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EFFECT OF CLIMATE SMART AGRICULTURAL PRACTICES ON POVERTY AMONG FARMERS IN NORTH WEST NIGERIA



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Thesis submitted for the degree Doctor of **Philosophy in
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ABSTRACT

The current level of poverty in Nigeria is disturbing and climate change impedes food security and increases poverty indirectly and directly on individuals or households. Farming households are changing agricultural practices as a result of global observation of climatic and environmental changes. This research work recognised a link which exists between climate change, climate smart agricultural practices (CSAP) and poverty status of farming households in North West Nigeria. The study examined the socioeconomic characteristics of farmers; the constraints of using climate smart agricultural techniques; factors influencing indicators of CSAP among different crops and livestock enterprises; poverty status for low-users and high-users of climate smart agricultural techniques and the effect of CSAP on poverty status of rural farmers. This is with a view to establishing the consequences of climate variation and its influence on poverty status among rural farmers in North West Nigeria. The multi-stage, sampling techniques was used to select three hundred (300) respondents who provided the relevant primary data for this study through a set of pre-tested structured questionnaires. The data were analyzed with descriptive statistics, Foster Greer and Thorberk and Equally Distributed Equivalent (EDE) indices, Principal Component Analysis (PCA), Ordinary Least Square regression and instrumental variable of Probit regression model. The descriptive analysis revealed that average age of high-users of climate smart agriculture (CSA) in Katsina State was 55 years but that of Sokoto State was 52 years. Majority of the respondents (94%) were males; 65% had informal Arabic education. Lack of demonstration of climate smart agricultural techniques and lack of processing technology were the major constraints to the use of CSAP. The regression analysis result showed that age, gender, education, marital status, household size, housing materials, communication kits and lack of time to use CSAP were significant for maize enterprise. While FGT relative poverty index for food expenditure showed that the low users of CSAP were 8% poorer than high users. And CSAP for both crops and livestock enterprises reduce the probability of being poor significantly. Hence, the study rejected the null hypotheses' which stated that CSAP do not significantly affect poverty status of farmers in the study area. The study recommended that Governmental and farmers' organisations can fashion out a favourable training workshop to inspire the low-users of CSA to improve on their performance. Also, the female gender should be encouraged to develop interest in CSAP, like the women empowerment programmes instituted by the government through Agricultural Development Project (ADP) and Katsina State Agricultural and Rural Development Authority (KTARDA). The policies on informal education should be enhanced and enforced in the curriculum to meet the CSAP challenges. Extension delivery system approach should be upgraded to meet the present information age.

Keywords: Climate Change, CSAP, Poverty, Household Famers, North West Nigeria.

DEDICATION

This research study is dedicated to Almighty God for His grace, mercies, divine favour and faithfulness, which enabled me to complete the years of my studies successfully.

DECLARATION

I, the undersigned student, declare that this thesis submitted to the North-West University, Mafikeng Campus for the degree of Doctor of Philosophy in Agricultural Economics, Faculty of Natural and Agricultural Sciences, School of Agricultural Sciences is my own work. The work contained herein, is my original work with the exemption of the citations, and I attest that this work has not been submitted to any other University for the award of any degree.

Name: **Daniel Ekpa**

Signature:

Date:

