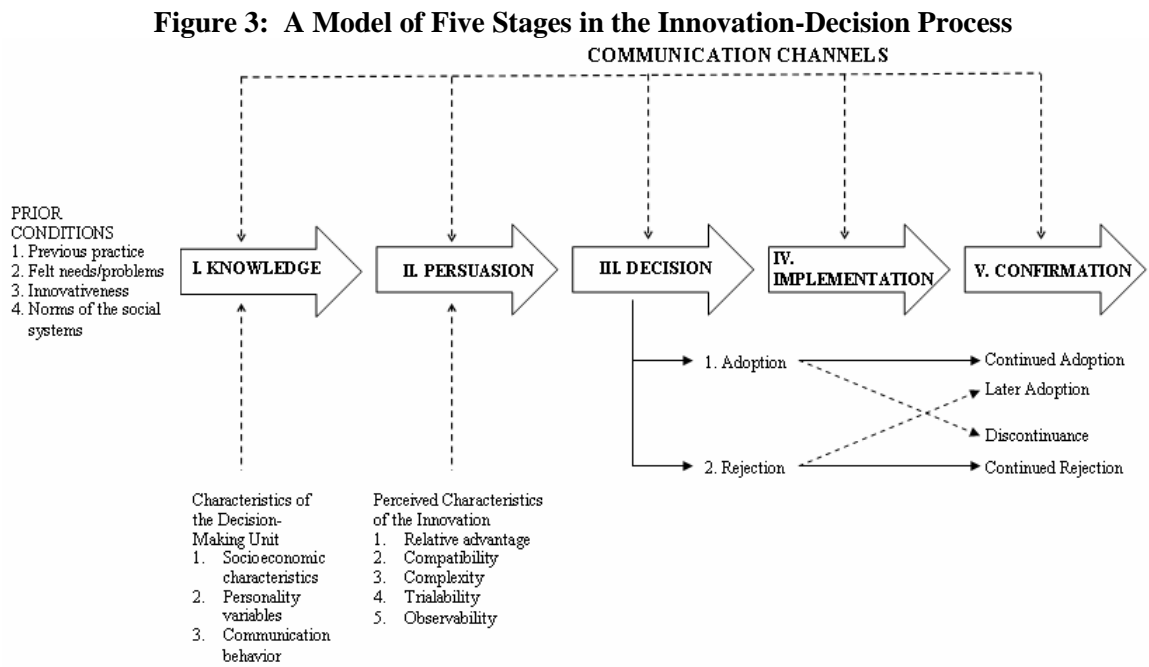
Adoption is regarded as the final stage of the process of diffusion. It is also viewed as a decision to make full use of an innovation or technology as the best course of action available. Adoption occurs when the individual apply the innovation or technology on a large scale and continue to use it in preference to old methods (Rogers, 2003). Adekoya and Telogbonse (2011), explained that adoption is the decision of an individual or group to make use of an innovation. Most farmers are said to go through a logical problem solving process known as Adoption process when considering to adopt any new technology. A farmer's decision about whether to adopt or not to adopt recommended new agricultural technology, occurs over a period of time in stages rather than instantaneous.

The Adoption process according to van den Ban and Hankins, (1996); and Rogers, (2003), consists of five stages that an individual goes through in adopting new technology. These adoption stages include: *Awareness; Interest; Evaluation; Trial and Adoption* stages. This is coded with an acronym A I E T A . These adoption processes according to van den Ban and Hawkins (1996), may not follow the sequence in practice, it depends on the technology and individual in question. Some critics observed however, that these stages are overlapping while others are skipped.

However, *Rejection* is possible in any stage of the innovation-decision process. Rogers expressed two types of *Rejection*:- *active* and *passive*. In an active rejection situation, an individual tries an innovation and thinks about adopting it, but later decided not to adopt it. A Discontinuance decision which is to reject an innovation after adopting it earlier may be considered as an active type of rejection. In a *passive* rejection (or non-adoption) position, the individual does not think about adopting the innovation at all.

Innovation-Decision process:

Rogers (2003), described the innovation-decision process as an information seeking and information processing activity where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation. The innovation-decision process involves five steps:- Knowledge; Persuasion; Decision; Implementation and Confirmation. These stages typically follow each other in a time-ordered manner (Rogers, 2003) as in Figure 3. below:



(Source: Rogers, 2003)

Rogers (2003), described the innovation-decision process as uncertainty reduction process and proposes attributes of innovations that help to decrease uncertainty about the innovation. The attributes of innovation include five characteristics of innovations:-

Relative advantage, Compactibility, Complexity, Triability, and Observability. He stated that individual perceptions of these characteristics predict the rate of adoption.

Obinne (1992), also added relevance of the innovation to the farmers as being an important factor. He opined that even if the technology is new, the farmer can still understand the relevance of the technology before adopting it. He noted that the capacity of the farmer to cope with adoption demand is also influenced by farmers' personal characteristics.

Cost as another factor is also considered important in adoption of innovation because no matter how profitable an innovation, if it is beyond the financial reach of the farmer, the technology will not be adopted (Mgbada, 2007).

2.2.2 Sustainable livelihood framework theory approach for assessing impact of agricultural technologies.

It has been argued that the sustainable livelihoods framework (SLF) can be seen as a theory, since it builds on the broader understanding of poverty and development. The SLF is an example of a useful tool for analyzing and planning development activities. It highlights how to understand, analyse and describe the main factors that affect the livelihoods of poor people. Sustainable livelihood thinking is inspired by the work of Robert Chambers in the 1980s and has been further developed by Chambers, Conway and others in the 1990s (DFID, 2008). The idea of sustainable livelihood approach (SLA) framework arose out of the 1992 Earth summit held in Rio and its promotion of Agenda 21 (Agenda for the 21st Century). Agenda 21 states that every one must have the "opportunity to earn a sustainable livelihood." This led to the acceptance of the SLA in international development in the late 1990s (DFID,1999).

Chambers and Conway, (1992) define as follows: " a livelihood comprises the capacities, assets (stores, resources, claims, and access) and activities required for a means of living; a livelihood is sustainable when it can cope with and recover from stress and

shock, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at local and global levels in the short and long term.”

This Chambers and Conway definition was modified by DFID in 1999, and gave a definition now widely used as:- “ a livelihood comprises the capabilities, assets, (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from shock and stresses and maintain and enhance its capabilities and assets both now and in the future, whilst not undermining the natural resource base.”

Sustainable livelihood Framework:

The Sustainable Livelihood Framework (SLF) is a tool for development work by highlighting how to understand, analyse and describe the main factors that affect the livelihoods of the poor people (DFID, 2008). However, since the 1980s, different scholars have had an influence on the Sustainable Livelihood Framework. Moreover, the SLF has been adapted by different organizations to suit a variety of contexts, issues, priorities and applications. This led to different versions of the SLF over the years. These SLF versions include those of CARE, Oxfam, UNDP, South Africa approaches under the Periperi framework and DFID (Carney *et.al.*, 1999).

Among these SLFs, the most widely used framework is the one used by the DFID (Figure 4). The DFID sustainable livelihood framework sets out to conceptualize:-

- How the SLF framework looks at the social and economic effects of a new technology in an integrated way, taking into account how the introduction of an agricultural technology affects the vulnerability and the requirement of capitals (financial, physical, human, natural and social capital) demanded from household.

- The framework further allows for an analysis of policies, institutions and processes that affect the adoption of a new technology by the poor and resulting effects on farmers' welfare (Chambers and Conway (1991); Ashley and Carney 1999,).

Applying the SLF requires inter-disciplinary work and used of both quantitative and qualitative research methods. It involves using both conventional Impact assessment method for analyzing hard facts and in-depth studies on household and community levels, taken into account subjective factors and the people's values.

The description of the DFID model shows that the SLF is a systematic and holistic way of describing the factors that affect the livelihood of the poor.

Various studies including Adato *et.al.*, (2007); Kerr and Kolavalli (1999); and Adato and Meinzen-Dick (2002), have adopted the Sustainable Livelihood Framework (SLF) approach in evaluating the impact of new agricultural technologies. The SLF approach has been designed to evaluate the impact of agricultural research on the livelihoods of poor farmers. Ashley and Carney, (1999) affirmed that the SLF is a particular form of livelihoods analysis used by a growing number of research and applied development organizations including the Department for International Development (DFID) of the United kingdom (one of the most ardent supporter of the livelihood framework); the United Nations Development Programme (UNDP); among others Non-governmental Organizations (NGOs) such as CARE and Oxfam.

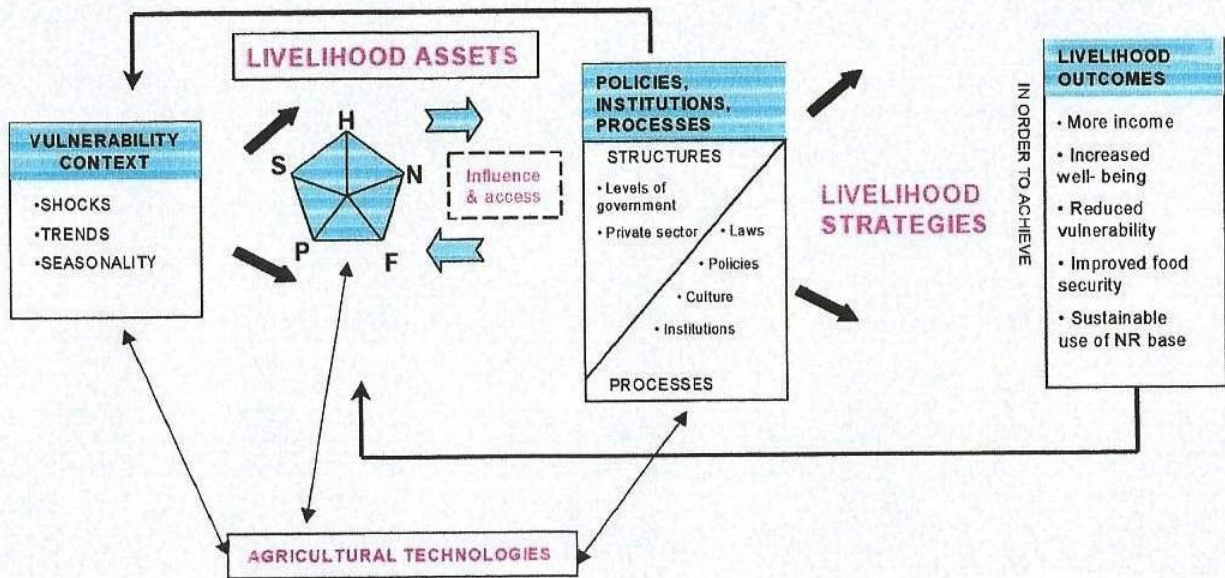
Walker *et.al.*, (2008), noted that livelihood conceptual framework is primarily the conceptual framework for analyzing the causes of poverty, people's access to resources and their diverse livelihood activities and relationship between relevant factors at Micro, Intermediate and Macro levels.

Adato *et.al.*, (2007); Alene, *et.al.*, (2007); pointed out that SLF draws on a number of theoretical and conceptual approaches to development thinking in that it is a holistic and synthetic framework which provide a method for thinking about a multiple and interactive influences on livelihoods with consideration for other important explanatory factors. Thus, SLF provides a ‘checklist’ of important issues to be considered in designing research initiative and conducting impact assessment such as: defining indicators; measuring changes in factors that contribute to livelihoods (capital asset, or livelihood asset, policies, institutional and processes; resilience or vulnerability of livelihoods; livelihood strategies and livelihood outcomes). They further noted that not everything in the ‘checklist’ can be included in one study, so prioritization is necessary.

The SLF is built on the belief that people need assets to achieve a positive livelihood outcome. People have different kinds of assets that they combine to help them achieve the livelihoods that they seek. The assets include human capital, social capital, natural capital, physical capital and financial capital (DIFD, www.livelihoods.org).

Figure 4, shows the conceptual framework of SLF approach that help researchers and development experts to understand how these indicators link to one another and the multiple factors that affect livelihoods among the indicators. The SLF illustrates the important interactions among agricultural technologies, livelihood assets, policies, institutions; and rural livelihood outcomes. According to Adato *et.al.*, (2007), that these interactions among the indicators have implications for research on adoption and impact of agricultural technologies.

Figure 4: The sustainable livelihood conceptual framework: Potential interaction with agricultural technologies



building blocks of livelihood. The five widely recognized classes of assets or capitals are natural assets (land, water); social assets (education, knowledge, health); physical assets (equipment, transport); human assets and financial assets (access to credit, remittances). They explained that a person or household needs improvements in some or all these assets to build a secure livelihood. They further explained that these livelihood assets interact with other variables of government policies, institutions and processes and which have major influence on the livelihoods of people and/or the livelihood strategies of households – the contribution to activities that households and their members engage in for a living, including agricultural production and non-farm activities, and the final livelihood outcomes (Alene *et.al.*, 2007).

Walker *et.al.*, (2008), posited that by considering the whole realm of farmers’ lives, impact assessment through the livelihood approach lens can capture many more of the aspects of impact, some obvious and some not so obvious. Livelihood impact indicators are designed

to measure changes in households' access to assets, institutional structures, relationships or livelihood strategies.

2.2.3 Methodologies and approaches used in impact assessment

In recent years, studies aimed at evaluating the contributions of agricultural technologies, farmers' livelihood impacts, to poverty reduction and food security in a comprehensive way have become more and more common. Since the use of econometric approaches to assess the costs and benefits of a technological innovations do not account for a range of Impacts that are of important to livelihoods outcomes of resource-poor farmers in developing countries, more comprehensive approaches have been introduced (Diagne, 2006).

Moreover, the awareness that so many smallholders remain out of the development process and did not adopt the proposed innovations has motivated several disciplines of social scientists (Economists, Sociologists, Anthropologists, Statisticians, etc.) to investigate the motive and justification to behaviour of non-adopters (Rogers, 2003).

Consequently, approaches to impact assessment analysis of causal effect encompassing these various disciplines led to the provision of a single unified methodological framework within which different types of impact programmes, policy change and technologies on various behavioral, environmental and livelihood outcomes can be quantitatively assessed from the perspectives of all these disciplines (Diagne, 2006; Alene *et.al.*, 2007; De Jenvry *et.al.*, 2011; Becker, 2014; Branch, 2019).

Studies including Alston *et.al.*; (1995); Baker (2000); De Janvry *et.al.*, (2011); Vanclay, *et.al.*, 2015; Stevenson, *et.al.*, 2018; among others have identified various methodologies and approaches for measuring impact of agricultural research. These methodological tools and approaches include the following:-

(1) Theory of Impact Evaluation and Counterfactual Evaluation.

The theory of impact evaluation hinges essentially on the counterfactual evaluation. The counterfactual is a comparison between what actually happened and what would have happened in the absence of the intervention. Basically, the theory of impact evaluation is a problem of missing data. Data can be collected on the factual but we cannot observe what would have happened to those affected by the intervention if the intervention had not happened. Therefore, there is need to establish a good comparison group to compare the outcomes of those that have been treated with those of the comparison group that have not been treated. In doing so, one attempts to pick a comparison group that is very similar to the treatment group such that those who received treatment would had outcomes similar to those in the comparison in the absence of the treatment (Bamberger, 2006; Shahidur *et.al.*, 2010).

Counterfactual Evaluation:

To fully assess the impact of agricultural research, it is important to establish a counterfactual - what would have happened in absence of the technologies (Adato *et.al.*, 2007). Kerr and Kolavalli (1999), found that lack of an adequate counterfactual was a key weakness of many studies of impact of agricultural research. According to Baker (2000), that determining the counterfactual is at the core of evaluation design. He affirmed that proper analysis of impact requires a counterfactual of what these outcomes would have been in the absence of the intervention. Impact evaluation is therefore, structured to answer the question: how would outcomes such as participants' well-being have changed if intervention had not been undertaken? This involves counterfactual analysis (White, 2006).

Counterfactual analysis therefore, enables evaluators to attribute cause-and-effect between interventions and outcomes. The counterfactual measures what would have

happened to beneficiaries in absence of the intervention, and impact is estimated by comparing counterfactual outcomes to observed outcomes. The counterfactual is a comparison between what actually happened and what would have happened in the absence of the intervention i.e. with the intervention (the factual), which is compared with the output and outcome of “without’ the intervention (the counterfactual) to determine the impact of the intervention through single or double difference estimates (IIIE, 2008; Wikipedia, (nd)).

According to Baker (2000), determining the counterfactual is the core of evaluation design. This can be accomplish using several methodologies which fall into two broad categories, *Experimental design (Randomization)* and *Quasi-Experimental design (Non-randomized)*. However, it has been recognized that impact from counterfactual conditions can be affected by history, selection bias, and contamination. (IIIE, 2008).

However, there are ranges of accepted approaches to determining an appropriate comparison group for counterfactual analysis using either prospective (*ex-ante*) or retrospective (*ex-post*) design. Data can be collected on the factual but we cannot observe what would have happened to those not affected by the intervention if the intervention had not happened (Bamberger, 2006).

Studies by Rossi and Freeman (1985), Ezemeniri *et.al.*, (1999) Baker (2000), and Baines, *et.al.*, (2013), have shown that impact evaluation designs are identified by the types of methods used to generate the counterfactual and which can be broadly classified into these categories – Experimental, Quasi–experimental and Non-experimental designs.

(a) Experimental design.

Experimental design also known as Randomization (or Randomized Control Trials (RCTs), are generally considered the most robust of the impact evaluation methodologies. Ravallion (2009), explained that under the experimental evaluation design, the treatment

groups and comparison groups (control groups) are selected randomly and both isolated from the intervention which may affect the outcome of interest. Baker (2000) however, noted that by randomly allocating the intervention among eligible beneficiaries, the assignment process itself creates comparable treatment and control groups that are statistically equivalent to one another given appropriate sample sizes. However, the difference between the treatment group and the control group on the average is that the control group does not receive the intervention. The experimental design evaluation approach is considered as most robust or ‘gold standard’ of evaluation, it has its own limitation. According to Bamberger and White (2007) and Deaton (2009), highlighted the limitation in applying RCTs to development intervention:

- that RCTs fall back on the Regression – based approach which they seek to avoid, thus subject to biases. Other problems include:

- the heterogeneous and changing context of interventions
- logistical and practical challenges
- difficulties with monitoring service delivery
- access to intervention by the comparison group and changes in selection criteria.

It is important to note that Random sample surveys, in which the sample for evaluation is chosen randomly, should not be confused with Experimental evaluation designs which require the random assignment of the treatment.

(b) Quasi – Experimental design approach

Quasi-experimental design approach for the determination of counterfactual can remove biases arising from selection on observables and where panel – data are available, time invariant unobservable. Quasi–experimental methods include Propensity Score Matching; Differencing or Difference-in-Difference or Double Differences (DD);

Instrumental variables, and Pipeline approach (stepped-wedge design); they are carried out using multivariate Regression analysis. (Wikipedia, Impact Evaluation (nd)). Quasi-experimental design technique generate comparison group that resemble or as similar as possible to the treatment group through methods of establishing controls. Quasi-experimental controls consist of constructed (or matched) controls and Reflexive controls (Rossi and Freeman, 1982). When these techniques are used, the treatment and comparison (counterfactual) groups are usually selected ex-post i.e. after the intervention has been initiated. This method can be used with Single Cross-section data especially when there is working time constraints (Baker, 2000).

(c) Non – Experimental design approach

Non-experimental impact evaluation does not involve a comparison group that does not have access to the intervention. The method for establishing controls used in Non-experimental evaluation is to compare intervention groups *before and after* implementations of the intervention. These control methods include Statistical controls, Reflexive controls, Generic and Shadow controls (Rossi and Freeman, 1982; and Ezemeneri *et.al.*, 1999).

Intervention interrupted Time Series (ITS) evaluation requires multiple data points on treated individuals *before and after* the intervention while before versus after (or Pre-test Post-test) designs simply require a single data point before and after. Post-test analyses include data after the intervention from the intervention group only. The Non-experimental impact evaluation design are only feasible for impact evaluation such as universally implemented programmes or national policy reforms in which no isolated comparison group are likely to exist.

(2) Quantitative approach methods

The quantitative approach methods for measuring impact of agricultural research generally use econometrics or economic models to measure the rate of returns to research. It is often commonly used for comparing returns across projects but not all impact is amenable to quantitative analysis (Baker, 2000). Some examples of the econometric model include: Cost benefit analysis; Economic rate of return assessment; Cost effectiveness analysis; Economic surplus model; Economic efficiency estimation (Norton and Davis, (1981), Jahnke *et.al.*, (1987); Alston *et.al.*, 1995).

The typical quantitative approach to evaluation can be viewed as ideally consisting of the following elements or phrases: (1). Experimental or Quasi-experimental design; (2) Quantitative data collection; and (3) Statistical analysis of data (Ezemenari *et.al.*, 1999)

(3) Qualitative approach methods of impact assessment

Qualitative techniques are also used to determine Impact by relying on something other than counterfactual to make a causal inference (Mohr, 1995). But the focus should be on understanding the processes, behaviours, and conditions as they are perceived by the individual or group being studied. (Valadez and Bamberger, 1994).

Baker (2000), reported that qualitative methods are particularly participants observation can provide insight into ways in which farming households and rural communities perceive a project and how they are affected by it. The qualitative method uses relatively open-ended methods during design, collection of data and analysis. Qualitative data can be quantified. Among the methodologies used in qualitative impact evaluation are techniques developed for:

- Rapid Rural Assessment: This relies on participants' knowledge of the condition surrounding the project or programme being evaluated;

- Participatory evaluation in which stakeholders are involved at all stages of the evaluation determining the objective of the study, identifying and selecting indicators to be used, and participating in data collection and analysis (World Bank, 1996).

Other qualitative tools used for impact assessment include: Interview/ In-depth interviews, Focus Group Discussion (FGD); Participatory Rural Appraisal (PRA), Field observation, Field visits, as well as reading anthropological and political literatures. Qualitative studies are useful because they typically elicit information on impact of a new technology directly from the people affected. This gives the researchers an idea of which impact to look for in a qualitative analysis (De Janvry *et.al.*, 2011).