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ABBREVIATIONS

ADP:	Agricultural Development Project
AHR:	Adjusted Headcount Ratio
BNARDA:	Benue State Agricultural and Rural Development Authority
BNF:	Biological Nitrogen Fixation
CA:	Conservation Agriculture
CBN:	Central Bank of Nigeria
CCAFS:	Climate Change Agriculture and Food Security
CGIAR:	Consultative Group for International Agricultural Research
CH ₄ :	Methane
CO ₂ :	Carbon dioxide
CSA:	Climate Smart Agriculture
CSAP:	Climate Smart Agricultural Practices
DFID:	Department for International Development
DHS:	Demographic and Health Surveys
EDE:	Equally Distributed Equivalent
FAO:	Food and Agricultural Organization
FANRPAN:	Food, Agriculture and Natural Resources Policy Analysis Network
FARA:	Forum for Agriculture Research in Africa
FEI:	Food Energy Intake
FME:	Federal Ministry of Environment
FGT:	Foster, Greer and Thorbecke
Fig.	Figure
FOS:	Federal Office of Statistics
GHG:	Green House Gas
GSM:	Global System Mobile
HASSP:	Harmonized Seed Security Project
IAASTED:	International Assessment of Agricultural Knowledge, Science and Technology for Development
ICARDA:	International Centre for Agricultural Research in the Dry Areas
IFRC:	International Federation of Red Cross
IGP:	Indo Gangetic Plain
IIED:	International Institute for Environment and Development

IPCC:	Inter-Governmental Panel on Climate Change
ISFM:	Integrated Soil Fertility Management
KIPPRA:	Kenya Institute of Public Policy Research and Analysis.
KTARDA:	Katsina State Agricultural and Rural Development Authority
LACM:	Lack of Access to Market
LAHQHB:	Lack of Access to High Quality Hybrid
LAICV:	Lack of Access to Improved Crop Variety
LAIR:	Lack of Access to Information from Radio
LGA:	Local Government Area
LPT:	Lack of access to Processing Technology
MAX:	Maximum
MDG:	Millennium Development Goal
MICCA:	Mitigation of Climate Change in Agriculture
MICS:	Multiple Indicators Cluster Surveys
MPCHE:	Mean Per Capita Household Expenditure
MLE:	Maximum Likelihood Estimation
MPI:	Multidimensional Poverty Index
N:	Nitrogen
NASA:	National Aeronautics and Space Administration
NBS:	National Bureau of Statistics
NCCAS:	National Climate Change Adaptation Strategy
NEPAD:	New Partnership for Africa's Development
NGO:	Non-Governmental Organisation
NIMET:	Nigeria Meteorology Agency
NLSS:	National Living Standard Survey
NMA:	National Meteorological Agency
N ₂ O:	Nitrous oxide
NRM:	Natural Resource Management
NPC:	National Population Commission
NSPFS:	National Special Programme for Food Security
NWN:	North West Nigeria
OECD:	Organisation for Economic Cooperation and Development
OLS:	Ordinary Least Square

PAR: Participatory Action Research
 PCA: Principal Component Analysis
 PPP: Purchasing Power Parity
 RDA: Recommended Dietary Allowance
 SAP: Structural Adjustment Programme
 SSA: Sub-Sahara Africa
 SUWBWCA: Source and Use of Water from Borehole for Watering Crops and Farm Animals
 SUWDI : Source and Use of Water from Deep well for Drinking
 SUWPI : Source and Use of Water from Pipe borne water for Irrigation
 SUWSD : Source and Use of Water from Stream for Drinking
 SUWDWCA: Source and Use of Water from Deep Well for Watering Crops and Farm Animals
 SUWSWCA: Source and Use of Water from Stream for Watering Crops and Farm Animals
 TAWASANET: Tanzania Water and Sanitation Network
 UNDP: United Nations Development Programme
 VIF: Variance Inflation Factor.
 WHS: World Health Survey

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The earth is warming up gradually and the rate at which it heats up keeps on increasing daily and yearly (Purkey and Johnson 2010). There is an undisputable report of the Inter-Governmental Panel on Climate Change (IPCC) 4th assessment report in 2007, which proposed whole enquiry into how the issue of climate change is impacting on natural, human and physical structures. Besides, there is a growing concern about the possible significances of climate change on poverty status, livelihood projections, economic development, as well as overall human development. According to Smith et al., (2007) the deprived populace in developing countries are likely to face the influences of climate change, with costs on households projected that surpass billions of dollars in many nations.