The qualitative approach to evaluation includes:

- (1). Inductive or “naturalistic” open-ended inquiry;
- (2). Qualitative data collection;
- (3) Content analysis: content analysis consists of describing, interpreting and analyzing patterns observed in qualitative data, as well as the accompanying processes and causal relationship that these data generate. (Ezemenari *et.al.*,1999).

Baker (2000), identified some benefits derived from the use of qualitative methods for impact evaluation. These include:

- it is flexible to use;
- it can be specifically tailored to the needs of the evaluators using open-ended approaches;
- it can be carried out quickly using rapid techniques; and
- it can greatly enhance the findings of an impact evaluation through providing a better understanding of stakeholders’ perceptions and priorities and the conditions and processes that may affect programme impact.

He further enumerated some of the draw backs of the qualitative methods. They include: subjectivity involved in data collection; the lack of a comparison group; and lack of statistical robustness, given mainly to small sample group; all of which makes it difficult to generalize to a larger representative population.

(4) Mixed Method approach in Impact Evaluation

Walker *et.al.*, (2008), observed that the methods used for impact evaluation usually depend on the type of assessment and its purpose. Baker (2000) however, noted that while majority of studies on impact of agricultural research are carried out using conventional econometric models, such as cost benefit analysis, the mixed methods which reflect sound disciplinary practices provide analytical methods for multi-dimensional impact assessment.

The mixed method approach is an integration of both the use of quantitative and qualitative tools. It is a multi-dimensional impact assessment method that embraces a diverse set of inquiries to exemplify the effects of technological change on growth linkages, labour market and migration, producers' welfare and poverty (Hazell and Ramasamy, 1991; David and Otsuka, 1994; Adato and Meinzen-Dick, 2007).

An example of the Mixed method approach to Impact evaluation is the multi-dimensional impact assessment livelihood approaches (DFID, 1999; Pasteur, 2001). According to Adato and Meinzen-Dick (2007), that use of the mixed method approaches, is integral to implementing livelihood prospectus. Combining quantitative and qualitative methods provide a quantification of impacts as well as explanation of given outcomes.

Ezemenari *et.al.*, (1999), in their report noted that these two “pure” approaches (quantitative and qualitative approaches) can be combined in various ways for enriching the analysis of programme impact evaluation as follows:

- (a) Experimental design, quantitative data collection, and content analysis;

- (b) Experimental design, qualitative data collection, and statistical analysis;
- (c) Inductive / naturalistic inquiry, quantitative data collection, and statistical analysis;
- (d) Inductive / naturalistic inquiry, quantitative measurement, and statistical analysis.

They further noted however that these combinations are far from being exhaustive and that in practice, a particular evaluation can include different types of design, data and forms of analysis.

Bamberger (2000), in his study revealed several benefits of using the mixed method integrated approaches in impact evaluation. Among these are:

- Consistency checks that permit the use of two or more independent estimates to be made for key variables, such as income, opinions of the projects, reasons for adopting or not adopting, and specific impact of a project.
- Different perspectives can be obtained
- Analysis can be conducted on different levels
- Opportunities can be provided for feedback to help interpret findings.

The greater flexibility of qualitative method permits a rapid follow-up to gather additional data in the field and also check on these cases. In practice, mixed methods – the integration of quantitative and qualitative methods should be carried out during each step of the impact evaluation (Bamberger, 2000).

(5) A Theory–Based approach to Impact Evaluation

A Theory–based evaluation design is one in which the analysis is conducted along the length of the causal chain from input to impact (IEG, nd). A Theory–based design involves mapping out the channel causal chain from inputs to outcomes and impact and testing the underlying assumption (White, 2009; White and Raitzer, 2018). In many cases according to the IEG, this analysis will already be contained in the Project Logical

Framework (Project Log-frame). The Log-frame may also specify indicators at various levels. White (2009), advocates more widespread application of a Theory-Based approach to impact evaluation as a means to improve policy relevance of impact assessments outlined six key principles of Theory-Based approach :-

- (i) Map out the causal chain (Programme Theory) which explains how intervention is expected to lead to outcomes and collect data to test the underlying assumption.
- (ii) Understand context of social, political, and economic setting of the intervention.
- (iii) Anticipate heterogeneity to help identify subgroups and adjusting the sample size.
- (iv) Rigorous evaluation of impact using a credible counterfactual.
- (v) Rigorous factual analysis of links in the causal chain.
- (vi) Use of mixed method approach (a combination of quantitative and qualitative analysis methods).

Rigorous impact evaluation is one which applies the appropriate technical procedures and relevance, which depend on a contextualized Theory-Based approach and which qualitative data provide vital context. According to IEG, adopting the Theory – Based approach to impact evaluation is the best way of ensuring relevance since it yields information on how the programme is working. Its application implies the use of mixed method evaluation design i.e. one that combines quantitative and qualitative methods and qualitative data collection including Focus Groups Discussion, In-depth interviews, Participatory Rural Appraisal (PRA) and Field visits as well as reading Anthropological and political literature (World Bank, 2002).

(6) Impact pathways framework approach for agricultural research impact evaluation

Baur *et.al.*, (2001) and EIARD (2003), affirmed that a central task of impact assessment is to establish highly plausible links between a research effort and the observed changes along the ‘Impact Pathway’. Maredia and Raitzer (2006) and Raitzer and Kelly (2008), also stressed that the principle of good practice impact assessment at all stages, is to enhance the rigor of establishing the links along the ‘Input – Output – Outcome – Impact pathways’ beyond ‘plausibility’ to substantially demonstrated impact. Walker *et.al.*, (2008) however, emphasized that either explicitly or implicitly all impact assessment (*ex-ante* or *ex-post*) studies must construct an impact pathway from research output to impact indicators of interest, including addressing essential counterfactual and attribution dimension.

‘Impact Pathway’ is a ‘Map’ or hypothesis of how a specific project is linked with various factors and observed changes in target impact indicators. Impact pathways are a type of logical model, that is, they constitute a model that describe the logic of what the project will do, is doing or what it did. It is a prelude to impact assessment as it provides a guide to the major focal points of the analysis and to data needs and sources. An impact pathway provides a pragmatic strategy for documenting hard-to-track consequences. Impact pathways provide hypothesis about the cause – and – effect linkages that connect project output to outcomes and under some circumstances, also impact (Walker *et.al.*, 2008). The pathway from research to outputs to outcomes to impact is a cumulative result of ‘cause – and – effect’ relationship between many players and different factors (Walker *et.al.*, 2008). They further stressed that even if it is not required, undertaking an impact assessment within an ‘Impact Pathway Framework’, helps to increase the likelihood that all intended and unintended, positive and negative impacts are identified and where possible quantified.

Some tools for developing Impact Pathway Framework in the context of project monitoring and evaluation are ‘Outcome Mapping’ and Participatory Impact Pathway Analysis (PIPA) – a version of outcome mapping that has project implementers and stakeholders working together to agree and define pathways, which are then made explicit as impact hypothesis (Walker *et.al.*, 2008).

(a) Outcome Mapping Approach

Earl *et.al.*, (2001), reported that ‘Outcome Mapping’ was originally proposed as a methodology for planning, monitoring and evaluating development programmes by the International Development Research Center (IDRC). They observed that the proponents’ of Outcome Mapping are skeptical about possibility of attributing impact to programme for social change because of the complexity of the development process and non–unidirectional nature of resulting and associated change. Hence Outcome Mapping focuses on outcomes defined as ‘the change in behaviours, actions or relationships of the key stakeholders (boundary partners) who can be influenced by the programme (CGIAR, 2006). Salas (2002), observed that Outcome Mapping helps the project to achieve its goals and enhances team and programme understanding of the intended change process.

(b) Participatory Impact Pathway Analysis (PIPA) approach

According to Douthwaite *et.al.*, (2007), noted that PIPA is a recently developed approach to planning, monitoring and evaluating Research–for–Development (R4D) projects that share similarities with outcome mapping. It involves holding workshop where project implementers and stakeholders make explicit the anticipated Impact Pathways (a principal point of difference from outcome mapping). The PIPA theory describes plausible Impact pathways by which project outputs are used by others to achieve a chain of outcomes leading to contribution, to eventual impact on social, environmental and economic

conditions. The advantage of using the PIPA generated Impact hypothesis rather than evaluator in outcome mapping – generated one, is that project staff and stakeholders are more likely to use and learn from the impact assessment findings (<http://impactpathways.pbwiki.com>).

Douthwaite *et.al.*, (2007), further affirmed that where the quantification of impact is difficult, Outcome Mapping and PIPA provide interim indicators of the links among outputs and outcomes. They observed also that one disadvantage of using the Outcome Mapping and PIPA is presumption that scientists know what their findings will be. Moreover, they reported that the value of these approaches need to be further assessed as it may be possible to identify all the potential outputs, outcomes, and impact to be realized particularly for research activity of 10 - 20 years down the road.

(7) Programmatic Approach to Agricultural Research Impact Assessment

Programmatic approach method to impact assessment in agricultural research involves the periodical review of research programme(s) generated by research centers (national or international). It involves the review of research activities and programmes already concluded or ongoing both as in Internal In-house Research Reviews (IIRRs) and External Programme Management Reviews (EPMRs).

Programmatic impact assessment can be carried out in retrospective analyses recording the technological changes that a research programme has contributed to (Walker *et.al.*, 2008). However, they stated that a good practice of programmatic ex-post impact assessment should entails ten years interval between one research review and another particularly for research areas that involve plant breeding which have substantially demonstrated impact in the past. Evenson and Gollin (2003), noted that a programmatic impact assessment of research if undertaken, may take several years to complete and where

resources have to be mobilized and scientists usually 50 – 100 from many partner Institutions participate in supplying harder field information that blends estimates with softer experts opinion.

(8) Estimating adoption of agricultural technologies approach for impact assessment

Adoption studies have been seen as important tools for measuring and assessing the Impact of agricultural technologies (CIMMYT, (1993); Feder and Umali, (1993); Rogers, (2003); Maredia, *et. al.*, (2013); Stevenson and Vlek, 2018). Technology adoption brings potential impact at farm household level. Analysis of the adoption process also permits investigation of the categories of farmers that benefited most from a particular technology (Sanginga *et.al.*, 1999).

Walker, *et. al.*, (2008), averred in their report that adoption or influence of a technology or policy is necessary for it to have an impact and that compared to estimate on other variables in ex-post impact assessment in agricultural research estimates on adoption are usually shrouded in uncertainty and should not be taken lightly.

Studies by De Jenvry *et, al.*, (2011) however, stated that in estimating agricultural technologies adoption for impact analysis, it is necessary to consider the dynamic nature of technology adoption and diffusion since it defines some types of analysis:

- the micro economic analysis that attempts to measure impact on adopters in the context of limited diffusion and where there are considerable number of counterfactual group (non-adopters); and
- measurement of aggregate impact of new technology.

Maredia (2009), earlier affirmed that the goal in performing an impact analysis for a technology innovation or intervention is to estimate the total effect of the new technology on

a set of outcome variables after some amount of diffusion has taken place. Maredia further outlined the steps or framework used by existing impact evaluation to estimate the total effect as:-

- ❖ the extent of adoption (E_c); and
- ❖ average effect that adoption has on outcomes for those who have adopted (E_s)

She explained that: E_c may be the total number of hectares planted with a new variety of crop or the number of villages that received the intervention; and E_s may be the average increase in annual profit per hectare. (E_s)

De Janvry *et. al.*, (2011), also stated in their studies that estimates of the extent of adoption E_c can be obtained from an adoption survey that samples the population under consideration. And that the principal data necessary for estimating E_c include indicators to identify whether household has adopted (if the adoption decision is binary) or measure of the extent of adoption (if the household's adoption is incomplete). They explained however, that estimating average impact of adopters from adoption E_s involves:

- (i) estimating effect for the current population: obtaining the effect of technology for farmers that actually adopted.
- (ii) establishing causality: isolating differences in observed outcomes that are due to adoption.
- (iii) accounting for spillover: including spillover from adoption in estimate of a technology impact.

However, to estimate the total effect of new technology therefore:

- for the short term impact, is a measure of itself - the average effect of adoption on adopters (E_s)
- the aggregate effect of technology is measured by simple product $E_c \times E_s$ (provided

estimated effect size E_s corresponds to the estimated area of adoption E_c).

Estimating adoption for ex-post impact assessment is usually derived from the following:

(1) Economic rate of return assessment that are predicted on annual estimate of adoption.

But it is only for very few technologies that annual estimates can be furnished from primary or secondary data without having to resort to projection or backward forecasting (Walker and Crissman, 1996).

(2) Typically, a survey is used to elicit information on adoption and this inquiry often relies on mixed methods evaluation approach that accounts for the bulk of operational cost for the measurement of ex-post impact assessment.

(3) Cross-checking with information on tangible technologies: the adoption of some tangible technological components can be estimated from data on market sales. Examples include sales of hybrid and open-pollinated planting seeds variety (from Research Institutes, seed agencies etc.), agricultural machinery, biological control products; etc. The skillful use of these data on production, sales and distribution over time may well provide 'harder' estimates of adoption than survey multi-purpose field research for ex-post impact assessment:- the adoption survey – field research for ex-post impact assessment data on user uptake.

Kshirsagar *et. al.*, (1994) in their studies however, cautioned that care must be taken that output sales and distribution data reflect the use of tangible technologies; and that apart from seeds, the initial demand for these tangibles usually public-sector products can be subsidized and institutional. Moreover, data on production tell us little on extent of adoption especially due to the incidence of product abandonment and/or underutilization. The suspicions about abandonment points to the need for a survey to document the level of use.

(4) Multi-purpose field research for *ex-post* impact assessment:- The adoption survey – field research for ex-post impact assessment is based on multiple instruments, ranging from Rapid Rural appraisals to detailed field measurement on technological changes. Adoption surveys are usually a staple element in field research for technological ex-post impact assessment. In contrast, traditional diffusion surveys are oriented towards understanding what determines adoption and the constraints on diffusion (Rogers, 2003).

However, depending on the geographical coverage of an ex-post impact assessment, an impact adoption survey is often conducted to estimate benefits. The survey seeks to answer the following questions:

- what are some of the characteristics of typical adopters?
- what technology did the new practices and varieties replace?
- what are the strength and weaknesses of the ‘new’ technology vis-à-vis the ‘old’ technology?

De Janvey *et. al.*, (2011), stressed that for the estimation of impact adoption survey, impacts to be considered must include:

- farm-level restricted profits are the natural place to start when looking for the immediate impact of a new technology. This represents the expected profitability that drives farmers to adopt a new technology and provide the channel through which adoption increases producers’ livelihoods and/or welfare.
- yield is apparently simpler measure of impact of agricultural technologies but it does not reveal the extent of producers’ welfare is affected by the technology.
- It is also important to estimate impact on household income, expenditure and poverty since these give a measure of the extent to which the technolog actually affect household livelihoods.

2.2.4 Overview of impact evaluation issues and challenges

In recent years, there has been growing concern to assess the impact of agricultural research at farmer's level to determine who benefit from technological change and in what specific ways at both small-scale and societal level (Saniginaga *et.al.*, 1999).

Kerr and Kolavalli (1999) and Guthrie, *et.al.*, (2018) averred in their studies on impact of agricultural technology that it is difficult to make generalization about impact of agricultural research on the poor and that distribution of benefits depend on underlying social, economic and political institutions rather than the intervention *per. se*. They therefore call for the need of finding the means of measuring and evaluating impact of agricultural technologies on the different producers' group.

However, a number of conceptual and operational difficulties particularly arising from methodological issues posed several limitations and challenges to the scope and depth of impact assessment works. According to the CGD (2006), that challenges arising there from include the argument on methodological approaches to impact evaluation particularly on the issue of 'Rigorous Impact Evaluation' coupled with the mistaken belief that supporters of this rigorous impact evaluation are pushing for an approach solely based on Randomized Control Trials (RCTs).

The current indication on the methodological issues of 'measuring results and using numbers' recognized the need for a range of approaches towards mixed methods–multi–dimensional impact assessment and stressing for a synthesis of quantitative and qualitative approaches in impact evaluation (CGD, 2006; White 2006; DFID, 2008; IIIIE, 2008; Vanclay and Esteves, 2011; Bice, 2020).

According to DFID (2008), noted that there is need for development experts to have greater understanding by assessing the links between agricultural productivity and poverty

and the extent to which small-scale agriculture can remain a ladder out of poverty for millions of poor people living in rural areas. They noted that the links between agriculture and poverty reduction are forged through four transmission mechanisms:-

- direct and relatively immediate impact of improved agricultural performance on rural income;
- impact of cheaper food for both urban and rural poor;
- agricultural contribution to growth and generation of economic opportunity in the non-farm sector; and
- agriculture's fundamental role in stimulating and sustaining economic transition as countries (as poor people's livelihood) shift away from being primarily agriculture towards a broader base of manufacturing and services (DFID, 2008).

Amongst other challenges in impact evaluation are issues of counterfactual (non-adopting group) - meaning having a comparison group that has not benefited from a programme or policy or intervention; including the need to find standard indicators which captures non-material impacts and which are sensitive to social difference; and also especially the challenges on the issues of:-

- (a) addressing the needs of the poor and/or how the impact of agricultural research on poverty and means by which contribution to poverty reduction can be increased (Pinstrup-Anderson and Javier, 2001).
- (b) issues of the many dimensions of poverty which measurement is susceptible to threats of construct validity- measurement can lack credibility because there is no natural unit of measurement (Shadish *et. al.*, 2002; Bamberger *et. al.*, 2006).

The challenges in poverty impact assessment are particularly critical also when broadening the enquiry to approaches and impact dimensions that go beyond the traditional econometric measures and indicator of poverty.

However, several studies, Adato *et.al.*,(2007), have recognized that given the complexity of the factors conditioning the impact of agricultural technologies on farmers' livelihoods and/or poverty, the following must be considered and taken into account when conducting impact evaluation:-

(i) The scope of the impact analysis:

It should be such that capture the direct impact of improved agricultural technology on the poor as well as the indirect impact. The direct impacts are captured by poor farmers who adopt improved technologies and who produce more outputs which they consume themselves or sell. There is also the indirect and cumulative impacts including the second/third order impacts (CGD, 2006). The secondary impact or indirect impact are those caused by primary or direct impacts which result or occur much later. The cumulative impacts are those resulting from incremental impact of an action added to other past, present and reasonably foreseeable future actions (CGD, 2006).

Spillover benefit to other households or regions especially spillover effects or impact from the generation of new employment, higher wages, less costly food to non-farm rural poor, the urban people and land less labourers should also be captured.

(ii) Use of integrated economic and social analytical methods:

The use of integrated economic and social analytical methods for measuring impact, and especially using quantitative and qualitative methodological approaches fully and satisfactorily to establishing causality. Triangulation and cross-checking of these methods is also important. Adato *et.al.*, (2007), further reported that the field of social analysis,

including various aspect of applied anthropology, rural sociology, political science and institutional analysis have been key in developing new ways of understanding and measuring poverty/welfare impacts. They observed that whereas the use of econometric based analysis approaches have been most common, other approaches that consider basic human needs, basic capacities, vulnerability, social support or exclusion and related factors can reveal more complex aspect of the live of poor people. These different facts of poverty cannot be easily measured using formal quantitative econometric methods.

(iii) Establishing an adequate counterfactual situation:

To assess what the situation would be like if the technology had not been adopted – the counterfactual situation. It is the comparable region or group of farmers who are identical in all respects to the adopters except that they have not had a chance to adopt the technology themselves. Kerr and Kolavalli (1999), found that the lack of an adequate counterfactual was a key weakness of many studies of impact of agricultural research. Therefore, impact studies most account for counterfactual by including the adopters and non-adopters and examining different conditions among them and controlling for any systematic differences in their characteristics that might affect their decision and performance.

(iv). Accounting for other factors:

Besides improved technologies, several other factors affect changes in agricultural production and their impact on the poor at farm-level. These factors include prices, risk, access to inputs, credit and market; Educational levels, land distribution among other factors also affect the rate of improved technologies uptake and extent to which they benefit the poor.

(v) Allowing for time lags:

There should be a long time lag between expenditure on agricultural research and the effect of the research; in addition to the long time lag inherent in most agricultural research can also lead to important time lag in adoption. Large scale farmers often adopted quickly compared to small-scale farmers that took several years to adopt (Hazel and Ramasamy, 1991). There may be further lags between adoption of improved technologies and their effects on production and poverty e.g. such technologies as establishment of farm trees e.g. Oil palm, livestock improvement which do not yield productivity gain for some years.

(vi). Accounting for risk and vulnerability factors:

According to Adato *et.al.*, (2007), vulnerability analysis incorporate risks, shock and threats which people face as well as their resistance and resilience. Vulnerability factors include trends, shocks and seasonality factors farmers' face in the process of technologies adoption and which may reduce or increase farmers' vulnerability in positive or negative direction. The trends in the population include resources such economic indicators as prices, governance, or technologies; Shocks include changes in human health, animal health, natural disasters - low land flooding, drought condition, political conflicts, sudden economic changes like prices, and currency fluctuations; Seasonality in prices of agricultural production, employment opportunities, resource availability or health, politics, belief, ethnicity, culture, gender, class, and other factors all these affect the nature or degree of farmers' vulnerability and their resiliency. These factors must be considered along with average returns; whose implications lead to variability and other dimension of technologies adoption. It has been observed that it is not just the objective risks, trends or shocks that matters, but the peoples subjective assessments of things that make them vulnerable (Adato *et.al.*, 2007).

(vii) Defining the benefits:

New technologies, practices, and the institutional context can potentially affect a wide range of indicators. Process indicator assess whether the new technology or intervention is being used and used as intended; Intermediate outcome indicator assess such outcomes of the intervention as change in crop yield, post-harvest losses, soil fertility, forest management. Livelihood-welfare outcome indicators assess the well-being of adopters and non-adopters of the intervention (Adato *et.al.*, 2007).

2.3 Conceptual framework of the study

Impact evaluation studies are faced with both conceptual and empirical challenges. This is due partly to the complexities of the relationships between agricultural technologies and rural livelihood and as the goal of agricultural technologies development change from that of increasing food production to the broader aims of improving farmers' livelihood and/or reducing poverty. The conceptual framework for assessing the impact of adoption of improved oil palm technologies on farmers' livelihood in the study area is made up of the independent, dependent and intervening variables as shown in the schema (Figure 5) below.

The independent variables are made up of selected socio-economic characteristics of the farmers and information on their farming operations, and sources information of the oilpalm technologies. Some of the farmers' socio-economic characteristics include age, gender, marital status, educational level attained, farmers household size, and membership of farmers' associations.

The dependent variables include research generated improved oil palm technologies; and farmers' livelihood impact/benefits resulting from the adoption of improved oil palm technologies. The intervening variables are variables considered to be very important in this

study and could affect the livelihood outcomes and/or farmers livelihood impact/ benefits. These intervening variables are government policies, institutions, and processes including state of the economy, infrastructure/rural infrastructure, cultural factors; constraints/vulnerability factors that can impinge on dependent and independent variables. The relationships between these variables are as summarized below:

The schema assumes that the relationship between the dependent and independent variables is strong but a weak relationship exist between the intervening variables and independent/dependent variables since they have no direct effect on the target population of the study. The relationship between the variables was based on the premises as follows:- that the adoption of improved oil palm technologies B by the farmers in the study area will be influenced by their socio-economic characteristics A. There is also interaction between B and E. These interactions will also influence the farmers' livelihood and consequently lead to livelihood outcomes in C and hence generate necessary impact. Among other interactions also in this schema are interactions between variables A and B, and between B and F. This can increase or decrease adoption of technologies.

This model however, summarizes the basis for the statistical analyses in this study.

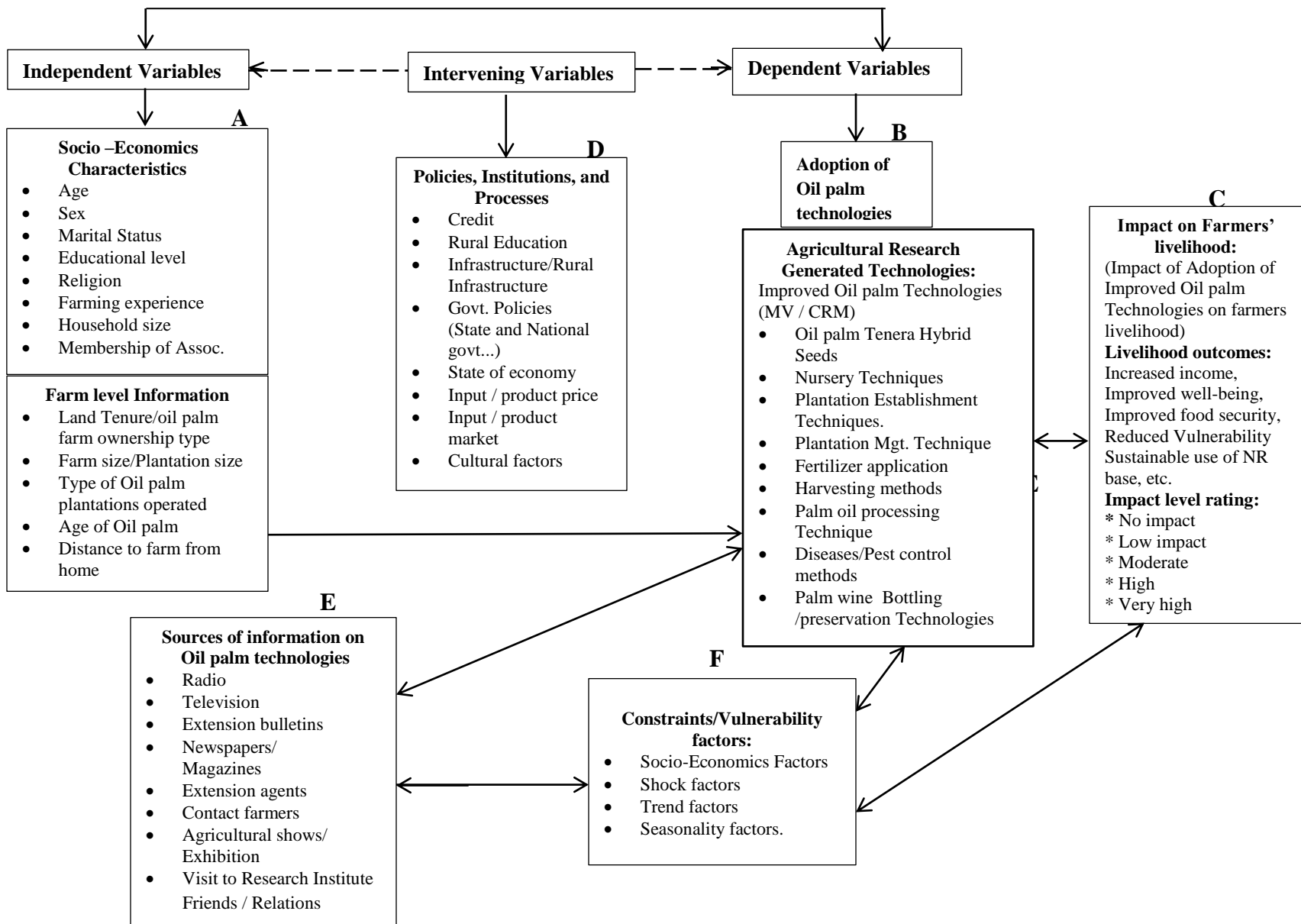


Figure 5: Conceptual Framework for Assessing the Impact of Adoption of Improved Oil palm Technologies on Farmers' Livelihood.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

This study was carried out in South-South agro-ecological zone of Nigeria. The zone consists of the following states, Edo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross Rivers (Figure 6.1). The area lies between latitude $4^{\circ} 10'$ and $7^{\circ} 30'$ North, and longitude $4^{\circ} 30'$ and $9^{\circ} 45'$ East. It has a total land area of 112,110 sq.km. The area has a population of 21,044,081 million people and with a growth rate of 2.83% per year (NPC, 2006; NDDC, 2008). The main ethnic groups of the zone are Ijaws, Efik, Anang, Ibibio, Ogoni, Urhobo, Edos, Itsekiri, Isoko, Igbos and among other ethnic groups. The rural population constitutes about 65% of the total population of the zone. The occupations of the people vary widely. The ethnic groups in upland areas engage mainly in farming while Ijaws and other people in the riverine and coastal areas are largely fishermen.

The south-south agro-ecological zone is dominated by land plains of less than 200m above sea level with major land forms of highland areas in northern part of Edo State and part of Cross-River State and low land areas and coastal plains in most parts of the zone. The dominant soil type is the acid sand soil – highly degraded deep sandy letosol called the Benin fasc/Calabar fasc soils to more highly weathered leached hydromorphic/Deltaic alluvial soils of the coastal areas (Gere, 2004). The climate of the zone is tropical equatorial with distinct dry and rainy seasons. The mean annual rainfall varies from 2600mm to over 3000mm in most parts of the coastal areas. The monthly temperature range is 18°C – 32°C during the dry season and with relative humidity of 70%. The vegetation type/sub-ecologies

found in this zone are mangrove swamp forest, lowland forest, rain/high forest and woodland/Southern guinea savanna (Shaib *et. al.*, (1997).

Farmers in this zone combine crops and fishery and sometimes livestock in their farming systems. The cropping systems are usually root and tree crops based, and largely dominated by subsistence needs and market demands. The dominant arable crops of the zone are cassava, plantain/banana, yam, maize, rice, cocoyam, pineapple and vegetables. oil palm and rubber and to a less extent cocoa are important tree crops, including forestry and timber logging. The zone is among the major producer of oil palm and rubber. (Shaib *et. al.*,1997). The oil palm in particular forms a very important part of the vegetation of the South-South agro-ecological zone and where it is widely distributed and cultivated as a major cash crop.

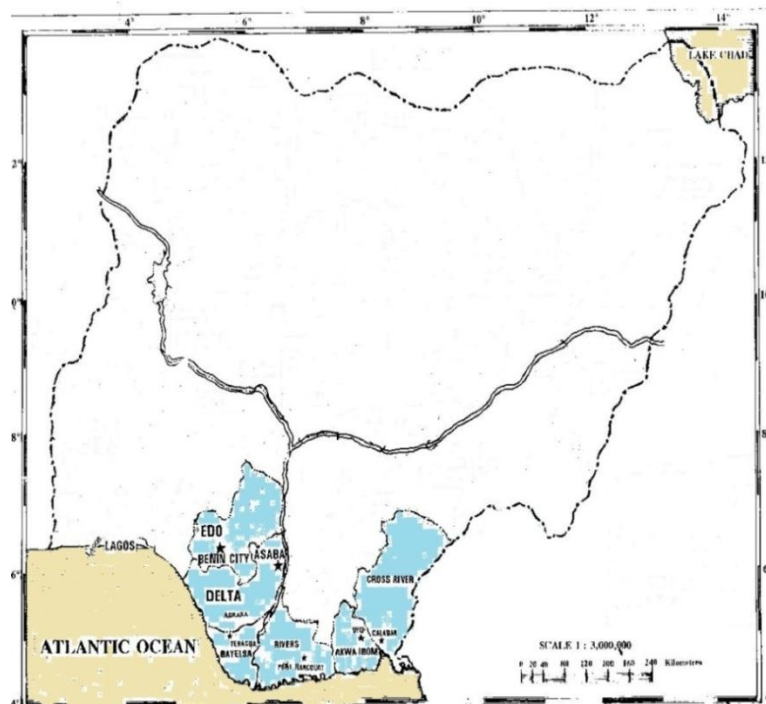


Figure 6.1: Map of Nigeria showing the South-South Agro-ecological Zone of Nigeria.

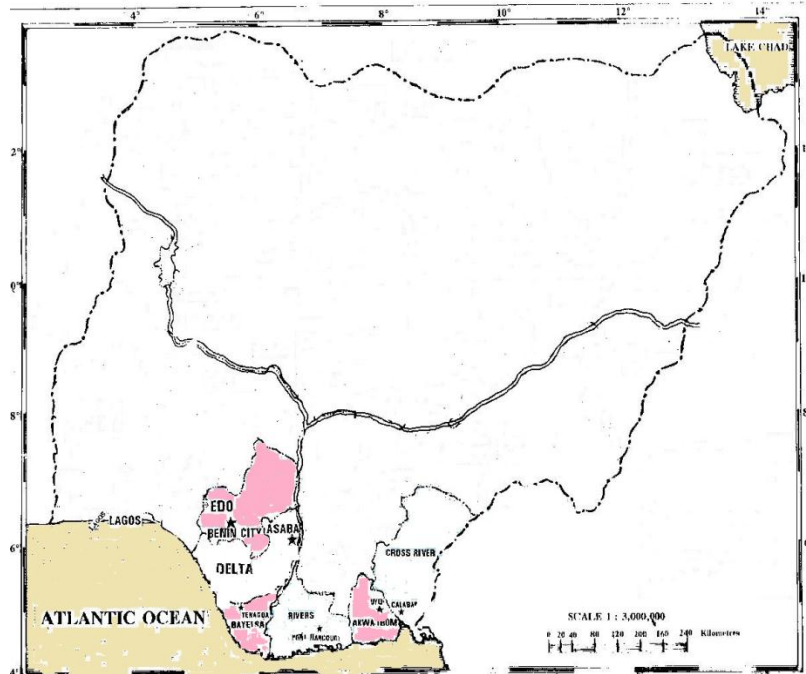


Figure 6.2: Map showing the selected study location of Edo, Bayelsa and Akwa Ibom states within the South-South Agro-ecological zone.

3.2 Sample Selection

The study was conducted in the South-South agro-ecological zone of Nigeria. The target population for this study were the smallholder oil palm farmers who have cultivated oilpalm for long period of time for impact to be observed. A multistage sampling method was employed to select the farmers. In the first stage, the states in the zone were stratified into three, based on their similarity of locations as follows:

Edo and Delta States – Western location of the zone;

Bayelsa and Rivers States – Southern location of the zone;

Akwa Ibom and Cross River States – Eastern location of the zone.

From each of the location strata, three states Edo, Bayelsa and Akwa Ibom were purposively selected. The reason for selection of Edo and Akwa Ibom States: they are classified among major oil palm producing states in Nigeria and also known to have a high cluster of oil palm cultivation/processing (Ayodele, 2010). Bayelsa State was regarded as

minor producing state. These states are believed to give fair representative sample for the study.

In the second stage, the Agricultural Development Projects (ADPs) of each of the state selected were sub-divided into a number of administrative units. Edo State was divided into three ADP zones – Edo north, Edo Central and Edo South; Bayelsa State was also divided into three ADP project zones of Bayelsa North, Bayelsa Central and Bayelsa South; and Akwa Ibom State also was delineated into Akwa Ibom North ADP zone, Akwa Ibom Central and Akwa Ibom South. For the purpose of this study, representative numbers of these zones per state were also purposively selected based on the population of smallholder oil palm farmers. Thus, from Edo State, the central and south ADP zones were selected; from Bayelsa State, Bayelsa north and Bayelsa central ADP zones were selected while in Akwa Ibom State, central ADP zone and South ADP zone were selected. (Table 3.1).

In the third stage, the target population of this study which comprised smallholder oil palm farmers who established oil palm farms well above five years were selected. The reason for selection of farmers in this category was based on the gestation of the oil palm which takes about four years for harvesting to commence and for any impact to be observed in the farmers' livelihood outcomes. Purposive selection of 930 farmers, 860 farmers and 300 farmers were selected from Edo, Akwa Ibom and Bayelsa States respectively. These gave a total sample frame of 2090 farmers. The Krejcie and Morgan (1970), table for the determination of sample sizes from a given comparison population was used to determine the corresponding sample size of the 2090 farmers. To obtain the required Sample size, enter the Krejcie and Morgan (1970) table at population Size $N = 2090$ and which corresponds at the population size $N=2000$. This gave a Sample size (S) of three hundred twenty-two 322 (see Apendix.4). From this total sample size of 322, the farmers were

randomly selected proportionately at the rate of 146 farmers(45.3%) for Edo State, 60 farmers(18.6%) Bayelsa State and 116 farmers (36.0%) Akwa Ibom State and used for the study. The Krejcie and Morgan (1970) Table is applicable to any defined population. According to Krejcie and Morgan (1970), the relationship between sample size and total population is that as the population increases, the sample size increases at a diminishing rate and remain relatively constant at slightly more than 380 cases.

Table 3.1. Population and Sample Size selection

Selected States	ADPs Administrative Zones	Selected ADP Zones	Selected Farmers Population(N)	*Sample Size (S)
Edo State	Edo South			
	Edo Central	Edo South	930	146
	Edo North	Edo Central		
Bayelsa State	Bayelsa North	Bayelsa North		
	Bayelsa Central	Bayelsa Central	300	60
	Bayelsa South			
Akwa Ibom State	Akwa Ibom North	Akwa Ibom Central		
	Akwa Ibom Central	Akwa Ibom South	860	116
	Akwa Ibom South			
Total			2090	= 322

* Population sample size was derived from Krejcie and Morgan Table (1970).

3.3 Data collection methods

To generate data for this study, several data collection methods were used. Data were collected from both primary and secondary sources. The basic survey instrument for the collection of primary data involved both quantitative and qualitative data collection methods include structured questionnaire, farmers' in-depth interview, focus group discussion (FGD) and field observations. The questionnaire contained both closed and open ended questions, structured into sections to capture and elicit information from the smallholder farmers based on the study objectives. The questionnaire consists of farmers' socio-economic characteristics and farm-level information; it also focused on adoption level of the improved

oil palm technologies, statement options on sources of information, and among others variables was used to elicit information for the study. The questionnaire were personally administered with the assistance of some trained field enumerators and extension administrators in the states' Agricultural Development programs (ADPs) in the study area under closed supervisions of the researcher. Interview scheduled and focus group discussions were also used for the collection of detailed indepth information from respondents, coupled with field observations. Journals, Proceedings, research reports and publications, books and information from development experts constituted secondary data sources, while the primary data were generated from field survey information.

Horris *et.al.*, (1995), posited that “understanding the economic and social forces shaping rural areas require a variety of theoretical and methodological approaches. The mixed method approaches which present a multi-dimentional impact assessment methods of both quantitative qualitative tools were used in this study. However, it is important to note that the target population in this study were smallholder oil palm farmers. These farmers have no comparism group that do not have access to oil palm intervention. Therefore, to establishing control in absent of counterfactual in this study, non-experimental evaluation design approach was used to compare the intervention group (oil palm farmers) *before and after* implementation of the intervention. The mixed method approaches to impact evaluation is the multi-dimensional impact assessment livelihood approaches (DFID,1999; Pasteur, 2001). According to Adato and Meinzen-Dick (2007), that use of the mixed method approaches is integral to implementing livelihood prospectus. Therefore method used in this study consist of quatitative data collection, statistical analysis, and qualitative data collection, content analysis, statistical control, interview/indepth interview, focus group discussion, and field observation.

3.4 Measurement of Variables of the study

The variables in the study were measured as follows:

Section A:

Socio-Economic characteristics of respondents:

Sex: This was measured as a dummy with Male = 1, Otherwise = 0

Age: Measured in years.

Marital status: Marital status was measured normally as follows:

(1) = Single, (2) = Married, (3) = Divorced, (4) = Widowed

Educational level: This was measured in a list of options scale of Education attainment:

(1) No Formal Education (2) Primary Education (3) Secondary Education
(4) Tertiary Education (OND, HND, Degrees).

Household size: Measured by farmers indicating the actual number of persons in the same house eating from the same pot:

(1) 1 - 4 persons (2) 5 – 8 persons (3) 9 – 12 persons (4) > 13 persons.

Farming Experiences: Measured in years and respondents indicating how long they have been farming.

1 – 4 years, 6 - 10 years, 11 – 15 years, 16 – 20 years and above 20 years.

Membership of farmers' social organisations: Measured as a dummy :-

Yes = 1 Otherwise = 0

Type of ownership of oil palm farm: Farmers identified types of farm ownership as:

(1) Self owned (2) Rented/Hired (3) Inherited (4) Family owned (5) Community owned

Farm Size / oil palm plantation size in hectares (ha): Measured in ha and farmers to indicate their farm size or number of oil palm planted in farm

Less than 1ha (1), 1 – 3 ha (2), 4 – 6 ha (3), 7 – 9 ha(4) and 10 ha above (5).

Oil palm Plantation farm type owned by the farmers: This was measured in a

4 option scale of : (1) Sole cropped oil palm plantation, (2) Oil palm + Arable crops,

(3) Oil palm+ arable crops+perennial crops and (4) Oil palm+ perennial crops.

Age of oil palm plantation: Measured in years and farmers indicated how long the plantation has been established/planned and in a class interval in year's option of:

(1) 1–10 years, (2) 11– 20 years, (3) 21 – 30 years, (4) Above 30 years.

Distance to farm from home: Measured in kilometers (km) and farmers to indicate of their farm from home : (1) < 1km, (2) 1- 2 km, (3) 3 - 4 km (4) 5 – 6 km, (5) 7 – 8 km,

(6) 9 – 10 km, (7) > 10 km

Section B:

Farmers Awareness of improved oil palm technologies in the study area:

Awareness of improved oil palm technologies was measured using dummy:

Aware = 1 Otherwise = 0

Section C:

Farmers' sources of information on improved oil palm technologies

Sources of information was measured on multiple responses indicated by the farmers on the difference sources of information on oil palm technologies including: Radio (1), Tv(2), extension bulletins(3), newspapers/magazines(4), extension agents(5), contact farmers(6), ministry of agriculture(7), ADPs (8), visit to research institute(9), friends/neighbours (10).

Farmers frequency of use of these sources of information was measured on a 5-point

Likert type scale of :- never used(1), seldom used(2), occasionally used(3), often used(4), very often used (5).

Section D:

Determination of level of Adoption of improved oil palm technologies among the farmers in the study area.

The level of adoption of ten (10) oil palm technologies' were measured on a Six(6) point

Likert type scale of: **no awareness =1, awareness = 2, interest =3, evaluation =4, trial =5,**

adoption = 6, on each of the oil palm technologies provided as:-

Improved oil palm planting materials (oil palm hybrid tenera seed/seedlings) (1), oil palm nursery establishment techniques: use of polythene bags nursery(double and single nursery methods) (2), oil palm plantation/field establishment/planting methods: 9m x 9m triangular spacing planting (3), oil palm plantation management techniques: methods of weed control, pruning of palm leaves, mulching (4), Fertilizer application methods (7), Harvesting techniques (5), Disease/Pests control methods (8), Palm oil processing techniques/use of Small Scale Processing Equipment (6), Palm wine tapping techniques (9), Palmwine preservation and bottling techniques: use of crown cork glass bottles and plastic bottles (10). Multiple responses were recorded.

The Likert scaling type measuring instrument is represented by the formula:

$\bar{x} = \Sigma Fx/N$. where Σ = summation sign, \bar{x} = mean score, F= frequency, N= number of farmers, x = number of nominal value of each of responding category ie. $1+2+3+4+5+6/6 = 3.5$ weighted mean. Therefore, mean value < 3.5 suggests low adoption; mean ≥ 3.5 suggests moderate to high adoption.

Section E:

Identification of oil palm livelihood activities in the study area.

Farmers identified in preference rating the important of oil palm livelihood activities from a list presented on a 4-point Likert scale as follows:

1= not important, 2 = less important, 3 = important and 4 = very important.

These were assigned weight of **1,2,3,4** respectively and used to measure the important of the different oil palm livelihood activities ie $1+2+3+4/4 = 2.5$ (mean score). Therefore, mean score < 2.5 suggests not/less important; mean score ≥ 2.5 suggests important to very important.

Section F:

Assessment of impact: Farmers' perceived impact of adoption of improved oil palm technologies on the oil palm farmers' livelihood.