Evidently, the general impacts of climate change on poverty status of the rural farmers are colossal such as drought, desertification, flooding, landslides and depletion of the ozone layers. Equally, the findings of Assuncao and Chein (2009) showed that on the average, agricultural productivity per hectare could decline as low as 18% by 2040 because of climate change in Brazil. It has also been noted that climate change leaves many people vulnerable to poverty, and it was projected that about half of the world's populace, as well as most of those who reside in the industrious urban areas located by the region of coastal delta are susceptible to climate tragedies; International Federation of Red Cross (IFRC, 2000).

However, most of the affected communities are mainly found where there is concentrated number of underprivileged families, mainly in Sub-Saharan Africa (SSA). As a result, the impacts of climate changes such as desertification, landslides, droughts and flooding, will not only decrease farm output for many farmers, but will also expose them to poverty in due course. Therefore, it is vital to design policies as well as impose practices that will adapt to the current observed climate changes. Besides, in the underdeveloped nations, climate change data and suitable reaction can be viewed as an advantage, especially at the general level. This is because both can function as catalysts for the provision of pressing basic amenities such as suitable and efficient health care, standard educational facilities, water supply, reliable power and sustainable infrastructural facilities. This data information can help the government and non-governmental organization to focus their attention at the areas and locations where the rural farming households are most deprived.

However, community base adaptations and awareness are significant features of climate change main stream, and congruently, community adaptation and focused estimations are important techniques in the community's sustainability which establishes adaptation approaches. As stated by Kijima et al., (2011) the usage of high quality resilient varieties/hybrids of crops and livestock is another adaptation method that could increase agricultural productivity and farm incomes, thereby reducing poverty. However, Local ecosystems provide the key source of livelihood for many of the world's poor and most of the rural poor in Sub-Saharan Africa (SSA) depend on highly climate-sensitive rain-fed subsistence or small-scale farming, pastoral herding and direct harvesting of natural ecosystem services such as forests and wetlands. The productivity of this livelihood base, are highly vulnerable to climate-related changes such as, changes in temperature, precipitation and increased incidence of droughts and floods. The vulnerability of the majority of the poor in Africa to climate-related stresses is worsened by widespread poverty and management incapability, education, ineffective institutional arrangements, and lack of social safety nets (IPCC, 2001).

Consequentially, emphases are now placed on the implementation of Climate Smart Agricultural Practices (CSAP) in order to meet the subsequent daily needs of individual households. CSAP are agricultural practices that sustainably increase agricultural productivity, income, adapt and build resilience to climate change, eliminate or reduce greenhouse gas emission or adapt to changing climate, which heightens the accomplishment of national food security and developmental goals which include poverty reduction; (FAO 2010). However, agriculture is said to be climate smart when it achieves three key objectives which are: building resilience to climate alteration, reduction of greenhouse gas emission and sustainable increase in agricultural productivity (Fanen and Adekola 2014). For instance, Mnkeni and Mutengwa (2014) noted that to increase food production, CSA stimulates renovation of agricultural systems and agricultural policies in order to improve food security and warrant affordable food with low input-cost; hence there is a reduction in poverty while conserving the biodiversity and guaranteeing resilience to a changing climatic environment.

Additionally, existing data revealed that Nigeria suffers from numerous environmental problems which have been directly associated with the ongoing climate change (Adefolalu 2007). The southern part of Nigeria, mostly known for high rainfall, is currently threatened with abnormality in rainfall patterns, while the Savannah zone is slowly increasing temperatures. In the same vein,

the northern part also faces the hazard of desert encroachment at a very high rate annually, brought by a serious decline in the volume of surface water, wildlife resources and vegetation biomass (Obioha 2008). Nevertheless, climate change adaptation, particularly in the rural areas, is vital because the impacts are best felt and understood at the local level; climate change influences are also experienced at the rural areas where the adaptive capability and susceptibility are very much felt. Consequently, in view of the foregoing, this study seeks to establish the effects of CSAP on poverty status among farmers in North West Nigeria. CSA has striving goals that include a wide range of sectors, stakeholders and disciplines, and requires actions that are carried out over several geographical scales and time frames. For this reason, the transition to CSA needs changes at many levels of policy making. To facilitate these changes, a new, step-by-step guide for the country-driven enactment of CSA has been developed.