The assessment of impact of oil palm technologies adoption on the farmers livelihood were measured at 3- levels:- (i) household and farm level impact; (ii) impact of adoption of the oil palm technologies on farmers social life *before and after* and (iii) Community level Impact;

(i) Household and farm level impact:

Household level impact outcome indicators include:- increased farmers enhanced Income(1), improved food security (2), increased financial contribution to family needs (children education, health care, provision of food, etc..) (3), improved farmers' materials well-being (4), farmers' decision making(5); and farm levels impact outcome indicators :- increase in farm yield (output) (6), oil palm varietal replacement (7), land use/Farm expansion (8), availability of wild vegetables due to intensification of oil palm production/ practices (9), increase farmers' knowledge (10), increase input use (11), increase on-farm employment(12), reduce vulnerability (risk, theft, fire,etc) (14), decrease soil fertility(15).

Farmers' perceived impact of these impact indicators was measured on the farmers' preference rating on: a 15 statement of the impact indicators presented at both household and farm-levels, on a 5-point Likert type scale of: Strongly agree, Agree, Disagree, Strongly disagree and Undecided, (and which also correspond to impact rating of:- Very high impact, High impact, Moderate impact, Low impact, and No impact) was assigned weight of **5,4,3,2,1** respectively; and used to measure the impact of adoption of improved oil palm technologies on the smallholder farmers' livelihood ie $5+4+3+2+1/5 = 3$ (mean score). Therefore, mean score < 3 suggests low impact; mean score ≥ 3 suggests moderate to very high impact.

(ii) Impact of adoption of improved oil palm technologies on farmers social life of the (before and after):

To assess the impact of adoption of improved oil palm technologies on the smallholder farmers social life, the before and after comparison method of material style of life (MSL) and human capital investment (HCI) indices or items (Schoerder, *et.al.*, 1985; DeWalt *et.al.*, 1990; Sanginga, *et.al.*, 1999) was used to measure /established a connection between individual farmers material world as expressed by the consumption of goods through which social status is acquired. MSL index/items include:- radios, cell phones, foam mattresses, bicycles, motorcycles, vehicles, houses (metal roofed houses, block/cemented houses), furniture, etc. HCI index/items include:- children education (payment of school fees), health care (payment of health bills), feeding of households, contribution to burial of kins, social obligations, etc. To measure the impact of adoption of improved oil palm technologies on the farmers social life and living condition/well-being, the respondents were asked to estimate the changes in household assets/items and the contribution of oil palm generated income had in their acquisition of household assets and other variable items (benefits) *before* and *after* the changes on their social life - living condition and well-being.

(iii) Community level impact:

Livelihood outcomes were measured on various livelihood activities impact indicators that bear on community persons' livelihood and well-being including:- Employment of labour; market development; innovativeness; oil palm value addition development; human capital development and the different on-farm oil palm production activities and non-farm oil palm related activities. Focus group discussion (FGD) and Evaluators' observations, were used to elicit outcomes and impact information from oil palm and non-oil palm farmers in study areas. Impact information was captured with the use of developed open

ended questions using seven helpers – what, why, who, when, where, how, and which (World Bank, 1999), to elicit information from oil palm and non-oil palm farmers.

Questions triangulation was presented from different perspectives. A total of six(6) focus group discussion(FGD) sessions were carried out in the study area.

Section G:

Description of the ‘impact pathways’ of improved oil palm technologies in the study area.

Oil palm technologies impact pathways was developed by constructing a stylized map or framework of impact pathways from oil palm research output to impact outcome indicators of interest. Outcome mapping technique, Earl, *et.al.*, (2001) and Salas, (2002)); and Participatory Impact Pathway Analysis (PIPA) (Douthwaite *et.al.*, 2007), methodologies were used.

Section H:

Identification of constraints affecting the adoption of oil palm technologies.

Constraints include:- **Socio-economic factors:** lack of capital(fund), lack of land/no access to land, lack of information, non-membership of farmers’association, high cost of inputs, lack/high cost of labour, lack/ineffective Extension service, unavailability of planting material (oil palm seeds/seedlings), gender inequality; **Trend factors:** (change in government policies and unstable government policies, changes in food prices/Food price fluctuation, changes in level of bio-diversity/reduction of forest inhabitats, decline soil fertility, sudden economic changes, changes in exchange rate); **Risk/shock factors:** (Food shortages(famine), change in human health-sickness (ill health), disease outbreak (HIV/AID, Ebola, Lassa fever,etc.); **Climate change/natural disasters:** (flooding, drought, bush fire outbreak, crop/animal disease outbreak, theft of produce/products,) and **Conflicts factors:** Ethno-religious crisis, political crisis, insecure farm land (land tenure), Insecurity to

life and properties (War, Terrorism, Fulani herdsmen attack, etc.) that are affecting farmers' adoption of oil palm technologies were presented.

Farmers' perceived preference ratings were measured from the list of Constraint variables on a 4 – point Likert type scale of: No constraint (1), constraint (2), Serious constraint (3), Very serious constraint (4). which was assigned weight of **4,3,2,1** respectively was used to measure the constraints to adoption of improved oilpalm technologies on the farmers ie $4+3+2+1/4= 2.5$ (mean score). Therefore, mean score < 2.5 suggests no constraint; mean score ≥ 2.5 suggests constraint to very serous constraint.

3.5 Standardization of research instrument.

In order to minimize error, the research instrument was pre-tested and the following procedures were adopted to determine validity and reliability of the list of items in the data collection instrument to ensure standardized measuring instrument.

3.5.1 Estimating validity:

Validity is concerned with whether the research survey instrument will measure what it intends to measure. It is the extent to which a survey instrument measures what it is designed to measure. The survey instrument of the study was subjected to face validity and content validity. Face validity was conducted with the assistance of experts in the field of agriculture and rural sociology. This was achieved by seeking their opinion on the adequateness of the items designed to measure the different variables of the study. The procedure assisted in capturing the content and items being evaluated in the study.

3.5.2 Estimating reliability

Reliability refers to the ability of an instrument to yield consistent and the same result when administered on the same respondent on different occasion. The instrument was subjected to reliability test after it has been pre-tested on a field outside the study areas and

to ensure its consistency and reliability in the measurement of the variables. The Split-half method of reliability test as developed by Kerlinger (1973) was used to test for the reliability of the instrument. The process involved scoring the even numbered items and the odd numbered items separately and later correlation of the two sets of scores was analysed to estimate their internal consistency reliability coefficient. This yielded reliability coefficient of $r = 0.75$. A high correlation coefficient is an indication of high reliability of the instrument (Osuala, 2001; Udofia, 2011).

3.6 Methods of data analysis:

The study used different analytical methods and models to address the objectives and Hypotheses of the study. Field survey data collected were analysed using descriptive and inferential statistics. The descriptive statistical tools of frequency counts, percentages, and mean score, tables, charts and diagrams were used. Inferential statistics including ordinary least square multiple regressions (OLS), pearson product moment correlation coefficient (PPMC), analysis of variance (ANOVA) and stepwise multiple regression technique were used for the presentation of results. Details of data analysis are specified as follows:

Objective 1

Socio-economic characteristics of the farmers was analyzed using descriptive statistical tools of frequency tables, percentages, and means.

Objective 2

Awareness of improved oil palm technologies were analyzed using frequency counts and percentages.

Objective 3

Sources of information of oil palm technologies were analyzed using frequency counts, percentages, and rank order.

Objective 4

Level of Adoption of improved oil palm technologies was analyzed using frequency counts, percentage of adopters and mean score (mean adoption score).

Objective 5

Identified farmers' oil palm livelihood activities important to them were analyzed using frequency counts, percentages, and mean score and rank order.

Objective 6

(i) Farmers' perceived impact of adoption of improved oil palm technologies on farmers' livelihoods at Household and Farm levels were analyzed using descriptive statistics of frequency counts, percentages, mean score.

(ii) impact of adoption of improved oil palm technologies on the oilpalm farmers' social life and well-being was analyzed *before* and *after* comparison description of frequency counts and percentages.

(iii) Also qualitative analysis, synthesis/field reports on community level impact was carried out using field notes information taken at FGD sessions, farmers' interview and recorded observations.

Objective 7:

Improved oilpalm technologies impact pathways was described using descriptive diagram. (Outcome mapping technique (Salas, (2002); Earl, *et.al.*,(2001) and Participatory Impact Pathway Analysis (PIPA) (Douthwaite, *et.al.*, 2007).

Objective 8

Constraint variables:- Socio-economic characteristics, Trends, Risk/shock, Climate change/Natural disasters and Conflicts factors affecting farmers' adoption of improved

oilpalm technologies were analyzed with descriptive statistics, frequency counts, percentages and mean scores

3.7 Test of Hypotheses:

Hypothesis 1:

Ho₁ - Ordinary least square multiple regression analysis (OLS) was used to generate *t*-ratio that were used to test the hypothesis which states that there is no significant relationship between some selected socio-economic characteristics of farmers and adoption level of improved oil palm technologies.

The OLS regressions model is implicitly stated as :

$$Y = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7, e)$$

Where

Y = Pooled Index of adoption score of improved oil palm technologies

x_1 = Sex (dummy variable, male =1 and Female = 0)

x_2 = Age (years)

x_3 = Marital status (Measured by assigning: Single =1, Married =2,
Widowed = 3, Divorced = 4)

x_4 = Educational level: (No formal Education = 1, Primary Education = 2,
Secondary Education = 3, Tertiary Education= 4)

x_5 = Farming experience (years)

x_6 = House hold size (Number of persons in the same house)

x_7 = Farm size (Hectares)

e = Error term

It is expected *a priori* that the coefficient of $x_1 x_2 x_3 x_4 x_5 x_6 x_7 > 0$

Hypothesis 2:

Ho₂ - Pearson Product Moment Correlation (PPMC) analysis was used to analyze this Hypothesis which states that there is no significant relationship between farmers' perceived impact of livelihood and adoption of improved oil palm technologies by the farmers in the study areas.

The model is computed as follows:

$$r_{xy} = \frac{N(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$$

Where:

x = Independent variables

x^2 = Square of score on independent variables

y = dependent variable (perception of farmers' of impact of adoption of oil palm technology components at household level)

y^2 = Square of score of dependent variables

xy = Product of x and y

Σ = Summation of score

N = number of score

Hypothesis 3:

Ho₃ - Ordinary Least Square Multiple Regression Analysis (OLS) was used to generate the t - ratios that were tested for this hypothesis which states that there is no significant relationship between some selected socio-economic characteristics of farmers and farmers' perceived impact of adoption at household level.

The OLS regressions model is expressed as:

$$Y = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7, e)$$

Where

Y = Pooled Index of farmers' perceived score of impact at household level.

x_1 = Sex (dummy variable, male =1 and Female = 0)

x_2 = Age (years)

x_3 = Marital status (Measured in 4 point scale: Single = 1, Married =2,
Widowed = 3, Divorced = 4)

x_4 = Educational level: No formal Education = 1, Primary Education = 2,
Secondary Education = 3, Tertiary Education = 4

x_5 = Farming experience (years)

x_6 = House hold size (Number of persons in the same house)

x_7 = Farm size (Hectares)

e = Error term

It is expected *a priori* that the coefficient of $x_1 x_2 x_3 x_4 x_5 x_6 x_7 > 0$

Hypothesis 4:

Ho₄ - For the test of this hypothesis which states that there is no significant difference in the farmers' perceived impact of adoption on livelihood among farmers' adopters of oil palm technologies across the three selected states in South-South, Nigeria. A one way Analysis of variance (ANOVA) model was used.

ANOVA formula is given as:

$$\begin{aligned} F &= \frac{MSB}{MSW} \\ MSB &= SSB/(k-1) \\ MSW &= SSE/(N-1) \\ &= \frac{SSB(N-k)}{SSE(k-1)} \\ SST &= SSW + SSB \\ SSB &= \sum n_j (\bar{x}_j - \bar{x})^2 \\ SSE &= \sum \sum (x - \bar{x}_j)^2 \\ SST &= \sum \sum (x - \bar{x})^2 \end{aligned}$$

Where

SST = the total sum of Squares

SSB = the between sum of Squares

SSW = the within sum of squares

n_j = Simple size from population

k = number of simples

x = individual observation

\bar{X} = overall sample mean

\bar{X}_j = sample mean of j^{th} treatment (or group)

N = total number of observations or total sample size

k = number of treatment or independent comparison

$k-1$ = degrees of freedom between treatment

$N-k$ = total degrees of freedom within sample.

Source: Lisa Sullivan, (2019)

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Socio-economic characteristics of the farmers

4.1.1 Sex

Table 4.1: Distribution of the farmers by Sex

Sex	Frequency	Percentage (%)
Male	256	79.5
Female	66	20.5
Total	322	100

Source: Field Survey Data, 2018.

Table 4.1 shows that majority (79.5%) of the farmers were male and 20.5% female. The result revealed that more male farmers were involved in oil palm production in the study area than female. It implies also that the male farmers have more easy access to land than their female counterparts who are affected by traditional/customary rights to land inheritance and could not have access to land to establish oilpalm plantation. Also the male, being heads of household assumed ownership of the farms.

4.1.2 Age

Table 4.2: Distribution of the farmers by Age

Age	Frequency	Percentage (%)
21 – 30	20	6.2
31 – 40	59	18.3
41 – 50	105	32.6
51 – 60	93	28.9
Above 60	45	14.0
Total	322	100

Source: Field Survey Data, 2018.

Mean Age = 49.19

The age distribution of the farmers, Table 4.2 revealed that age bracket of 41- 50 years constitutes the largest age class of about 32.6% of the total farmers. This was followed by the age class of 51- 60 years and 31- 40 years representing 28.9% and 18.3% of the farmers, respectively. The farmers mean age was 49.19. It implies that most of the oil palm farmers are middle aged and can be regarded as active and agile in agricultural activities. The age distribution in this study tends to agreed with studies by Solomon (1994) and Ekong (2003), that farmers in Nigeria are within the age bracket of 40-60years. This age bracket also falls within the United Nations middle age category that is considered very active to engage in agricultural activities and so expected to make substantial contributions to enhance family livelihoods

4.1.3 Marital Status

Table 4.3: Distribution of farmers according to Marital Status

Marital Status	Frequency	Percentage (%)
Single	37	11.5
Married	249	77.3
Divorced	19	5.9
Widowed	17	5.3
Total	322	100

Source: Field Survey Data, 2018

The result in Table 4.3 indicates that majority (77.3%) of the Oil palm farmers' are married with only about 11.5% being single. Also 5.9% and 5.3% were divorced and widowed respectively. The implication is that these married farmers are matured and can take crucial decisions jointly with their spouses. Moreover, majority of those married may have the needed support for labour and agricultural activities from their spouses and children.

4.1.4 Educational Level

Table 4.4: Distribution of the farmers according to educational level

Educational Status	Frequency	Percentage (%)
Non Formal Education	20	6.2
Primary Education	60	18.6
Secondary Education	127	39.4
Tertiary Education (OND, HND, Degrees)	115	35.7
Total	322	100

Source: Field Survey Data, 2018

Mean Educational Level = 3.06

The findings in Table 4.4 of the study revealed that 93.7% of the respondents had one form of formal education or the other and only about 6.2% of the farmers had no-formal education. This suggest therefore that there is a relatively high level of literacy among the

farmers and which might have a positive effect on the farmers' determination to adopt improved technologies. This result is in agreement with Agwu and Anyanwu, (1996), reported that increase in education of farmers positively influence adoption of improved farm practices. Moreover, Asiabaka (2002) and Rogers (2003), viewed formal education as a means of facilitating farmers' use of written information sources and increasing their knowledge and comprehension of new farm practices. Onyenwaku (1989) and Iwueke (1989) also found that education and contact with extension service to be positively and significantly associated with adoption. From this findings, it can be inferred that the level of education in the study area was relatively high and which might have influenced the adoption level of improved oil palm technologies.

4.1.5 Household size

Table 4.5: Distribution of the farmers by household size

Household size (No of persns)	Frequency	Percentage (%)
1 - 4 person	54	16.8
5 – 8	182	56.5
9 – 12	58	18.0
13 persons and above	28	8.7
Total	322	100

Source: Field Survey Data, 2018

Mean Household Size = 6.69

The result in Table 4.5 revealed that 56.5% of the total respondents had household size of 5-8 persons, while 18.0% and 16.8% of the respondents had household size of 9-13 persons and 1- 4 persons per household respectively. About 8.7% of the respondents have above 13 persons per household. The mean household size was 6.69 persons per household could said to be large on the average. The implication of this findings is that more labour would be

available and relatively cheaper since large household size may favour the farmers in terms of labour supply for farming activities. According to Effong (2005), a relatively large household size enhances the availability of family labour and reduces the constraints on labour demand in agricultural production.

4.1.6 Farming experience

Table 4.6: Distribution of farmers by farming experience

Farming Experience (No of Years)	Frequency	Percentage (%)
1 - 5 years	19	5.9
6 – 10	82	25.5
11 – 15	100	31.1
16 – 20	75	23.3
20 years and above	46	14.3
Total	322	100

Source: Field Survey data, 2018

Mean Farming Experience = 16.01

The result in Table 4.6 shows that about 31.0% of the respondents had farming experience of between 11-15 years, while 25.5% and 23.3% of the respondents had 6-10 years and 16-20 years farming experience respectively and 14.3% having over 20 years of farming experience in oil palm production. The mean number of farming experience was 16.01 years. The result indicates that majority of the respondents in the study area had long time farming experience and which implies that they have wealth of knowledge and understanding of the oil palm farming system and in better position to extend information to other farmers and identify challenges. Also most of the farmers would be conversant with use of the technologies to increase oil palm production, increase farmers' level of acceptance/adoption of the technologies, and over coming their production constraints.

This long time farming experience is an advantage for increase in farm productivity since it encourages rapid adoption of farm innovations (Obinne,1991). According to Nwaru (2004), that farmers some times count on their age of farming experience than their educational attainment in order to increase their productivity.

4.1.7 Membership of farmers’ social organisations

Table 4.7: Distribution of farmers according to membership of social organizations

Farmers’ Organization	Frequency	Percentage (%)
Yes	171	53.1
No	151	46.9
Total	322	100

Source: Field Survey Data, 2018

Table 4.7 showed that 53.1% of the respondents belong to farmers’ groups while 46.9% of the respondents are not affiliated to any social organisations. According to Onweremadu and Njoku (2007), reported that being a member of an association encourages social participation which serves as forum where farmers could exchange ideas about new farm practices. However, for the large proportion of the farmers 46.9% who do not belong to any farmers’ association, implies low innovativeness among them due to lack of group dynamic effects. It indicates that the farmers had lean access to farm resources, agri-inputs information, credit and even Extension contact. This can also affect adoption of oil palm technologies.

4.1.8 Type of ownership of oil palm plantation farms

Table 4.8: Distribution of farmers according to type of ownership of oil palm plantation farms

Oil palm plantation farm ownership	Frequency	Percentage (%)
Self-owned	166	51.6
Rented/Hired	40	12.4
Inherited	65	20.2
Family Owned	37	11.5
Community Owned	14	4.3
Total	322	100

Source: Field Survey Data, 2018

The characteristics of oil palm plantation ownership in the study area in Table 4.8 indicates that a large proportion (51.6%) of the farmers operate on self owned oil palm plantation farms through self-acquisition, 12.4% of the farmers rented/hired their oil palm plantation farms and paying annual rents on existing palm trees, 20.2% of the other farmers inherited their oil palm plantation farms mainly through inheritance while 11.5% and 4.3% of the farmers operate on family and community owned oil palm plantation farms, respectively. The observed oil palm farm ownership was due probably to the perennial nature of the oil palm which confers permanent holding and ownership of farm land to farmers. Omereji (2005) contended that land tenure complication is a major institutional constraint hindering progress of oilpalm development in Nigeria.

4.1.9 Farm size/oil palm plantation farm size(ha)

Table 4.9: Distribution of farmers' farm size/oil palm plantation farm size(ha)

Farm size/oil palm plantation size	Frequency	Percentage (%)
< 1 ha	23	7.1
1 – 3 ha	200	62.1
4 – 6 ha	50	15.5
7 – 9 ha	13	4.0
10 ha and above	36	11.2
Total	322	100

Source: Field Survey Data, 2018

Mean Farm Size = 4.15

The results in Table 4.9 revealed that majority (62.1%) of the farmers operate on farm size of 1-3ha while 15.5% operate on 4-6ha. This is a confirmation that a greater majority of the farmers in the study area are small scale oil palm farmers. This result agreed with Erie (1996), that small farm holdings in Nigeria constitute more than 70% of all farming activities. The result also revealed that a smaller proportion of the farmers 4.0% and 11.2% operate on 7- 9ha and above 10ha farm size respectively. The mean farm size was 4.15. This implies that the study area is dominated with small scale oil palm holdings hence the farmers were at present not in position to enjoy the full benefit of economic of scale in their production activities. This result agreed also with Olayide (1992), that Nigeria farmers are small scale farmers that cultivate small area of land. This relatively small farm size holdings could lead to subsistence farming and may constitute a major constraint to technology adoption. It is important to note that the oil palm being a tree crop, requires large expanse of land for more profitable production.

4.1.10 Type of oil palm plantation operated by the farmers

Table 4.10: Distribution of farmers according to type of oil palm plantation operated by the farmers

Type of oil palm plantation	Frequency	Percentage (%)
Sole cropped oil palm plantation	178	55.3
Oil palm + Arable crops	87	27.0
Oil palm+ Arable crops + Perennial crops	25	7.8
Oil palm + Perennial Crops	32	9.9
Total	322	100

Source: Field Survey Data, 2018

The study investigated type of oil palm plantation operated by the farmers as shown in Table 4.10. The result indicates that about 55% of the farmers cultivated sole cropped oil palm plantation, 27% intercropped oil palm with arable crops such as cassava, maize and yam. 78% of the farmers intercropped oil palm with arable crops and perennial crops such as kolanut and cocoa, while 10% other farmers intercropped oil palm with perennial crops in their farming system. In areas where land is scarce farmers usually intercrop in oil palm farms. The large inter-row spaces within oil palm planting can accommodate arable crops such as maize, cassava, pineapple, cocoyam among other early maturing crops and including shade tolerance perennial tree crops such as cocoa and kolanut. Intercropping in oil palm plantation is carried out probably to maximize the usage of the land. Oil palm farm also allow the raising and grazing of animals such as sheep and goats including cattle. This could enable farmers to meet their subsistence food needs, earn additional income and so enhance family livelihood before the oil palm gestation period. In some other cases, cropping within the oil palm inter-row spaces help in the control of weeds and general maintenance of the oil palm plantation.