The module introduces a theory of change for CSA and lays out a recommended set of steps for facilitating the integration of CSA approaches in policy making at the national level. Activities that have confirmed, based on evidence, to contribute to the meeting CSA goals can be implemented at the local level for example the promotion of agroforestry. A holistic CSA approaches must encompass all these levels to safeguard the systemic transformation of agricultural systems in the face of climate change. CSA is rooted in the pursuit to achieve sustainable food and agricultural production in a changing climate. The theory of change for CSA comprises four broad areas of action that are based on a country's needs: the development of an evidence base to support and monitor change; continuous dialogue with stakeholders; the formulation of tools to enable change; and innovative and multidisciplinary approaches to create and sustain change in food and agricultural systems FAO (2017).

Forming the theory of change: this is required to delineate in a participatory way, the possible options and their anticipated changes and results chains between activities, expected behaviour changes, outcome and impacts. These can then be reinforce in the intervention design and process, often in the form of logical frameworks that outline indicators, assumptions and risks to achieving these changes. These will help define: inputs and activities that is the details and resources of the actual interventions; outputs which is the direct results and deliverables of the interventions that are required for the outcomes; purpose-level and transitional outcomes which is also the expected external changes from the intervention; and higher-level outcomes or impacts that interventions may contribute to, usually affecting household and individual living states, and changes in the

environment. CSA in the framework of Feed the Future all of the above around CSA need to be placed in the context of Feed the Future's approach and theory of change that places smallholder farmers, pastoralists and fisher-folk at the center of the investment approach. Integration of CSA will be all round solutions that small-holders choose to consider and adopt as part of their production decisions. Thus CSA needs to be integrated into best practices and approaches that support overall Feed the Future goals around poverty and nutrition; this is clearly classified in the first pillar. Having stated that, sustainable productivity and income growth benefit from attention to both adaptation and mitigation, the second and third pillars of CSA. CSA adds extra importance to efforts and innovation aimed at uptake of new technologies and practices by smallholders, in particular behavioral change communication so that sustainable and rational solutions can reach scale. In this situation, as in others, CSA needs to be integrated into best practices around rural farmer and community engagement as emphasized across Feed the Future Programme FTF, (2016).

1.2 Problem Statement

Nigeria faces diverse environmental problems which are directly associated with recent climate change (Ikhile 2007). Obioha (2008) confirmed that- northern Nigeria generally, is under constant attacks and faces hazard of desertification, which has been prompted by decrease in the quantity of rainfall. Empirical studies of the climate change in the North-Western part of Nigeria between 1915 and 2008 revealed that the rainfall of that zone has fluctuated significantly (Ekpoh and Nsah 2010). In Africa, CSA offers multiple benefits in consonant with attainment of the goals to sustainably increase agricultural productivity, increase smallholder farmers' resilience to the effects of climate change and reduce greenhouse gas (GHG) emissions from agricultural activities and carbon sequestration (Naess 2011). This is the process in which trees, crops and other plants absorb carbon dioxide into the soil and after decomposition, oxygen is released into the atmosphere via the process of photosynthesis, which is also, the process in which carbon dioxide and water are converted into oxygen and sugar by the helps of sunlight as energy. The oxygen released in this process help in the reduction of global warming.