4.1.11 Age of oil palm plantations

Table 4.11: Distribution of farmers according to established age of oil palm plantations (years)

Age of oil palm plantation	Frequency	Percentage (%)
1 – 10 years	120	37.3
11 - 20 years	145	45.0
21 – 30 years	49	15.2
Above 30 years	8	2.5
Total	322	100

Source: Field Survey Data, 2018 Mean Age of oil palm Plantation = 15.43

The mean age of the farmers' oil palm plantation in the study area is 15.43 years. The result in Table 4.11 indicates that 37.3% of the oil palm farmers had oil palm plantation aged 1-10 years, 45% others had oil palm plantation aged 11-20 years, while about 17.7% of other farmers had oil palm plantation aged between 21-30 years and above. It is important to note that the age of oil palm plantation determines its profitability to the farmer. The result revealed that about 82% of the oil palm farmers had oil palm plantations aged 1-20 years and which fall within profitable high yield stage for the oil palm. The palm fruits can easily be harvested using cutlass/chisel and or hook knife/short pole (NIFOR, 2009). Improved oil palm hybrid Tenera planting material starts fruiting as from three years after field planting; it attains its peak fruiting potential as from age 7-8 years and continue up to 30 years. Above age 30 years, there is decline in profitability due mainly to high cost of harvesting and maintenance of the tall palm trees. Also it becomes difficult and costly for farmers to harvest the tall palms with hook knives except by experience rope climbers who are older and few. The attendant fear of height scare young climbers. It is recommended at this stage that the farmers cut down the tall palms and replant their farms all over again, and by gradual replacement of palms.

The implication of this finding is that age of oil palm plantation determines profitability and income since cost of oil palm fruits harvesting and plantation field maintenance increase as palms grow older and tall. This implies that with adequate capacity building and adoption/proper application of improved oil palm technologies farmers have the chance of obtaining optimal output from their oil palm plantation early.

4.1.12 Distance of oil palm plantation farm from home (km)

Table 4.12: Distribution of farmers according to distance to farm from home(km)

Distance to Farm from Home (km)	Frequency	Percentage (%)
< 1 km	34	10.6
1 – 2	150	46.6
3 – 4	62	19.3
5 – 6	29	9.0
7 – 8	12	3.7
9 – 10	13	4.0
10 km above	22	6.8
Total	322	100

Source: Field Survey Data, 2018

Table 4.12 shows a summary of farmers' farms distance from their homes. The result indicates that 47% of the farmers had farms located about 1-2 km from their homes. About 10% and 19% of the farmers had farms located in less than 1km and 3-4km respectively from their homes. The result also showed that about 24% of other other farmers had oil palm farms located within distances of 5-10km from their homes. The implication of distance of farmers' farms location from home is that when farms are located far from home, the frequency of farm attendance/visit is reduced; there might be delay/distrupction in farm operation schedules particularly for input application such as

fertilizer, weed herbicides spray, field maintenance, and harvesting of crops. And for the oil palm, fruits harvesting may be affected and leading to rot of produce. Moreover, there could be increase in cost/difficulty of transporting farm labour to and fro farms and evacuation of farm produce to market.

However, result in this study revealed that most of the farms are located within less than 1 – 4km for about 76% of the farmers’ home. The result support observations by Soyebó, *et. al.*, (2005) and Solomon, (2009), that communal pattern of land ownership encourages farm land sharing among community and family members and that most oil palm farms are located about 1km – 3km within communities and not too far from homes.

4.1.13 Farmers’ major sources of income

Table 4.13: Distribution of farmers by major sources of income

Major Sources of Income	Frequency	Percentage (%)
Farming	150	46.6
Wage labour	53	16.5
Services	20	6.2
Business (Trading)	99	30.7
Total	322	100

Source: Field Survey Data, 2018

Result in Table 4.13 shows quite clearly the smallholder farmers’ major sources of income. About 47% of the oil palm farmers have farming as their major source of income. Some 31% and 17% other farmers engage in business/trading and wage labour respectively as their major source of income beside farming. This implies that some part-time farmers engage in oil palm farming as a livelihood strategy to meet their household food needs.

4.1.14 Oil palm farmers monthly income

Table 4.14: Distribution of farmers according to monthly income (₦)

Monthly income level (₦)	Frequency	Percentage (%)
< 50,000.00	123	38.2
50,000.00 – 100,000.00	73	22.7
101,000.00 – 150,000.00	39	12.1
151,000.00 – 200,000.00	35	10.9
Above 200,000.00	52	16.1
Total	322	100

Source: Field Survey Data, 2018

Mean Monthly Income = 30,800.00

Table 4.14 shows that about 38% of the farmers earned monthly income of less than ₦50,000, 22.7% earned between ₦50,000 and ₦100,000 while a lesser proportion 12% and 11% of the farmers earned monthly income of between ₦101,000 – ₦ 150,000 and ₦151,000 – ₦200,000 respectively. Only about 16% of the smallholder oil palm farmers earned above ₦200,000.00. The mean monthly income was ₦30,800.00. And this indicate that the average oil palm farmer lives above the basic national minimum wage in the country. The present minimum wage is put at ₦ 18,000 monthtly. However, comparing the proportion of the farmers' oil palm plantation farm size(ha) holdings and their income earnings, indicated that about 70% of the oil palm farmers are small scale farmers earning less than ₦100,000.00. These oil palm farmers therefore need financial support to improve and expansion their farm size holdings. It was also noted that most of the oil palm farmers earned additional income from business/trading, salary/labour wages, services and other off-farm activities. This implies that a greater percentage of the oil palm farmers in the study area have other livelihoods strategies beside farming to earn additional income.

4.2. Farmers awareness of improved oil palm technologies in the study area

Table 4.15: Percentage distribution of farmers according to awareness of improved oil palm technologies

Oil palm technologies	Aware	Not aware
	Freq (%)	Freq (%)
Improved oil palm planting materials (Oil palm Tenera seeds/seedlings)	267(82.9)	55(17.1)
Oil palm nursery establishment techniques:		
use of polythene bags nursery methods: –	230(71.4)	92(28.6)
Double & single stage nursery methods		
Oil palm plantation/field establishment /planting methods: 9m x 9m triangular spacing planting	269(83.5)	53(16.5)
Oil palm plantation management techniques: methods of weed control; pruning of palm leaves; mulching	293(91.0)	29(9.0)
Harvesting methods of oil palm fruit bunches: use of harvesting chisel, hook knife	268(83.2)	54(16.8)
Small-scale palm oil processing methods: use of digester screw press mill; nutcracker /nutcracker separator	230(71.4)	92(28.6)
Fertilizer application methods: in nursery and plantation palms	254(78.9)	68(21.1)
Pests/disease control methods for nursery and plantation palms	221(68.6)	101(31.4)
Palm wine tapping techniques	83(25.8)	239(74.2)
Palm wine preservation and bottling techniques: use of crown cork glass bottles and plastic bottles	39(12.1)	283(87.9)
Source: Field survey Data, 2018. (Multiple responses recorded)		

Table 4.15 shows result of farmers awareness of improved oil palm technologies. The result revealed that a large proportion (83%) of the farmers were aware of improved oil palm planting materials (oil palm tenera seeds/seedlings). While 83.5% and 83.2% of the farmers were aware of oil palm plantation field establishment/planting methods (9meters x 9meters triangular spacing/planting techniques) and harvesting methods respectively, 91% were aware of oil palm plantation field operations management techniques, and with only about 29% of the farmers were not aware of oil palm Nursery establishment methods. The

result further show that 71% of the farmers had awareness on small-scale palm oil processing methods and 78.9% others had awareness on fertilizer application techniques. It was observed also that 74% and 88% of the farmers were not aware of palm wine tapping techniques and palm wine preservation/bottling techniques respectively. However, the result showed that there is generally high awareness of the improved oil palm technologies among the oil palm farmers. It also indicated the extent the improved oil palm technologies had diffused. This implies however, that majority of the oil palm farmers have a good knowledge and high awareness of the improved oil palm technologies. Asiabaka, *et. al.*, (2001) similarly expressed in their views that for farmers of different agro-ecological zones to adopt new agricultural technology, they must be aware of the technology, have up to date information on the technology, the applicability of the technology to their farming system and received the technical assistance necessary for the application of the technology.

4.3 Farmers' sources of information on improved oil palm technologies.

Table 4.16 (a): Distribution of farmers by sources of information on improved oil palm technologies

Sources of Information	Farmers response	Rank order
	Freq (%)	
Radio	221 (68.6)	6 th
Tv	176 (54.7)	8 th
Extension bulletins	169 (52.5)	9 th
Newspaper/magazines	82 (25.5)	11 th
Extension agent	278 (86.3)	2 nd
Contact farmers	264 (82.0)	4 th
Ministry of agriculture	231 (71.7)	5 th
Agric. development programs (ADP)	276 (85.7)	3 rd
Visit to research institute	157 (48.8)	10 th
Agricultural shows/exhibition	182 (56.5)	7 th
Friends/neighbours	297 (92.2)	1 st

Source: Field survey 2018. (Multiple responses recorded)

Table 4.16 (b): Distribution of farmers according to use of sources of information on improved oil palm technologies often used.

Sources of Information	Farmers' perception on use of sources of information				
	Very often	Often used	Occasionally Used	Seldom used	Never used
	Freq.(%)	Freq(%)	Freq.(%)	Freq(%)	Freq. (%)
Radio	43(13.4)	81(25.2)	72(23.3)	25(7.8)	101(31.4)
Tv	35(10.9)	58(18.0)	61(19.0)	22(6.8)	146(45.3)
Extension bulletins	10(3.1)	27(8.4)	96(29.8)	36(11.2)	153(47.5)
Newspaper/magazines	8(2.5)	18(5.6)	40(12.4)	16(5.0)	240(74.5)
Extension agent	83(25.8)	119(37.0)	61(19.5)	13(4.0)	44(13.7)
Contact farmers	37(11.5)	103(32.0)	113(35.1)	11(3.4)	58(18.0)
Ministry of agriculture	41(12.7)	72(22.4)	90(28.0)	28(8.7)	91(28.3)
Agric dev. programs (ADP)	139(4.2)	93(28.8)	35(10.9)	9(2.8)	46(14.3)
Visit to research institute	3(1.0)	49(15.2)	60(18.6)	45(14.0)	165(51.2)
Agricultural shows/exhibition	9(2.8)	26(8.1)	120(37.3)	27(8.4)	140(43.5)
Friends/neighbours	36(11.2)	79(24.5)	153(47.5)	29(9.0)	25(7.8)

Source: Field survey 2018. (Multiple responses recorded).

Sources of information among the oil palm farmers were examined and analysed. Table 4.16(a&b) gave a summary of the sources of information on improved oil palm technologies used by the farmers. The result Table 4.16(a) indicates that (92.2%) of the farmers obtained information on oil palm technologies from Friend/Neighbours followed by extension agents(86.3%) ranked 1st and 2nd respectively while agricultural development projects (ADPs) 85.7% and contact farmers (82.0%) ranked 3rd and 4th in that order. The use of Newspapers/magazines (25.5%), ranked 11th , Radio(68.6%) ranked 6th and Tv.(54.7%) ranked 8th also appeared valuable as good sources of information on improved oil palm technologies to the farmers. However, farmers perception of sources of information mostly used, Table 4.16(b) indicated that 47.5% of the farmers occasionally used friends/neighbours, 37% often used extension agents while 43.2% other farmers very often used ADPs. The result further revealed that 7.8% of the farmers seldom used Radio and 51.2% never used Visit to Research institute as their sources of information on oil palm technologies.

It could be inferred from the result that Friends/Neighbours was the major source of information used by the oil palm farmers and followed by Extension agents. This findings agreed with Onoh and Onoh, (2012), reported that majority of oil palm farmers used friends/neighbours followed by extension agents as sources of information on oil palm production technologies. The implication of this result is that friend/neighbours, extension agents and agricultural development programs (ADPs) are very important sources of information in the dissemination of oil palm technologies the farmers.

It was also revealed that Newspapers/Magazines the least used sources of information is not considered important source for agricultural information. This finding support the claim that newspapers as a source of agricultural information is very limited for the purpose of

reaching the rural populace as most of the farmers are unable to read, understand and/or have access to Newspapers and that radio play an important role in the dissemination of agricultural information (Farinde and Soetin, 1999).

Table 4.17: Percentage distribution of oil palm farmers by level of adoption of improved oil palm technologies in the study area

Oilpalm technologies	<i>Not Aware</i>	<i>Aware</i>	<i>Interest</i>	<i>Evaluation</i>	<i>Trial</i>	<i>Adoption</i>	Mean
	(1) Freq.(%)	(2) Freq.(%)	(3) Freq.(%)	(4) Freq. (%)	(5) Freq.(%)	(6) Freq.(%)*	\bar{x}
Improved oil palm planting materials (Oil palm Tenera seeds/seedlings)	55(17.1)	6(1.9)	0(00)	0(00)	0(00)	261(81.0)	5.07
Oil palm nursery establishment techniques: use of polythene bags nursery (Double & single stage nursery methods)	92(28.6)	13(4.0)	0(00)	0(00)	4(1.2)	213(66.2)	4.39
Oil palm plantation/field establishment /planting methods: 9m x 9m triangular spacing planting	53(16.5)	7(2.2)	0(00)	0(00)	0(00)	262(81.3)	5.09
Oil palm plantation management techniques: (methods of weed control; pruning of palm leaves; mulching)	29(9.0)	6(1.9)	0(00)	0(00)	0(00)	287(89.1)	5.46
Harvesting methods of oil palm fruits: use of harvesting chisel, hook knife	54(16.8)	21(6.5)	0(00)	0(00)	0(00)	247(76.7)	4.9
Small-scale palm oil processing methods-: use of digester screw press mill; nut cracker /nut cracker separator	92(28.6)	36(11.2)	0(00)	0(00)	0(00)	194(60.2)	4.12
Fertilizer application methods: in nursery and plantation palms	68(21.1)	37(11.5)	0(00)	0(00)	0(00)	217(67.4)	4.48
Pests/disease control methods for nursery and plantation palms	101(31.4)	22(6.8)	0(00)	0(00)	19(5.9)	80(24.8)	2.09
Palm wine tapping techniques	239(74.2)	48(14.9)	5(1.6)	0(00)	0(00)	35(10.9)	1.72
Palm wine preservation and bottling techniques: use of crown cork glass bottles and plastic bottles	263(81.7)	54(16.8)	2(0.6)	0(00)	0(00)	3(0.9)	1.18

Source: field survey, 2018.

*Percentages in parenthesis

4.4 Examination of level of adoption of improved oil palm technologies among the farmers

Table 4.17 showed the level of adoption and the intensity of use of improved oil palm technologies among the farmers. The result indicated that oil palm plantation management techniques (weed control, pruning of palm leaves, mulching,) mean (\bar{x}) = 5.46, had the highest level of adoption followed by use of oil palm plantation establishment/planting methods (9m x 9m triangular spacing planting method) \bar{x} = 5.09 and improved oil palm planting material (hybrid oil palm tenera seeds/seedlings) \bar{x} = 5.07. Harvesting methods of oil palm fruits (use of harvesting chisel and hook knife) \bar{x} = 4.9, fertilizer application methods in nursery and plantation palms \bar{x} = 4.48, and small scale palm oil processing technique \bar{x} = 4.12 respectively, recorded high level of adoption among oil palm farmers. However, palm wine tapping and palm wine bottling/preservation techniques with mean level of adoption of \bar{x} = 1.72 and \bar{x} = 1.18, respectively were the less adopted by the farmers. It was observed at the trial stage, that only 1.2% and 5.9% of the farmers had trials for oil palm nursery establishment techniques and pest/disease control methods respectively. While 1.6% of the farmers had interest for palm wine tapping techniques, only less than 1% had interest for palm wine preservation and bottling techniques. At the evaluation stage of the adoption process, the farmers did not evaluate any of the oil palm technologies.

The high level of adoption of these improved oil palm technologies indicated that farmers are well educated, having high awareness and better access to information and other resources on the improved oil palm technologies. The result revealed that the technologies the farmers adopted were those they had awareness. These farmers awareness could probably due to the fact that these technologies increase yield of the oil palm and invariably enhance their livelihood and the cultural practices of the crop could be accomplished by use

of family labour/hired labour. This result confirmed the views and findings of different studies that for adoption of improved technologies to take place, there must first be awareness of those technologies (Asiabaka *et.al.*, (2001); Agwu, (2001) and Ajayi, 2002). The high adoption level recorded for the oil palm technologies further indicated that the farmers had good chances of making money through high yield and probably due to the material nature of the technology ease of transfer (Swanson, 1996). The high level of adoption could have been influenced also probably by some determinants of the technologies' attributes including its compactibility with the farmers' existing farming practices, profitability and/or simple or easy nature of the technology. This result further confirmed the findings of Asiabaka and Michelle (2002), in their study of adoption behavior of rural farmers in Nigeria, that technology attributes are significant determinants of farmers adoption behavior. Farmers are also known to be more likely to adopt a technology when the technology is simple, has comparative advantage, compactible with the farmers existing farming practices, its availability and affordable (Rhoades and Booth, (1992); Asiabaka and Michelle, 2002). Also the high adoption level with regard to these oil palm technologies' components could be associated with the farmers' high awareness of the fact that these technologies increase yields and invariably enhance their livelihoods; and its cultural practices could be accomplished by use of family labour and/ or hired labour.

4.5 Identification of farmers' oil palm livelihood activities in the study area

Table 4.18: Percentage distribution of farmers perception according to the importance of oil palm livelihood activities

Oil palm livelihood activities	Farmers' response				Mean Score \bar{x}	Rank Order
	Very important Freq (%)	Important Freq (%)	Less important Freq (%)	Not important Freq (%)		
On-farm oil palm activities						
Oil palm plantation establishment/cultivation	178(55.3)	132(41.0)	11(3.4)	1(0.3)	3.51	5 th
Oil palm nursery establishment activities	148(46.0)	109(33.9)	43(13.4)	22(6.8)	3.19	8 th
Palm oil milling /processing activities	196(60.9)	103(32.0)	18(5.6)	5(1.6)	3.52	4 th
Palm kernel cracking	147(45.7)	138(42.9)	24(7.5)	13(4.0)	3.30	6 th
Oilpalm fruit harvesting	200(62.1)	112(34.8)	6(1.9)	4(1.2)	3.58	2 nd
Palm wine tapping	36(11.2)	65(20.2)	138(42.9)	83(25.8)	2.17	13 th
Local gin (Ogogoro) distilling	28(8.7)	66(20.5)	123(38.2)	105(32.6)	2.05	14 th
Broom making	74(23.0)	123(38.2)	97(30.1)	28(8.7)	2.75	10 th
Basket weaving	30(9.3)	112(34.8)	117(36.3)	63(19.6)	2.34	11 th
Rope making	34(10.6)	84(26.1)	120(37.3)	84(26.1)	2.21	12 th
Non-farm oil palm activities						
Transportation of oil palm produce/products	213(66.1)	88(27.3)	16(5.0)	5(1.6)	3.58	2 nd
Local fabrication of oil palm processing equipment	89(27.6)	121(37.6)	77(23.9)	35(10.9)	2.82	9 th
On-farm employment (hired farm labour)	126(39.1)	154(47.8)	40(12.4)	2(0.6)	3.25	7 th
Marketing of palm produce (palm oil, kernel, palm fruits)	216(67.1)	102(31.7)	1(0.3)	3(0.9)	3.65	1 st

Source: Field SurveyData, 2018.

(Multiple responses recorded)

Table 4.19 identified various oil palm livelihood activities and their importance to the farmers' well-being. The result revealed that the farmers identified oil palm field establishment and cultivation activities mean (\bar{x})=3.51 and oil palm fruits harvesting activities (\bar{x} = 3.56) as very important livelihood activities among the farmers. While the farmers also identified palm oil milling/processing activities with \bar{x} =3.52 as very important, basket weaving (\bar{x} =2.34) and rope making (\bar{x} = 2.21) respectively were

perceived less/not important livelihood activities among the farmers. Also palm wine tapping technique ($\bar{x} = 2.17$) and local gin(ogogoro) distilling($\bar{x} = 2.05$) respectively, were considered less important livelihood activities to most of the farmers. However, on-farm employment (hired farm labour) ($\bar{x} = 3.25$) was perceived as very important livelihood activities to majority of the farmers.

Moreover, for the non-farm oil palm production livelihood activities including marketing of palm produce (palm oil, kernel, palm fruits, etc) ($\bar{x} = 3.65$) and transportation of oilpalm produce/products ($\bar{x} = 3.5$) respectively were also very important livelihood activities to the farmers. The result revealed that there was a high cluster of farmers around such livelihood activities as marketing of palm products (palm oil, palm kernel, palm fruits), oil palm fruits harvesting and transportation of oil palm produce/products among the farmers. The involvement of farmers around these oil palm production activities on-farm and off-farm made these livelihood activities as major vocation for many households. It implies therefore, that oil palm production has the potentials to meet the basic needs of the farmers, increase their income, generate employment, reduce poverty and raise their living standard. Thus oil palm production/cultivation activities have formed part of the culture and means of livelihood for many families and also serve as a bailing out of poverty.

4.6 Impact of adoption of improved oil palm technologies on farmers' livelihood:

4.6.1 Farmers perceived impact of adoption of improved oil palm technologies at household and farm levels:

Table 4.19: Distribution of farmers according to perceived impact of adoption of improved oil palm technologies on farmers' livelihood

Statement	Farmers' Response					
	Strongly agreed Freq (%)	Agree Freq (%)	Undecided Freq (%)	Disagree Freq(%)	Strongly disagree Freq (%)	Mean Score \bar{x}
Household level impact Indicators						
Increase farmers income (saving/financial independent)	148(46.0)	131(40.7)	12(3.7)	24(7.5)	7(2.2)	4.21
Improved food security	111(34.5)	164(50.9)	8(2.5)	33(10.2)	6(1.9)	4.06
Improved nutrition	76(23.6)	176(54.7)	31(9.6)	34(10.6)	5(1.6)	3.88
Improved farmers materials well-being (properties acquisition – houses, cars, Tv, motor cycle etc.)	80(28.4)	140(43.5)	22(6.8)	52(16.1)	28(8.7)	3.60
Increased financial contributions to family needs (Children education, health care, provision of food etc.)	121(37.6)	143(44.4)	14(34)	26(8.1)	18(5.6)	4.00
Enhanced farmers' decision making	87(27.0)	146(45.3)	43(13.4)	43(13.4)	3(0.9)	3.84
Farm level impact Indicators						
Increased farm yield (output)	137(42.5)	140(43.5)	15(4.7)	27(8.4)	3(0.9)	4.18
Oil palm varietal replacement	83(25.8)	116(51.6)	31(9.6)	31(9.6)	11(3.4)	3.87
Farm expansion /land use	68(21.1)	162(50.3)	37(11.5)	48(14.9)	7(2.2)	3.73
Increased use of inputs	95(29.5)	151(46.9)	25(7.8)	44(13.7)	7(2.2)	3.88
Increase farmer's knowledge	150(46.6)	133(41.3)	20(6.2)	18(5.6)	1(0.3)	4.28
Increase on farm employment was significant	90(28.0)	150(46.6)	49(15.2)	31(9.6)	2(0.6)	3.92
Availability of wild vegetables due to intensification of oil palm production/practices	61(18.9)	119(37.0)	56(17.4)	78(24.2)	8(2.5)	3.46
Reduced farmer's vulnerability to risk, theft, bush fire etc.	49(15.2)	155(48.1)	23(7.1)	61(18.9)	34(10.6)	3.40
Soil fertility decreased significantly	54(16.8)	144(44.77)	38(11.8)	74(23.0)	12(3.7)	3.48

Source: Field Survey Data, 2018.

(Multiple responses recorded)

The result in Table 4.19 presents descriptive analysis of the impact of adoption of improved oil palm technologies on farmers' livelihoods. The result indicates generally that there was high impact as reflected by the farmers perceived impact ratings at both household and farm levels. The findings revealed at household level that the farmers had increased farm income (Savings/financial independent) with mean (\bar{x}) = 4.21 and indicating very high impact. Also improved food security (\bar{x} =4.06), and improved household nutrition (\bar{x} =3.88),

impact ratings indicated respectively high to very high impact among the farmers. The result further revealed that there was high impact among the farmers' adopters with improved farmers material well-being (aquisition of assets:- house, cars, Tv, household items, etc.) ($\bar{x}=3.60$). There was also high to very high impact recorded on increased financial contribution to family needs (children education, health care, provision of food, etc.) ($\bar{x}=4.00$) and enhanced farmers' decision making ($\bar{x}=3.84$) respectively as perceived by the farmers' adopters.

Moreover, the farm level impact indicators showed that oil palm varietal replacement ($\bar{x}=3.87$) and increase in farm yield (increase farm outputs) ($\bar{x}=4.18$) had high impact among the farmers. While the result at farm level further revealed that there was reduced farmer's vulnerability to risk, theft of palm produce, bush fire, etc, ($\bar{x}=3.40$) had high impact on the farmers livelihood, decrease soil fertility in farmers' farms ($\bar{x}=3.48$) had high but negative impact on the farmers' adopters. However, it was observed that perceived farmers impact from increase in on-farm employment ($\bar{x}=3.92$), farm expansion/land use ($\bar{x}=3.72$), increased use of inputs ($\bar{x}=3.88$) and increased farmer's knowledge ($\bar{x}=4.28$) generally indicated high to very high impact on the farmers livelihood. It must be noted that impact can be positive or negative. Therefore not all impact rating as expressed in the findings had positive impact on the farmers' livelihoods. For instance decrease soil fertility on farmers' farms had significant negative high impact on the farmers' adopters.

However, the result revealed generally that the adoption of improved oil palm technologies had positive impact on the smallholder farmers' livelihood. These positive impact could stem from the different opportunity created by oil palm production activities as means of livelihoods. It could also due probably to the impressive diffusion and high level of adoption of the oil palm technologies by more farmers; and which may have led to

changes in factors' productivity, increased crop yields, increase farmers' income, improved food security among households and improved farmers' material well-being. It also led to farm expansion of the oil palm including oil palm varietal replacement and contributing to the significant increase in farm employment. Implicitly, oil palm production activities have great potential as means of livelihood as it serves as a major vocation for many communities in the oil palm growing areas of Nigeria. It implies therefore, that an efficient and strong oil palm agricultural subsector in Nigeria will enable the rural poor smallholder farmers to be part of the solution to poverty challenges through the provision of employment and a means of livelihood. The justification for this, is probably due to the numerous ways in which the oil palm can be used and many would be employed in the process.

4.6.2 Impact of adoption of improved oil palm technologies on farmers social life and well-being (*before and after*):

Table 4.20: Percentage distribution of farmers by assets/valueable items benefit on social life from impact of adoption of improved oil palm technologies

Assets/items benefit variables	Before		After	
	Freq	(%)	Freq	(%)
Ownership of house				
Mud house with zinc roof	62	(25.8)	24	(7.5)
Block house cemented with zinc roof	00	(00)	159	(49.4)
Block house cemented with aluminum roof	00	(00)	58	(18.0)
Household items				
Furniture	54	(16.8)	138	(42.9)
Fans	15	(4.7)	89	(27.6)
Refrigerators	17	(5.3)	52	(16.8)
Foam matrasses	00	(00)	246	(76.4)
Means of mobility				
None	198	(61.5)	96	(29.8)
Bicycles /	46	(14.3)	37	(11.5)
Motorcycles	58	(18.0)	109	(33.9)
Vehicle (cars,vans,lorries)	20	(6.2)	76	(23.6)
Motor boat/Canoes	00	(00)	9	(2.8)
Communication items				
Radios	28	(8.7)	73	(13.4)
TV	82	(25.5)	215	(66.8)
Cell phones (gsm phones)	38	(1.8)	317	(98.4)
Health care				
Self-medication	172	(53.4)	68	(21.1)
Native treatment	51	(15.8)	34	(10.6)
Hospital health care	00	(0.0)	163	(50.6)
Children education				
(payment of school fees)	29	(9.0)	193	(59.9)
Feeding of households	74	(22.9)	248	(77.0)
Clothing	38	(11.8)	187	(58.0)
Marriage	00	(0.0)	59	(18.3)
Burial ceremonies	56	(17.3)	123	(38.1)
(burial of Kin group member)				
Contribution to social obligations	35	(10.9)	128	(39.8)

Source: field survey, 2018.

Multiple responses

The result in Table 4.20 presents *before and after* comparison percentage distribution of changes in assets/valuable items and proportion of farmers that indicated how income generated from oil palm production had contributed to enhancement of their social life-social status and well-being. The result indicated that there were positive changes and improvement in the farmers housing condition by about 67% farmers ownership and/or living in block houses with metal roofs after their adoption of improved oil palm production

technologies. Payment of school fees for children education improved by 60%; while health care recorded changes by 51% in hospital health care among the farmers. The farmers mobility status also recorded positive changes as 34% of the farmers had motorcycles compared to 18% before their involvement in oil palm production activities. Also 23.6% of the farmers were able to acquired more vehicles (cars,vans, lorries) as against only 6.2% of the farmers of vehcles before their adoption of oil palm technologies. While 77.% of the farmers were able to feed their households after oil palm technologies adoption, clothing of farmers family increased by 58% among farmers. There was also improvement on farmers social status in the acquisition household items:- furniture (42.9%), use of foam mattresses (76.4%); and ownership of communication items – Tv (66.8%), cell-phones (98.4%) and radios (13.4%) indicating adoption impact on the oil palm farmers’ adopters social life. Moreover, there was also 39.8% increase in farmers contribution to social obligations in their communities and 38.1% increase in burial ceremonies of kins group members from 17.3% before among the farmers’ adopters. The result revealed that the adoption of improved oil palm technologies had impact and contributed to the social life and well-being of the farmers in the study area.

4.6.3 Community level impact:

Figure 7: Contribution of benefits of oil palm livelihood activities on-farm and off-farm to farmers and non-farmers social life and well-being in the study areas

Farmers / non-farmers category	Benefits to oil palm farmers and non-oil palm farmers
Owners of oil palm plantation/hired plantation operators	Own house, own land, cash reserved /savings in bank, health care, children education, food security, own household items,
Owners of palm oil mills/hired mill operators/Palm kernel cracking	Savings in bank, food security, additional mill, own house, own land/farm land, health care, children education, own household items/ furniture, Tv
Farm workers/hired labour (harvesters, palm oil millers field workers)	Rent farm land, feed household, own motorcycle, bicycle, rent house, savings in bank, children education, gain skill/experience, purchase livestock (goats, poultry), clothings, Tv, Radio,
Palm produce marketers (men & mostly women)	Own storage tanks, savings in bank, own stores, health care, children education, own land/house, rent house, own household items/ furniture, clothings,
Oil palm mills/palm kernel equipment fabricators	Own workshop, feed family, rent house, own house/land, health care, children education, earn additional income training others,
Oil palm produce transporters	Own vehicles, feed household, rent house,healthcare, children education, own land/house

Source: Field Survey Data, 2018

Results of the qualitative analysis and synthesis of FGD sessions and farmers interviews revealed positive impact on the adoption of improved oil palm technologies among the farmers. The cultivation and adoption of the oil palm crop created immense livelihood opportunities for both the rural poor and urban population especially in the employment of hired labour on-farm and off-farm, oil palm produce marketing and locally fabricated oil palm milling and processing equipment.

Firstly, it was observed that the oilpalm farmers and non-farmers alike developed positive attitudes towards the value of the oil palm crop not only as cash crop and sources of food, there are also sayings that the oil palm is a ‘golden crop’ and a ‘life saver’ in the different communities, and not only providing food but also household items including

brooms, baskets, soaps, and medicines. The oil palm agricultural subsector provides a-ray of livelihood activities in its production chain on-farm and off-farm. These activities include increased demand for hired labour in oil palm plantation field operations – field maintenance, cultivation activities, fresh fruit bunches (ffb) harvesting, palm oil milling processes, and palm kernel cracking/recovery. These activities had positive impact on the incomes of poor rural households who are employed by working in the oil palm farms. The adoption and adaptation of the oil palm in also had impact on the redistribution of income over a large number of people both in the rural and urban areas. Apart from the direct impact it had on-farm on increase crop yield and employment of labour, a lot of people are involved in off-farm incomes generation notably from palm oil processing and marketing activities. Besides other economic activities including craft products – brooms, baskets, and ropes production, palm wine tapping, soap production, etc, which are now nation-wide businesses.

The result from farmers interview also revealed that women labour largely dominated most of the oilpalm production activities particularly in palm oil processing, picking and carrying of palm fruits during fresh fruit bunches (ffb) harvest, marketing of palm produce in both rural and urban markets, and interstate distributional trade. This had resulted in some obvious impact on women empowerment through supplementary incomes, contributing to the social and economic development of the rural communities and support to nutritional, well-being and food security of households. This finding is in agreement with previous result of some related studies in oil palm production in Nigeria which also showed that women are known to be major actors in palm produce industry, notably palm oil processing, storage, and marketing; and that women took part in 82% of all the palm oil processing operations identified (Nwankwo and Eboh, 1998; Nwosu and Okon, 2013).

It was revealed also that the market structure of oil palm production in these communities greatly impacted on men and women, particularly women who are in majority. The domestic palm oil market is dominated by private marketers either by women groups processing and selling directly to the local markets or private middle men marketers for distribution in interstate trade. In addition, oil palm production offers a livelihood to other chain players, such as transporters of ffb and palm produce, agro-inputs sellers and more especially palm oil mill and palm kernel equipment fabricators who are outside the production area.

Community level impact from oil palm technologies adoption are not only felt directly on farming households, indirect impact on other non-adopting households are also important in the study areas. Most notable are reduced palm oil prices made possible by increase production of the crop which had impact on rural and urban poor who are net purchaser of food. Besides, the farmers interviewed did not report any negative impact from oil palm production to the environment. They say that cultivation of oil palm did not have any adverse effect on their environment, or deplete soil fertility, forest and forest inhabitats. This finding tend to agree also with studies, NIFOR, (2008) and Ayodele, (2010), that many of the local owners of oil palm plantations as well as those involved in oil palm business in Nigeria have not experience any environmental harm as a result of oil palm production.

The qualitative information obtained from the FGD/farmers interview on the contribution of benefits to the social life and well-being of some identified category of oil palm farmers and non-oilpalm farmers involvement in oil palm livelihood activities, revealed the following in Figure 7. They stated differently that their involvement in the different oil palm livelihood activities enabled them improve on their living standard and well-being; and acquiring or own some or more properties including houses and/or

improved on existing house, own vehicles, motorcycles, Tv, Radio and household items – furniture, foam mattresses; feed households, healthcare, and children education. Some others were able to marry wives, and carried out burial ceremonies of lost ones. They further stated that they were able to carryout money contributions, cash saving in bank, buy land/farmland, among other benefits (Figure 7). This qualitative information (Figure.7), help in illustrating the benefits or impact derivable by these identified category of farmers and non-farmers engaging in the different oil palm livelihood activities had generated information not captured quatitatively in the study. Remarkably however, oil palm production has been perceived as contributing to the farmers social status enhancement and providing a means for vertical social mobility in these study areas.

4.7 Description of improved oil palm technologies ‘Impact Pathways’ in the study areas

Figure 8, shows the result of a constructed stylized ‘Map’ or schema of ‘Impact Pathways’ framework for the introduction of improved oil palm technologies in the oil palm growing areas of Nigeria. The impact pathway framework helps to give an *Abstract conceptual picture* in the mind of researchers of what impact is and how it works. Figure 8, therefore, help to demonstrate the impact of NIFOR’s research i.e. impact the improved oil palm technologies – oil palm high yielding varietal materials, agronomic practices, management and engineering technologies, had on the ultimate adopters along the impact pathways - from *research inputs* to *impacts* on the *final users*. This framework provides a foundation for ex-post impact assessment (epIA) perspective for adopted oil palm technologies on the degree of difficulty of measuring effects.

The dissemination and diffusion of these improved oil palm technologies over the years in the study areas were aimed at encouraging farmers adoption to improve their living standard and well-being and the cultivation and expansion of the oil palm crop for food and cash. The ‘Map’ or schema impact pathway framework (Figure 8), therefore show in perspective, how *outputs* of the oil palm research results are promoted by various Agricultural and Extension agencies (*next users*), and translated to farmers’ adopters (*final users*). Thus, resulted in *outcomes* from the cultivation and expansion of the oil palm in the study areas and leading to adopters level changes in yield of the oil palm, changes in farm practices, and among other changes in production costs and farm level output of the crop (Figure 8)

The framework (Figure 8), further showed how impact is realizable at households, farm level and community level with indication for changes in direct economic condition of the farmer’s adopters, such as increase in yield of the crop, increase in farmers’ income, profit;

and indirect economic effects, including changes in market effects (market prices, market efficiency), distributional changes, increase labour demand - employment of labour on-farm and off-farm, and up and down stream multiplier impact. Invariably, these changes could affect producers and consumers economic well-being; changes in social conditions- attitude, education, health care, food security, poverty reduction and environmental sustainability.

This impact pathway framework for the NIFOR research oil palm technologies, provides a description of the planned outputs, intended users, expected outcomes and likely impact.

Studies (Walker, *et.al.*, 2008), have shown that the development of impact pathways, as in Figure 8, for the oil palm research technologies, serves as an important prelude to ex-post impact evaluation as it provides a guide to major focal points of the analysis and data needs and sources. They affirmed that even if the impact pathway is not required, undertaking an ex-post impact assessment (epIA) within an impact pathway framework, as carried out in this study for the oil palm technologies, will help to increase the likelihood that all intended and unintended and positive and negative impact are identified and where possible quantified.

Walker *et.al.*, (2008), emphasized that either explicitly or implicitly, all *epIA* studies must construct an 'Impact Pathway' from research outputs to impact indicators of interest. In agreement with Walker *et.al.*, (2008) and CGIAR (2006.b), recommendation, this 'Impact Pathway' framework for the oil palm research technologies Figure 8, was constructed for this study. The framework gives a simplified representation of the complex interrelationships on the many players and factors involved in creating an impact, though not depicted in the framework. According to CGIAR, (2006.b) studies however, noted that not all players and factors involved or listed in any 'Stylized Map' or schema will be part of all the impact pathways.

It was observed also in Figure 8, that various agricultural extension agencies were actively involved in the communication and dissemination of the oil palm research developed technologies. Although it was also observed that there is a flow of impact resulting from the introduction of improved oil palm technologies in the impact pathway framework, it is difficult to measure or quantify the outcomes or estimate the effects of research induced positive or negative changes that may occur along the impact pathways.

However, as illustrated by some recent studies (Maredia and Raitzer, 2006; Raitzer and Kelley, 2008), essentially noted that a principle of good practice epIA, is to enhance the rigor of establishing the links along the 'Input - Output – Outcome – Impact' pathway beyond 'plausibility' to substantially demonstrate impact. Baur *et.al.*, (2001) and EIARD (2003), affirmed equally that the central task of impact assessment is to establish highly plausible link between a research effort and observed changes along the impact pathways.

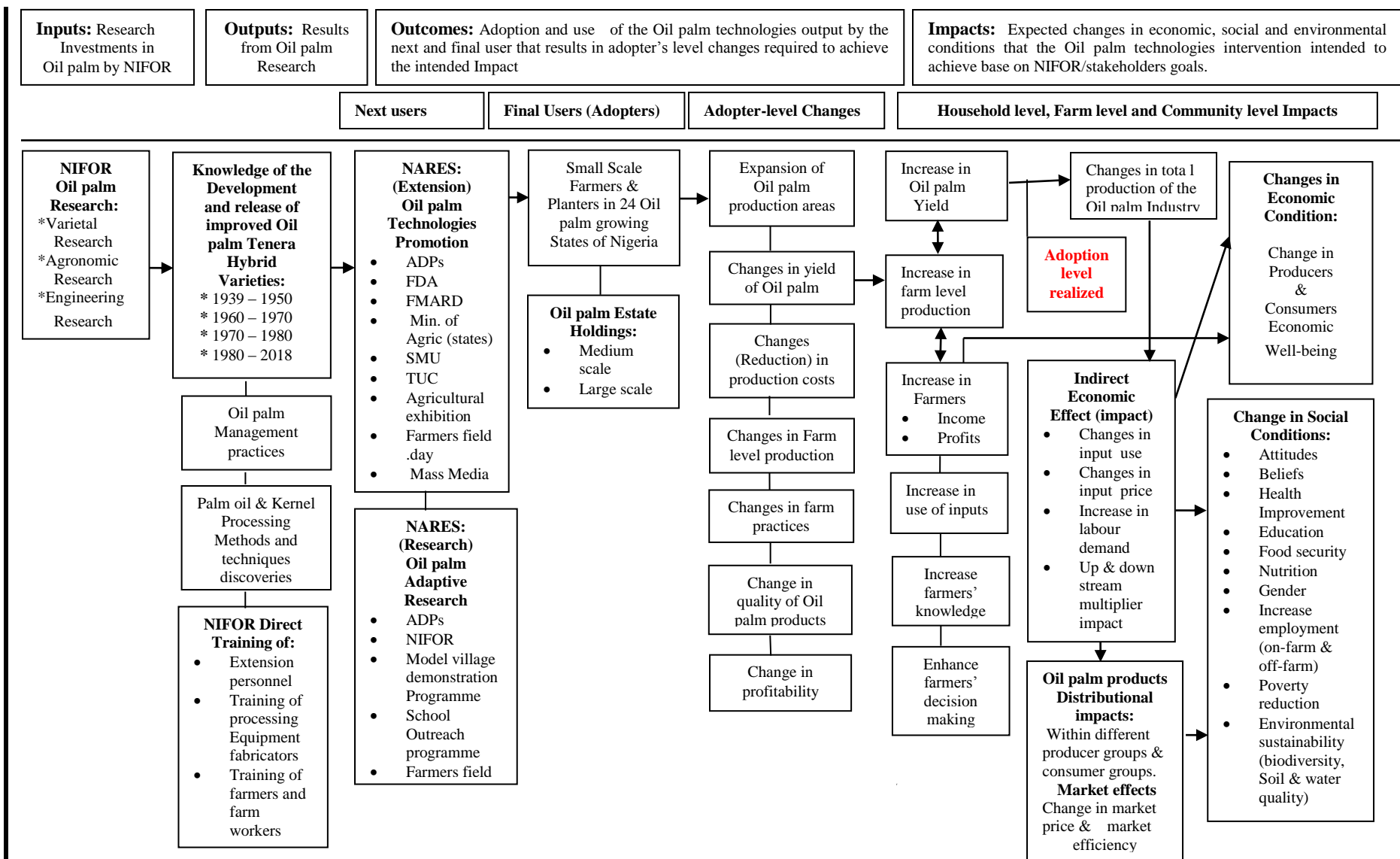


Figure 8: A Stylized 'Map' (schema) of 'Impact Pathways' framework for Oilpalm Research and Development (Improved Oil palm Technologies generated by NIFOR. It involves factors and players along the pathways from research inputs to outputs to outcomes to impacts for NIFOR research perspective (NARES – National Agricultural Research and Extension System; ADPs – Agricultural Development Programmes in 24 Oilpalm Producing States of Nigeria; FDA-Federal Department of Agriculture; FMARD - FederalMinistryAgriculture & Rural Development; TCU–Tree Crop Unit (Delta and Edo state); SMU – Smallholder Oilpalm Management Unit (Imo and Anambra States); NIFOR – Nigerian Institute for Oilpalm Research; ePIA - *ex-post* Impact Assessment.)