Climate change has been reported to multiply existing inequalities within communities (Dankleman 2008). While exposure to climate variations may be the same for men and women in a given location, there are varied gender based differences in vulnerability and consequently adaptive capacity and adaptation practices (Adger et al, 2005). Adaptation to climate change such as CSAP is generally costly, largely revolving around adoption of new or improvement of

technologies such as improved varieties and hybrids or use of improved crop husbandry practices (Kalungu et al., 2013) but is a response, many resource poor farming households have embraced despite the low capital hence inefficiency (Thornton et al., 2006). The level of vulnerability of individual farming households is a key component to decision making when considering adaptation to climate change which is a common challenges to the rural farming household (Stern 2006). Fanen and Adekola (2014) opined that, although, many nations are projected to embrace CSA, its demonstration in an African perspective is not yet so, neither has its sustainability been evaluated. However, subsequent global warming and changes in climate are impending dangers to food security, with a consequential increase in poverty levels in numerous developing nations, including Nigeria due to the high dependence of agricultural systems on some climatic parameters (Bello et al., 2012). Additionally, the rising problem of climate change effects is a worldwide issue, and the developing nations are particularly the most vulnerable, because the African nations' agricultural production system are mainly rainfed and basically relying on the whims of weather, (Nwafor 2007 and Onyenechere 2010).

In the northern part of Nigeria, the number of rainy days has dropped by 53% which brings about irregular rainfall arrangement with subsequent increase in temperature in North West Nigeria. The impact of this, drop has resulted into a rise in desertification, drought and evapo-transpiration which patently can result in the reduction of moisture content or the complete dryness of streams, and particularly with continuous annihilation of biodiversity and forest (Adefolalu 2007). According to Akor (2012), there are three main climatic zones in Nigeria, namely: Sudan, Sahel and Guinea Savannas. Temperature, rainfall and humidity differ considerably through these three climatic regions. Nevertheless, in the semi-arid belts comprising the Sahel, Guinea and Sudan savannas, extreme temperatures could be as high as 40°C. The report of Nigerian Meteorology Agency (NIMET) (2008), revealed that, the northern part of Nigeria has been subjected to poorer than normal rainfall but gradually became drizzlier than normal. Also, the research confirmed that between 1941 and 2000, annually rainfall in the greater parts of Nigeria has declined from eight to two millimeters. Drought and Seasonal rainfall have regularly become perpetual features of northern part of Nigeria which is seriously affecting the livelihood of the rural farming households in the study area.

The dry season is commonly severe, and hence it is very essential for farmers to engage in soil moisture preservation agricultural practices in order to ease the destructive effect of climate change at this period. The North West region of Nigeria remains an agricultural hub for the nation with a huge proportion of its population in the agricultural sector (Olapojo 2012). Nevertheless, it is the

poorest zone in Nigeria according to National Bureau of Statistics (NBS 2013). There is also a prevalence of high-income inequality among the populace (Action Aid Nigeria 2009). Obayelu (2010) avers that agriculture is the major source of income for many families in North-West Nigeria, and weather condition plays an important role in ensuring sustainable agricultural productivity in many parts. In addition, lack of improved agricultural tools compels wide use of traditional farming system. The latest discrepancies in the climate and weather of the area have taken severe toll on crop output with some crop yields now declining (Reddy and Hodges 2000). In 2010, conventional CSAP were introduced to farmers in North-Western part of Nigeria through a programme called International Institute for Environment and Development (IIED) with the help of the Katsina State Agricultural and Rural Development Authority (KTARDA) and the Sokoto Agricultural Development Project (ADP). The CSAP that were introduced by the agencies consisted of organic manure, agro-forestry, conservation agriculture, the use of improved hybrid varieties, integrated crop/livestock management as well as irrigation for small-holder farmers. Obviously, this was in response to low agricultural productivity with low agricultural output and high incidence of poverty among farmers in North-West Nigeria. In point of fact, presently, desertification and drought have affected several portions of the north, with a resultant daily and yearly extensive decrease in agricultural yields from one locality to another (Oyekale 2009).