4.8 Constraints to farmers adoption of improved oil palm technologies

Table 4.21: Distribution of farmers according to constraints to adoption of improved oil palm technologies

Constraint variables	Farmers perceived constraints				Mean score \bar{x}
	No constraint	Constraint	Serious constraint	Very serious constraint	
	Freq(%)	Freq(%)	Freq(%)	Freq(%)	
Socio-economic factors					
Lack of capital/fund availability	12(3.7)	64(19.9)	89(27.6)	157(48.8)	3.21
Lack/No access to land	34(10.6)	78(24.2)	92(28.6)	118(36.6)	2.91
Lack of information	89(27.6)	100(31.1)	101(31.4)	32(9.9)	2.24
Non-membership of farmers' association	140(43.5)	101(31.4)	51(15.8)	30(9.3)	1.90
Lack/ineffective extension service	111(34.5)	69(21.4)	109(33.9)	33(10.2)	2.20
High cost of inputs	18(5.6)	65(20.2)	128(39.8)	111(34.5)	3.03
Unavailability of planting materials (Oil palm seed/seedlings)	68(21.1)	96(29.8)	95(29.5)	63(19.6)	2.48
Lack/high cost of labour	16(5.0)	82(25.5)	112(34.8)	112(34.8)	3.05
Gender inequality	90(28.0)	97(30.1)	97(30.1)	38(11.8)	2.26
Trend factors					
Change/unstable government policies	60(18.6)	135(41.9)	79(24.5)	48(14.9)	2.36
Changes in resource level (Biodiversity/reduction in forest inhabitants)	32(9.9)	154(47.8)	91(28.3)	45(14.0)	2.46
Decline in soil fertility	32(9.9)	129(40.1)	96(29.8)	65(20.2)	2.60
Change in food prices (food price fluctuation)	33(10.2)	123(38.2)	108(33.5)	58(18.0)	2.59
Sudden economic changes (exchange rate price change)	33(10.2)	98(30.4)	82(25.5)	109(33.9)	2.83
Shock/risk factors					
Food shortages (famine)	61(18.9)	112(34.8)	81(25.2)	68(21.1)	2.48
Ill health (sickness), disease outbreak (HIV/AIDS, Ebola, Lassa fever)	67(20.8)	79(24.5)	82(25.5)	94(29.2)	2.63
Climate change/natural disasters					
Flooding	97(30.1)	88(27.3)	94(29.2)	43(13.4)	2.26
Drought	75(23.3)	86(26.7)	86(26.7)	75(23.3)	2.50
Bush fire outbreak	43(13.4)	72(22.4)	96(29.8)	111(34.5)	2.85
Pests/disease outbreak	39(12.1)	104(32.3)	102(31.7)	77(23.9)	2.67
Theft of produce/products	32(9.9)	80(24.8)	104(32.3)	106(32.9)	2.88
Conflict factors					
Ethno-religious crisis	115(35.7)	118(36.6)	50(15.5)	39(12.1)	2.04
Political crisis	98(30.4)	112(37.9)	52(16.1)	50(15.5)	2.17
Insecure farm land (land tenure)	40(12.4)	105(32.6)	82(25.5)	95(29.5)	2.72
Insecurity to life/properties (war, terrorism, Fulani herdsmen attack)	37(11.5)	75(23.3)	86(26.7)	124(38.5)	2.92

Source: Field survey data, 2018

(Multiple responses recorded)

Table 4.21 presents a summary of the constraints to farmers adoption of improved oil palm technologies in the study area. The result shows the mean score of the different

categories of constraints/vulnerability factors affecting the adoption of oil palm technologies as experienced by the smallholder farmers. The study identified among the socio-economic factors that lack of capital/lack of fund mean (\bar{x}) = 3.21 poses very serious constraint to adoption of oil palm technologies to the farmers. Also lack/high cost of labour (\bar{x} =3.05); high cost of inputs (\bar{x} =3.03); and lack/no access to land (\bar{x} =2.91), in that order, posed serious constraint to very serious constraint to larger proportion of the farmers. However, while non-membership of farmers association (\bar{x} =1.90), lack/ineffective extension services (\bar{x} =2.20) and gender inequality (\bar{x} =2.26) posed no constraint to the farmers, unavailability of oil palm planting materials (\bar{x} =2.48) posed constraint to farmers adoption of the oil palm production technologies in the study area.

The result among trend factors indicated that the decline in soil fertility on farmers' farms (\bar{x} =2.6) and sudden economic changes(exchange rate, and price changes) (\bar{x} =2.83), respectively posed constraint to very serious constraint to farmers' adopters. The result observed among conflict factors, showed that ethno-religious crisis (\bar{x} =2.04) and political crisis (\bar{x} =2.17), posed no constraint to the farmers. but insecurity to life/properties(war, terrorism,Fulani herdsmen attack, etc.)(\bar{x} =2.92), and insecure farm land(land tenure) (\bar{x} =2.72), respectively posed serious to very serious constraint to farmers adoption oil palm technologies.

However, the result revealed that among factors of climate change/natural disasters including drought effects (\bar{x} =2.50); and pest/disease outbreak (\bar{x} =2.67) respectively posed constraint to serious constraint while bush fire outbreak (\bar{x} =2.85) and theft of palm produce (\bar{x} =2.88) posed very serious constraint to among farmers adoption of oil palm technologies. Furthermore, among the shock/risk factors, the study identified that while food shortage (famine) (\bar{x} =2.48) posed constraint, ill-health(sickness)/disease outbreak (HIV/AIDS, Ebola,

lassa fever,etc,)($\bar{x}=2.63$) posed serious constraint to farmers adoption oil palm technologies.

The result in this study showed that there are various constraints/vulnerability factors affecting farmers adoption of oil palm technologies. Among these are lack of capital/fund availability, high cost of inputs, insecure land tenure/unavailability of land, contact with extension services and other farm specific constraints. However, the result revealed explicitly that majority of the oil palm smallholder farmers agreed that lack of capital/fund availability, lack of labour/high cost of labour and high cost of inputs were major constraints to adoption of oil palm production technologies. This implies that most of the oil palm farmers in the study area were resource-poor farmers who do not have adequate financial resources to expand production. According to Agwu and Anyanwu (2000), that in many circumstances, the development of sustainable agricultural production requires increased use of purchased inputs such as seeds, fertilizers and equipment; however acquiring these factors of production, requires availability and adequate financial resources. Therefore, policies aimed at addressing these constraints will result in higher adoption of the oil palm technologies by farmers.

4.9 Hypotheses' testing

Hypothesis 1: Relationship between socio-economic characteristics of farmers and adoption of oil palm technologies.

Table 4.22. Ordinary least square multiple regression analysis of relationship between some selected socio-economic characteristics of farmers and adoption level of oil palm technologies

Explanatory Variables	Linear function	Semi-log Function	Double-log Function	Exponential function
Constraints	3.440	4.233	4.052	2.673
Sex(x ₁)	1.070 (0.042)	1.217 (0.686)**	0.045 (0.543)**	0.006 (0.032)
Age(x ₂)	0.047 (-2.880)**	2.034 (-4.653)	0.003 (0.358)	0.001 (0.215)**
Marital status(x ₃)	0.734 (1.570)	2.726 (0.054)	0.486 (0.053)**	0.342 (0.006)**
Education(x ₄)	0.489 (-3.74)**	1.468 (-6.638)**	0.324 (2.536)	0.213 (1.649)
Household size(x ₅)	0.158 (3.52)**	1.358 (5.637)	0.034 (2.171)	0.021 (2.015)**
Farming Experience(x ₆)	0.052 (-0.24)**	1.267 (-4.647)	0.024 (-0.035)	0.018 (-0.436)**
Farm size(x ₇)	0.069 (0.170)	1.249 (0.536)	0.023 (0.003)**	0.003 (0.001)**
R²	79.67	65.78	75.87	75.23
F-value	4.17	7.90	3.35	3.18
N	320	320	320	320

Source: Computed from Field Survey Data, 2018

Figures in parenthesis are t-ratio

****Significant at 1%**

Table 4.22 shows estimate of multiple regression results of the determinants of on socio- economic characteristics of the farmers and adoption level of oil palm technologies. The linear function from the regression result produced the lead equation. The result reveals that the co-efficient R^2 was 79.67% of the variation of farmers adoption oil palm technologies could be explained by their socio-economic characteristics. The result indicates that four(4) out of the seven(7) farmers socio-economic characteristics:- sex, marital status, household size and farm size had positive relationship to adoption of improved oil palm

technologies while the other three(3) farmers socio-economic of:- age, educational level and farming experience had negative relationship to adoption.

The co-efficients of determination for the variables of sex(x_1)(t-ratio value 0.042), marital status(x_3) (t-ratio value 1.570), household size(x_6) (t-ratio value 3.52), and farm size(x_7) (t-ratio value 0.170) had positive relationships to adoption and significant at 0.001 level. This implies that the increase of these variables will increase level of adoption of improved oil palm technologies. Age(x_2) (t-ratio value -2.880), educational level(x_4) (t-ratio value -3.74) and farming experience(x_5) (t-ratio value -0.24) though had negative values and significant relationship to adoption of the oil palm technologies did not imply decrease in adoption level since farmers who are older in age, educated with more yaers of farming experiences are known to have positive influence on adoption of farm technologies. The implication of this result is that decreases in these variables notwithstanding, the adoption of improved oil palm technologies' components may have be constrained by other interviening variables affacting the farmers.

However, the result was confirmed by the F-ratio value of 4.17 which was significant at 0.001 and 0.005 level of probability. Therefore the null hypothesis which states that there is no relationship between some selected socio-economic characteristics of the farmers and adoption level of the improved oil palm technologies was hereby rejected.

Hypothesis 2: Relationship between farmers' perceived impact of livelihood and adoption of oil palm technologies

Table 4.23. Pearson product moment correlation (PPMC) analysis of relationship between farmers perceived impact of livelihood and adoption of improved oil palm technologies.

Items	Mean	Std.d	R	Sig	Decision
Farmers' perceived impact	11.6667	2.33140	0.454	<0.001	Significant
Adoption of oil palm technologies' components	32.2298	8.76502			

Source: Computed from Field Survey Data, 2018

Correlations

		Farmers perceived impact	Oil palm technologies
Farmers' perceived impact	Pearson correlation	1	.454**
	Sig. (2-tailed)		.000
	N	322	322
Adoption of improved oil palm technologies	Pearson correlation	.454**	1
	Sig. (2-tailed)	.000	
	N	322	322

** Correlation is significant at the 0.01 level (2-tailed).

Source: Field Survey Data, 2018

The hypothesis which states that there is no significant relationship between farmers' perceived impact of livelihood and adoption of improved oil palm technologies by smallholder farmers was analysed using the pearson product moment correlation (PPMC) model. The result obtained (Table 4.23) were rescaled into two variables labeled Farmers' perceived impact and Adoption of oil palm technologies respectively. The result shows that correlation co-efficient (r) between farmers' perceived impact of improved oilpalm technologies on livelihood and adoption of oil palm technologies was 0.454 or 45.4% ie $r = 0.454$ (45.4%). This implies that in terms of strength and direction, there was a fairly moderate positive relationship between farmers' perceived impact of livelihood and adoption of oil palm technologies. The p-value of < 0.001 shows statistically significant

relationship between farmers' perceived impact of livelihood and adoption of oil palm technologies. Therefore, the hypothesis that states that there is no significant relationship between farmers' perceived impact on livelihood and oil palm technologies adoption by the smallholder farmers was rejected in favour of the alternative hypothesis.

Hypothesis 3: Relationship between socio-economic characteristics of farmers and farmers' perceived impact of adoption of oil palm technologies at household level

Table 4.24 Result of Ordinary least square multiple regression analysis of relationship between some selected socio-economic characteristics and farmer's perceived impact of oil palm technologies at household level

Term		Adj SS	Adj MS	Coef	SE Coef	T-Value	P-Value	VIF	F-value	R-sq	R-sq (adj)
Constant	8	1786.3	223.289	50.65	3.44	14.72	0.000		4.17	79.67	76.35
Sex	1	0.1	0.096	0.05	1.07	0.04	0.966	1.11	0		
Age	1	442.8	442.798	0.1378	0.0479	-2.88	0.004*	1.71	8.28		
Status	1	132.0	131.971	1.153	0.734	1.57	0.117	1.3	2.47		
Household	1	662.4	662.435	0.556	0.158	3.52	0.000*	1.21	12.38		
FarmingExp	1	332.1	323.142	0.0127	0.0522	-0.24	0.008*	1.05	0.06		
Farm Size	1	1.5	1.51	0.0117	0.0697	0.17	0.867	1.11	0.03		
Education	1	746.8	746.799	-1.828	0.489	-3.74	0.000*	1.13	13.96		
OilpalmType	1	58.7	58.726	0.444	0.424	1.05	0.296	1.01	1.1		
Error		312	16694.5								
Total		320	18480.8								

* Significant predictor

Source: Computed from field survey data, 2018

Farmers' perception of impact in the study area positively and significantly related to sex, age, marital status, household size, farming experience, farm size, educational level, and oilpalm plantation type. The ordinary least square regression analysis (OLS) was used to determine the relationship between the farmers socio-economic characteristics and farmers' perceived impact of oil palm technologies at household level. The result in Table 4.24 shows the co-efficient of each contributing variables: Regression equation given as:

$$\begin{aligned} \text{Perception} = & 50.65 + 0.05*\text{Sex} - 0.1378*\text{Age} + 1.153*\text{Marital status} + \\ & 0.556*\text{Household size} - 0.0127*\text{Farming experience} + 0.0117*\text{Farm size} - \\ & 1.828*\text{Education level} + 0.4441*\text{Oil palm plantation types}. \end{aligned}$$

The co-efficient of determination R- Square (R^2) was 79.67% and the adjusted R-Squared (R^2 adj) usually taken at 95% confidence value, was 76.35%. The hypothesis which states that there is no significant relationship between the farmers' perception of farmers impact at household level and some selected socio-economic characteristics of farmers was rejected in favour of the alternative hypothesis $p\text{-value} < 0.001$. The result of the regression analysis showed that out of the eight(8) farmers socio-economic characteristics namely sex, age, marital status, household size, farming experience, farm size, educational level, and oil palm plantation farm type, only four(4) of the farmers socio-economic characteristics (age, household size, farming experience and educational level) were found to be positive and statistically significant. The result indicates that the coefficient of: age $p\text{-value} = 0.004$, household size ($p\text{-value} < 0.001$), farming experience ($p\text{-value} = 0.008$), and educational level ($p\text{-value} < 0.001$) all showed statistically significant with the capability of predicting perception of farmers impact at household level. The regression co-efficient of the other variables are statistically negative and significant with perceived farmers impact.

The finding showed that the co-efficient of determination for age $p\text{-value} = 0.004$ correlated positively and significantly with farmers' perceived impact of improved oil palm technologies at household level. This implies that farmers in the study area who are advanced in age were likely to perceived more impact from engaging in oil palm production activities than the younger farmers. This might due to the fact that the older farmers are

more exposed and experience therefore, more increase in their productivity engaging in oil palm livelihood activities

Educational level was also significant and correlated positively with $p\text{-value} < 0.001$. This implies that those farmers that are highly educated are more likely to perceive more impact of the improved oil palm technologies due to their awareness of oil palm production farm practices. Also high educational level influences the adoption of technologies and which might have also increase the productivity of the crop and hence more perceived impact deriveable.

Farming experience as a personal characteristic is also significant and correlated positively at $p\text{-value} = 0.008$. this implies that the longer the years of farming, the more the perceived impact of improved oil palm technologies. It is expected also that the farmers who have spent more years in farming should be more knowledgeable and experienced to be able to perceive more impact of the oil palm technologies and engaging in oil palm production activities.

Household size $p\text{-value} < 0.001$ on the other hand shows that the oil palm farmers with large household size had the needed farm labour required to carry out these oil palm livelihood activities and therefore increase income and more impact deriveable from use of improved oil palm production technologies.

Hypothesis 4: Difference in farmers’ perceived livelihood impact among farmers adopters of oil palm technologies across the three selected states in south- south, Nigeria.

Table 4.25a: Show the descriptive statistics of result of the ANOVA test of difference in farmers’ livelihood impact among farmers’ adopters of oil palm technologies across the three selected states in south-south, Nigeria.

	N	Mean	Std. Deviation	Std. Error	95% Confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
Edo	146	28.2552	4.12610	.34265	27.5779	28.9325	17.00	42.00
Bayelsa	60	29.3833	5.48678	.70834	27.9659	30.8007	18.00	53.00
AkwaIbom	116	27.1293	5.39328	.50075	26.1374	28.1212	14.00	43.00
Total	322	28.0592	4.93200	.27528	27.5176	28.6008	14.00	53.00

Source: Computed from Field Survey Data, 2018

Table 4.25b: ANOVA Table showing the relationship among farmers’ livelihood impact among farmers’ adopters of oil palm technologies across the three selected states in South-South, Nigeria.

ANOVA Table

Farmer’s Livelihood Impact

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	211.073	2	105.537	4.432	.013
Within Groups	7572.802	318	23.814		
Total	7783.875	320			

Source: Computed from Field Survey Data, 2018

Table 4.25c: Post-HOC test showing the relationship among farmers’ livelihood impact among farmers’ adopters of oil palm technologies across the three selected states in South-South, Nigeria.

Tukey HSD

Multiple Comparisons

Dependent Variable: Farmer’s Livelihoods Impact

(I) stateG	(J) stateG	Mean difference(I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
1	2	-1.12816	.74909	.289	-2.8921	.6357
	3	1.12586	.60789	.155	-.3056	2.5573
2	1	1.12816	.74909	.289	-.6357	2.8921
	3	2.25402*	.77601	.011	.4267	4.0813
3	1	-1.12586	.60789	.155	-2.5573	.3056
	2	-2.25402*	.77601	.011	-4.0813	-.4267

Source: Computed from field survey data, 2018.

* The mean difference is significant at the 0.05 level.

For the test of this hypothesis (H_{04}) which states that there is no significant different in the farmers' livelihood impact among farmers' adopters of oil palm technologies across the three selected states in the South-South, Nigeria, a one way analysis of variance (ANOVA) model was used. The result in Table 4.25(a,b & c) indicated that there was significant relationship between the farmers' perceived livelihood impact among the farmers' adopters of improved oil palm technologies across the three selected states of Edo, Bayelsa and Akwa Ibom in South-South, Nigeria.

The ANOVA result yielded a p-value of 0.013 with an F- Statistics of 4.432. Therefore, the hypothesis that states that there is no significant difference between farmers' perceived livelihood impact across the three selected states in the South-South, Nigeria was rejected in favour of the alternative hypothesis. Since no significant difference had been established, the post-HOC multiple comparisons using the Turkey HSD test Table 4.25c indicates that the mean score for Edo state ($M = 28.2552$, $Sd = 4.12610$) was not statistically difference from Bayelsa state ($M = 29.3833$, $Sd = 5.48678$) and the mean score for Bayelsa state was not statistically difference from that of Akwa Ibom state ($M = 27.1293$, $Sd = 5.39328$).

The result also show that there is no variation among the farmers' adopters in the study area and particularly their means of livelihoods which did not also varies, irrespective of their state location.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The study assessed the impact of adoption of improved oil palm technologies on smallholder farmers' livelihood in south-south, Nigeria. A multistage stage random sampling method was used to select a total of 322 farmers from three states – Edo, Bayelsa and Akwa Ibom of the south- south, Nigeria. The population for the study comprises of only oil palm farmers that were randomly selected. A structured questionnaire, interviewed schedule and focus group discussion was used for the collection of data. The study specifically described the farmers socio-economic characteristics; identified improved oil palm technologies awareness among the farmers; ascertained farmers' sources of information on oil palm technologies; examined the level of adoption of oil palm technologies; and identified the farmers oil palm livelihood activities. The study assessed the impact of smallholder farmers' adoption of improved oil palm technologies at three levels:- farmers perceived impact of adoption at household and farm level; impact of adoption of improved oil palm technologies on farmers social life (*before and after*); and at community level; developed and discribed the oil palm technologies "Impact Pathways" in the study area; and finally identified constraints/vulnerability factors to smallholder farmers' adoption of oil palm technologies.

The result from the findings of the study on the farmers socio-economic characteristics showed that 79.5% of the oil palm smallholder farmers were dorminated by males, 77.3% of the farmers were married and with 56.5% of the farmers having household size of 5-8 persons. It was observed that 31.1% of the farmers had 11-15 years of farming experience

with age distribution bracket of 41-50 years. It was noted that majority of the farmers (93.8%) had formal education and which probably resulted in the high level of adoption of improved oil palm technologies recorded in the study area. The result also revealed the following oil palm farm level information where 62.1% of the farmers had oil palm plantation farm size of between 1-3ha. Thus confirmed that they were predominantly smallholder oil palm farmers; 55.3% of the farmers cultivated/planted sole oil palm plantation, 27% cultivated oil palm with arable crops. The result on ownership of oil palm plantation farms showed that 51.6% of the farmers self-owned oil palm plantation while 20% of the farmers inherited their oil palm plantation farms. Also, while about 45% of the farmers had oil palm plantation aged 11-20 years old, 47% of the farmers had their oil palm farms located 1-2km distance from home. The farmers had a mean monthly income of N30,800.00. The result further showed that the main sources of information on improved oil palm technologies mostly used by a large proportion of the farmers were friend/neighbours, extension agents and agricultural development programs(ADPs) ranked 1st 2nd and 3rd respectively. It was found that the farmers had high awareness of the oil palm technologies and hence the high level of adoption recorded among the farmers. The findings from the study further revealed that among the identified oil palm livelihood activities, marketing of palm produce (palm oil, palm kernel and palm fruits) $\bar{x}=3.65$, transport of palm produce/products ($\bar{x}=3.58$), oil palm fruits harvesting ($\bar{x}=3.58$), Palm oil milling/processing($\bar{x}=3.52$), were found to be very important and highly rated livelihood activities among the farmers. The adoption of improved oil palm technologies had positive impact on the farmers' livelihood at household and farm level; on farmers social life (*before and after*) and community level; and where there was perceived farmers' impact of:- increases in crop yield, increase in farmers' income, improved food security, increase farm

yields, and expansion in oil palm farms; improvement in farmers social life material benefits and well-being, among other impact indicators perceived by the farmers.

The study developed an “Impact Pathway” conceptual framework for research generated improved oil palm technologies by NIFOR to described in perspective and explained how these disseminated oil palm technologies could have impact on lives of the farmers and community persons in both rural and urban areas. The study also revealed the major constraints/vulnerability factors militating against farmers’ adoption of improved oil palm technologies including, lack of capital/fund availability, lack or no access to land, high cost of inputs, lack /high cost of labour and insecurity to life and properties (Fulani herdsmen attack, terrorism, war, etc).

The linear function lead equation from the regression analysis result indicated that the co-efficient $R^2 = 76.67$ and F- ratio = 4.17 was significant at 0.001 and 0.005 level of probability. The result showed that four(4) out of the seven(7) farmers’ socio-economic characteristics of:- sex, marital status, household size and farm size had positive t-ratios relationships to adoption of improved oil palm technologies. Age, educational level and farming experience had negative t-ratios relationship to adoption. Pearson product moment correlation analysis showed that a significant and positive relationship existed between farmers’ perceived impact of improved oil palm technologies on farmers’ livelihoods and adoption of oil palm technologies’ components. Also the regression analysis result showed that age (p-value = 0.004), household size (p-value < 0.001), farming experience (p-value=0.008) and educational level (p-value < 0.001) had a statistically significant positive relationship between the perception of farmers’ impact at household level. The ANOVA result revealed that there was significant relationship between farmers livelihood impact

among the farmers' adopters of improved oil palm technologies across the three selected states in the study area.

5.2 CONCLUSION

It has been noted that for agricultural research technologies to have an impact on the farmers, it must first be adopted. From the result of findings of the study, it was observed that there was high level of adoption of improved oil palm technologies among the smallholder farmers. Farmers perceived impact showed that positive changes had occurred in their livelihood and with evidences that adoption of improved oil palm technologies had led to reliable yield increases obtained from improved oil palm technologies and resulted subsequently to increases in the farmers' incomes, improved food security, expansion of oil palm plantation farm land, employment generation, and improvement in the farmers social life material benefits and well-being, beside other positive impact recorded among the farmers and non-farmers at the community level.. Therefore, it was concluded that the adoption of improved oil palm technologies had positive impact on the oil palm smallholder farmers' livelihoods in the study area.

5.3 RECOMMENDATIONS

In line with the results of the study, the following recommendations are made:

1. Since adoption of improved oil palm technologies led to creating impact on farmers' livelihood and households well-being, measures such as continuous investment in farmers education, to increase farmers awareness about the potential benefits and the need to adopt the improved oil palm technologies, farmers and planters should be intensified through the various states' ADPs across the oil palm growing belts of Nigeria.
2. Inview of the identified constraints to oil palm technologies adoption among the

farmers, measures such as:-

- access to credit or grant to the farmers and prospective oil palm farmers should be considered as a core component by government for the development of oil palm agricultural subsector farmers; and also including the introduction of oil palm input subsidy scheme to farmers by government is recommended. Subsidizing farm inputs such as fertilizer and agro-chemicals to reduce cost of inputs will encourage the ease of technologies' adoption and increase farm outputs.
- 3. Oil palm production requires large land area for cultivation and expansion of the crop. Therefore, to solve the problem of lack/no access to land and its acquisition, measures aimed at reviewing the land use policy by government in favour of farmers should be put in place to provide more land for establishment of large scale oilpalm plantation is recommended.
- 4. The low farmers' membership of social organization/social participation observed among oil palm farmers in this study was not encouraging. Therefore, farmers should be encouraged through appropriate government agencies to form social associations such as cooperative societies where agricultural information, credit and farm inputs could be channelled to the farmers and or have access to funds from lending institutions.

5.4. Contribution to knowledge:

The study's contribution to knowledge are:

- 1 It provided the basis for undertaking in-depth assessment of impact; including the methods/approaches of assessing the impact of improved Oil palm technologies.
- 2 The study contributed to understanding the processes of how research technologies lead to improvement of rural livelihoods and/or poverty reduction.

- 3 In addition, the study identified the ‘Oil palm Impact Pathways’ through which impact may occur.
- 4 Furthermore, the study contributed to strategic learning particularly with respect to the actual value of the research in economic, social and environmental terms and that impact assessment depend on the socio-economic context.
- 5 The study provides the implications of Oil palm cultivation on the smallholder rural-poor farmers’ livelihoods.

Suggestions for further Research:

- (i) A replication of this study topic could be conducted in other agro-ecological zones of the oil palm belts of Nigeria for a wider coverage and robustness information gathering. This will enhance generalized recommendation for the oil palm technologies.
- (ii) Ex-post impact adoption study can also be carried out so as to evaluate the changes that have taken place as a result of the adoption of the improved Oil palm technologies in the oilpalm growing areas of Nigeria.

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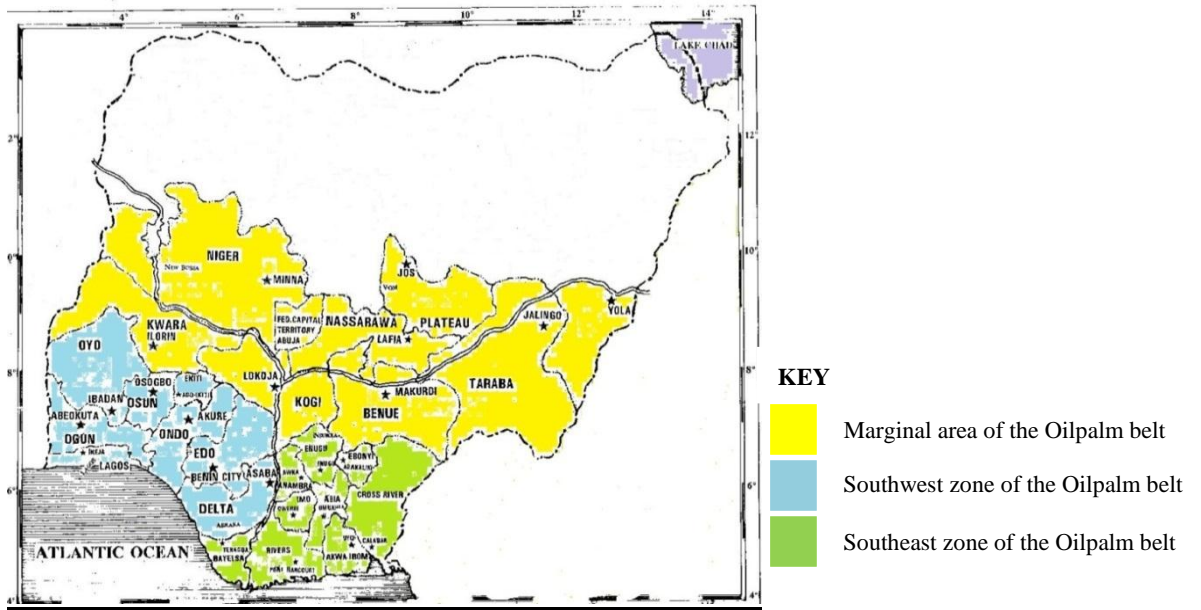
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APPENDICES

Appendix 1 :



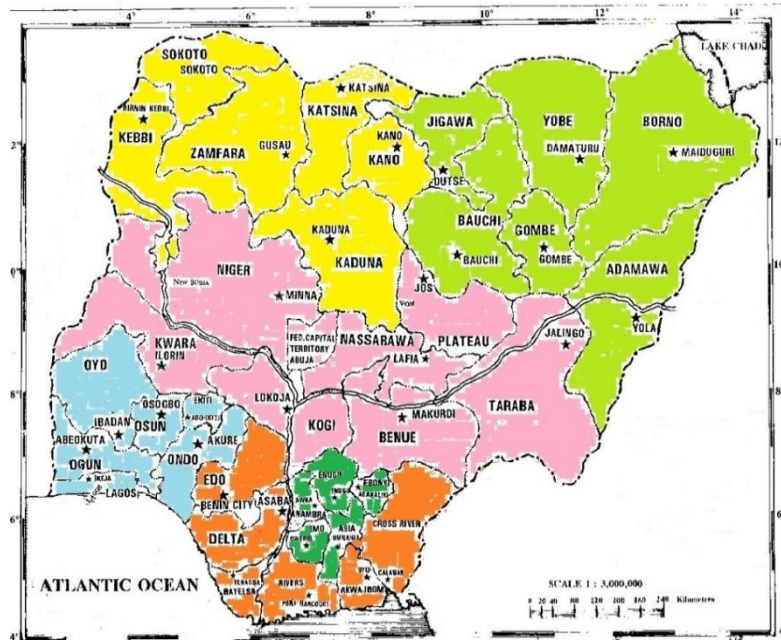
Appendix 1: Map showing the 'Oilpalm Belts' of Nigeria.

Appendix 2 :



Map showing 24 Oilpalm growing states of Nigeria

Appendix 3 :



Map of Nigeria showing the Six (6) Agro-ecological zone

Appendix 4

Table for Determining Sample Size from a Given Population

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	228	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	106	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	133	1000	278	75000	382
210	136	1100	285	1000000	384

SOURCE: Krijcie, R. V., & Morgan, D.W. (1970). 'Determining Sample Size for Research Activities *Educational and Psychological Measurement* 30: 607– 610. This table was based on a formula Published by the research division of the National Education Association.

NOTE: N is population size; S is sample size.

Appendix 5:

Introduction Letter

Department of Agricultural Extension
Federal University of Technology,
Owerri, Nigeria.

Dear Sir / Madam,

Questionnaire on: 'Impact of Adoption of Improved Oil Palm Technologies on Farmers' Livelihoods in South-South, Nigeria'

I am a postgraduate Student in the Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria. I am conducting a study on the Impact of Adoption of Improved Oilpalm Technologies on Farmers' livelihood in selected States in South-South, Nigeria.

Please fill free to express your opinion in response to each question in the questionnaire.
Information obtained will be treated as confidential and used for this research purpose only.
Thank you for your kind and anticipated cooperation.

Yours faithfully,

Solomon Gere
Student Researcher

QUESTIONNAIRE

SECTION A

INSTRUDUCTION:

Please tick (✓) where applicable and respond appropriately where necessary.

Socio-Economic Characteristics of respondents

1. Name of Community–Town/Village: -----
2. States: -----
- 3: Sex: 1. Male [] 0. Female []
4. Age in year: []
5. Marital Status: Single [], Married [], Divorced [], Widowed []
6. Educational level: (1) No formal Education [], (2) Primary Education [],
(3) Secondary Education [], (4) Higher Education (OND, HND, Degree []
7. House hold Size: (Number of person in your house) []
8. Farming Experience (Years): How long have you been farming (OilPalm Farming?) []
9. Membership of Social organization: Yes [] No []
- 10 Do you have Oilpalm plantation: Yes [], No [].
- 11 Land Tenure / Ownership of Oilpalm plantation is it: Self-owned [],
Rented/Hired [], Inherited [], Family owned [], Community-owned [].
- 12 What are your Farm size / size of Oilpalm plantation (ha) operated? (or number of palms planted?) -----
- 13.Oilpalm plantation farming system operated by the farmer (what type of plantation Farming system do you have):
Solely planted Oilpalm plantation [], Oilpalm + Arable crops [],
Oilpalm + Arable crops + Perennial crops []. Oilpalm + Perennial crops [].
14. Age of Oilpalm plantation (years) operated by the farmer. How old are your palms []
15. What is the distance to your farm from home (Km): []
16. Farmers Income level (what is your monthly income N) []
17. Do you carry out off–farm activity to generate income apart from farming?
Yes [], No []
18. What is your major source of income? 1. Farming [] 2.Wage labour []
3. Services [], 4.Business []

SECTION B

Identification of awareness of Oilpalm technologies among the farmers in the studyarea.

Please indicate by ticking (√) from the list, Oilpalm technologies that you are aware of in your farming operation.

Oilpalm Technologies components	Farmers Response	
	Aware	Not Aware
Improved Oilpalm planting Materials(OilpalmTenera seeds/seedlings)		
Oilpalm Nursery Establishment Techniques: Use of Polyethene bags nursery methods – Double & Single stage nursery methods		
Oilpalm plantation/field Establishment/planting Methods: 9m x 9m Triangular spacing planting;		
Oilpalm plantation Management techniques: methods of weed control; pruning of palm leaves; mulching;		
Harvesting methods of Oilpalm fruit bunches: use harvesting chisel, Hook knife,		
Small-scale palm oil processing methods: use of Digester screw press mill; nutcracker/nutcracker separator;		
Fertilizer application methods: in nursery, and plantation palms		
Pests/Disease Control Methods for nursery & plantation palms		
Palm wine Tapping Techniques		
Palm wine preservation and Bottling Techniques: use of crown cork glass bottles & plastic bottles		
Other available Technology, Please specify -----		

(Multiple Response)

SECTION C

Farmer's sources of information on improved Oilpalm production Technologies.

Please indicate your sources of information on improved Oilpalm technologies (yes or no) below; and how often do you use these sources of information?

Please tick (√) where applicable.

Sources Information	Farmers' Response		Farmers' perception rating of sources of information mostly used				
	Yes	No	Very often Used	Often used	Occasionally used	Seldom Used	Never used
Radio							
TV							
Extension Bulletins							
Newspapers/Magazines							
Extension Agent							
Contact Farmers							
Ministry of Agriculture							
Agricultural Development programs (ADPs)							
Tree Crop Unit (TCU)							
Smallholder Oil palm mgt. Unit (SMU)							
Visit to Research Institute (NIFOR)							
Agricultural Shows/Exhibition							
Friends / Neighbors							
Other sources, please Specified-----							

(Multiple Response)

SECTION D:**Improved Oilpalm Technologies Adoption among the respondents**

Have you adopted any of the Improved Oilpalm production Technologies ?

please specify the Extent of Adoption or use of any of the Oilpalm technologies

S/ N	Oilpalm Technologies	<i>Not Aware</i>	<i>Aware</i>	<i>Interest</i>	<i>Evaluation</i>	<i>Trial</i>	<i>Adoption</i>
1	Improved Oilpalm planting materials (Oilpalm Tenera seeds /seedlings)						
2	Oilpalm nursery establishment techniques: use of polythene bags nursery (Double & single stage nursery methods)						
3	Oilpalm plantation/field establishment/planting methods: 9m x 9m triangular spacing planting						
4	Oilpalm plantation management techniques: (methods of weed control; pruning of palm leaves; mulching)						
5	Harvesting methods of Oilpalm fruits: use of harvesting chisel, hook knife						
6	Small-scale palm oil processing methods:- use of digester screw press mill; nut cracker/nut cracker separator						
7	Fertilizer application methods: in nursery and plantation palms						
8	Pests/Disease control methods for nursery and plantation palms						
9	Palm wine tapping techniques						
10	Palm wine preservation and bottling techniques: use of crown cork glass bottles and plastic bottles						

(Multiple Response)

SECTION E

Identification of farmers' Oilpalm livelihood activities in the study area.

What are the Oilpalm livelihoods activities in your farming area? Please indicate by ticking (√) how each of the Oilpalm livelihood activities are important to your well-being.

Oilpalm Livelihood Activities	Farmers Response			
	Very Important	Important	Less Important	Not Important
Oilpalm plantation establishment and cultivation				
Oilpalm Nursery establishment activities				
Palm oil milling /processing activities				
Palm kernel Cracking				
Oilpalm fruit Harvesting				
Palm wine Tapping				
Local gin (Ogogoro) Distilling				
Broom making				
Basket weaving				
Rope making				
Non-farm Oil Palm Activities				
Transportation of Oil palm produce/ Products				
Local fabrication of Oilpalm processing equipment.				
On-farm employment (hired farmlabour)				
Marketing of palm produce (palm oil, kernel, palm fruits,)				
Other Oilpalm production Activities, please specify -----				

(Multiple Responses)

SECTION F

(a) Assessment of farmers' perceived impact of Adoption of improved Oilpalm technologies on farmers' livelihoods.

Please Tick (✓) where appropriate

STATEMENT Household level Impact Indicators	Farmers' perceived impact preference rating				
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
There is Increase Farmers Income (Saving / Financial Independent)					
There is Improved Food Security					
There is Improved Nutrition					
There is Improve Farmers Materials well-being (Acquisition of properties- House, Cars, TV, Motor cycle, etc.)					
There is Increase Financial contribution to Family needs (children Education, Health care, Provision of Food, etc.)					
There is an Enhanced Farmers' decision making					
Farm Level Impact Indicators					
There is Increased Farm yield (output)					
There is Oilpalm varietal Replacement					
Farm expansion /Land use					
There is Increased use of input					
Increase farmers knowledge					
Increase on-farm employment was significant					
Availability of wild vegetables due to Intensification of Oilpalm production / practices					
There is Reduced farmers' vulnerability to Risk, theft, bush fire, etc.,					
Soil Fertility Decreased significantly					
Other benefits					

(Multiple Responses)

(b) Assessment of farmers by benefit of effects of adoption of improved oil palm Technologies (before and after)

Please tick(√) as appropriate the changes that takes place in your household assets/valueable items you owned or acquired before and after you adopted oil palm technologies and/or engaged in oil palm production activities.

Benefit variables	Before	After
Ownership of house		
Mud house with zinc roof		
Block house cemented with zinc roof		
Block house cemented with aluminum roof		
Household items		
Furniture		
Fans		
Refrigerators		
Foam matrasses		
Means of mobility		
None		
Bicycles /		
Motorcycles		
Vehicle		
Motor boat		
Communication items		
Radios		
TV		
Cell phones (gsm phones)		
Health care		
Self-medication		
Native treatment		
Hospital health care		
Children education (paying school fees)		
Feeding of households		
Clothing (more or better clothing for family)		
Marriage		
Burial ceremonies (burial of Kin group member)		
Contribution to social obligations		

(Multiple responses)

(c) Community Level Impact Assessments:

Focus Group Discussion (FGD); in-depth Interviews; and Investigator observation will be used. A total of 6 Focus Group Discussion sessions is expected to be carried out in the study area. . (See attached Impact Assessment Check List Questions below).

SECTION H

Identification of constraints to farmers' adoption of the oilpalm technologies.

Please indicate by ticking (√) as appropriate below the effect of constraints affecting your adoption of improved oilpalm technologies

Constraint variables	Magnitude of constraints/vulnerability factors: Farmers perceived preference rating			
	No constraint	Constraint	Serious constraint	Very serious constraint
Socio-economic factors				
Lack of capital/Fund availability				
Lack/No Access to Land				
Lack of Information				
Non-Membership of farmers' Association				
Lack/ineffective Extension service				
High cost of Inputs				
Unavailability of planting materials (Oil palmseeds/seedlings)				
Lack/High cost of Labour				
Gender Inequality				
Trend factors				
Change/Unstable Government policies				
Changes in Resource level (Biodiversity /Reduction in Forest inhabitats)				
Decline in Soil Fertility				
Change in food prices (Food price fluctuation)				
Sudden Economic changes (exchange rates, price changes)				
Shock/Risk factors				
Food Shortages (Famine)				
Ill health (Sickness), Disease outbreak (HIV/AIDS ,Ebola, Lassa fever)				
Climate Change/Natural Disasters				
Flooding				
Drought				
Bush Fire Outbreak				
Pests/Disease Outbreak				
Theft of produce/products				
Conflict factors				
Ethno – Religious crisis				
Political crisis				
Insecure farm land (Land Tenure)				
Insecurity to life/ properties (War, Terrorism, Fulani Herdsmen attack, etc.).				

(Multiple Responses)

Focus Group Discussion (FGD) / Farmers Interview:
Check List Impact Assessment Questions.

Community Level Impact assessment:

Project Title: Impact of Adoption of Improved oil palm technologies on smallholder farmers' livelihoods in South-South, Nigeria.

Location: (Village/Town/Farm) -----

Researcher/Interviewer: -----

FGD/Farmers Interview Questions Guide

1. Why did farmers in your community adopt oil palm cultivation or oil palm production technologies?
2. Who in the community really use the technologies? (children, adult men or women, elderly women or men)
3. (i) who among members of the community benefit from activities in the oil palm operation?
(ii). In what aspect of these oil palm activities did they benefit? (employment on-farm, employment off-farm, marketing of produce, etc.).
4. In what aspect did adoption of oil palm technologies benefited non-farmers in your community? (in terms of direct and indirect employment of labour in oil palm field operations, Harvesting, palm oil processing, palm kernel extraction, etc.,)
5. What other benefits did the technologies adoption/ cultivation of oil palm has on non-farmers in the community?
6. What did private persons (non-farmers) did to support or encouraged the use of oil palm technologies? (in terms of production of inputs, fabrication of equipment, provide training(capacity building), value addition in production process, provide transportation for produces evacuation, etc.,)
7. How has the cultivation of oil palm affected you and members of your community?
 - Any effect on food consumption, increase income, increase production,
 - Any effect on farm land – in terms of soil fertility, soil erosion, increase / decrease in forest resources,
 - affect water bodies (rivers, streams, ponds, lakes, dams).
8. What Impact did the adoption of oil palm technologies have on the well-being of farmers (increase income base/asset base, gives recognition, prestige, increase knowledge, bestow political power, economic power,)
9. What Impact has the adoption of the technologies made on:
 - (i) Food security of families/household members? (provide more food, eat better quality food, no longer buy palm oil from the market, etc.,).
 - (ii) Impact on the community generally? (Provide cheap and more food, provides employment (on-farm and off-farm), increase income – much more income or

- steady income, improve well-being, etc.).
10. How did the use of the technologies improved the natural environment in your community? (What impact did the adoption of the oil palm technologies made on the environment? (- reduce erosion and soil loss on farms, increase soil fertility, increase moisture availability, increase deforestation, improved bio-diversity of the environment, etc.)
 11. What other secondary impact did oil palm production livelihoods activities opportunity provided to persons in your community? (marketing and sales of palm produce, transport business and transportation of goods, etc.,)
 12. Are there any negative effects of adopting the oil palm technologies and or cultivating the oil palm in your community on forest land, increase erosion, pollution of water bodies – rivers, streams, etc.,?
 13. What government policies favoured the use of the oil palm technologies in your community? (subsidy on fertilizers, extension services, export trade promotion, provision of input (seeds/seedlings), security, etc.,)