Furthermore, Thornton et al., (2009) predicted that by the year 2050, in the sub-tropics, crop yields may decrease by 10 – 20% as a result of global warming but there are some places where the crop yield damages may be more severe. Meanwhile, Global warming causes erratic and great weather events that impact negatively with a gradually processes of affecting crop growth, as a result of droughts and floods on soil water and sea level rises with a prevalent diseases (Zoellick and Robert 2009). Then, the restraints set by climate change on agricultural activities in this region range from prominent variation in precipitation which may be shorter periods of rainfall or irregular rains, (which limits crop production) to repeated droughts. Moreover, the droughts unveil such features as fictional onset of the rains, late onset of the rains, prominent halts through the rainy season, and early termination of the rains, leading to severe modifications in the pattern of seasonal rainfall dissemination (Ayanwale 2007).

The report of Tadross et al., (2009) indicated that influence of climate change on crop yield is not restricted to total rainfall effects alone, the intra-seasonal shocks are also very significant because intra-seasonal arid spells may be more destructive to growth than short entire rainfall. Very high extreme temperature through the growing season is also considerably unfavourable to crop yields (Thornton and Cramer 2012). Such sequential deviation is anticipated to rise in many parts of

Africa nations under most climatic change situations (Boko *et al.*, 2007). According to the submission made by United Nation Development Programme, high rate of poverty makes majority of the population susceptible to climate change and compromises their adaptation capacity (UNDP 2011). Similarly, Etim and Udofia (2013) argued that 70% of Africa's deprived households are mostly found in rural areas and rely solely on agricultural activities. Englama and Bamidele (1997) also avowed that the majority of the rural dwellers are engaged in farming activities. The implication of this is that, a greater percentage of the rural poor are farmers. Given this, most of the poverty deliberations and considerations in Nigeria are always associated with farming households (World Bank 1996). This is due to the fact that farming is still the backbone of the Nigerian economy and it has continued to employ 72% of the people (Ogbalubi and Wokocha 2013) despite its decreased role in providing foreign exchange income to the Federal Government. But these farmers, due to their low productivity coupled with inadequate access to capital, transportation, storage and processing facilities are usually exposed to negative impacts of climate change and poverty.

Nevertheless, despite this alarming consequence of climate change that seems to worsen with time, the poverty statistics of North West Nigeria are equally very worrisome. However, the universal climate changes indicated that SSA will be one of the most affected areas, with anticipated agricultural yield declines of up to 20% for crops and possibly high levels of poverty and food insecurity mainly in the rural communities (Cline 2008). According to Diale (2011) failure to be equipped for the impacts of climate change can results in starvation, malnourishment and a high rate of poverty among others. Even though Nigeria is a country that is gifted with vast natural resources, physical and human endowments yet a large proportion of its populace live below the relative poverty lines.

The national evaluation of between 2003 and 2004 confirmed that slightly above half of the populace, that is, 51.6% live below US\$1 dollar per day and the relative national poverty incidence was found to be 54.4% National Bureau of Statistics (NBS 2005). Additionally, the Human Development Report by the United Nations Development Programme (UNDP 2007) affirmed that about 83.7% of the populace live below \$1.25 per day. However, this poverty status is worse in the rural communities where over 70% of the population dwell and earn their living via agricultural activities other than in the urban cities. Moreover, more than 86.5% of the rural populace are involved in farming activities (NBS, 2005). Consequently, this consistently defines agriculture as an important sector capable of affecting majority of Nigerians in various ways. Importantly, the persistence of poverty and hunger in Nigeria, to a large degree must then be attributed to the failure

of the agricultural sector to fully impact positively on the largest and most populated nation in Africa. Climate change is a serious risk to poverty reduction and threatens to undo decades of development efforts “the adverse effects of climate change are already evident, natural disasters are more frequent and more devastating and developing countries like Nigeria are more vulnerable.” While climate change is a global phenomenon, its negative impacts are more severely felt by poor people especially those in the northern part of Nigeria being the most poorest zone according to NBS (2013). They are more vulnerable because of their high dependence on agriculture, natural resources, and their limited capacity to cope with climate variability and extremes. Climate change will further reduce access to drinking water, negatively affect the health of poor people, and will pose a real threat to food security in many States in the northern part of Nigeria. In some areas where livelihood choices are limited, decreasing crop yields threaten famines. The macroeconomic costs of the impacts of climate change are highly uncertain, but very likely have the potential to threaten development in many States in Northern part of Nigeria (Faraut et al., 2011).

Mohammad (2009) reports that desert, which now covers about 35 percent of Nigeria's land mass, is advancing at an estimated 0.6 km per annum while deforestation is taking place at 3.5 percent per annum. Moreover, the Sudan Sahel region of northern Nigeria has suffered decrease in rainfall in the range of 3-4 percent per decade since the beginning of the nineteenth century. The Director-General, Nigerian Meteorological Agency highlights that analyses of rainfall data (1911 -2000) in three 30 years intervals - 1911-1940; 1941-1970; 1971- 2000.

Climate Change and Adaptation Measures in Northern part of Nigeria: Empirical Situation and Policy Implications 2000 show that many more places are recording late onset of rains, early cessation of rain, shortened length of the rainy season and reduced annual amount of rain especially in the northern part of the country and there are frequencies of drought, more persistent hammattan smog and increasing temperature trends. The concern with climate change is heightened given the linkage of the agricultural sector to poverty. In particular, it is anticipated that adverse impacts on the agricultural sector will exacerbate the incidence of rural poverty. Impacts on poverty are likely to be especially severe in the northern States of Nigeria where the agricultural sector is an important source of livelihood for a majority of the rural populace. (Mohammad 2009).

1.2.1 The Gap to be filled by the Study

Existing studies on climate change such as Codjoe et al., (2013); Ozor et al., (2013) and Anselm et al., (2010) have focused mostly on adaptation, perception, awareness to climate change, and food security. This research study will contribute to knowledge by highlighting the link between climate change, CSAP and poverty status of smallholder farming households in the study area. This study will equally, contribute to the knowledge of the policy makers and research scholars, which will offer some significant perspectives that are expected to assist in shaping future policies as well as ongoing research work in this area of study.

Additionally, it is hoped that this study will help the farmers in the study area to embrace more CSAP which in turn can reduce their poverty levels through sustainable increase in agricultural productivity and income. Finally, another salient contribution of this study to knowledge is that it will underscore the establishment of CSAP as one of the major, and important functional facilities that reduce poverty and GHG emission (mitigation) through the process of carbon sequestration. This is the process in which trees, crops and other plants absorb carbon dioxide into the soil and after decomposition, oxygen is released into the atmosphere via the process of photosynthesis, which is also, the process in which carbon dioxide and water are converted into oxygen and sugar by the helps of sunlight as energy. The oxygen released in this process help in the reduction of global warming. Global Multidimensional Poverty Index, (2015) posits that 80% of the population in North West live below poverty line, closely followed by the North East with 76.8%, 45.7% in North Central, 27.4% in the South East, 25.2% noted in South-South and 19.3% recorded in South West. These statistics was an affirmation of the 2010 NBS poverty profile of Nigeria that showed that, the North-West and East had the uppermost poverty rates in the country in 2010 with 78% and 76% respectively (National Bureau of Statistics, 2010). High rate of poverty in northern Nigeria makes majority of the rural population susceptible to climate variation, which in turn compromises their adaptation capacity (UNDP, 2011).

Therefore the impact of climate change could be greater due to their inability to adopt CSA as a result of their poverty status. It is therefore pertinent to examine the impacts of different agricultural practices in the context of CSAP in the study area, to improve our understanding of their practices and mitigation impacts and potentials to contribute to food security and reduce poverty under the specific climate, agro-ecological and socio-economic conditions of the region. A better understanding of the region and its agricultural practices has broader significance as well

and the potential for expanding cultivated area in the flat regions has almost been exhausted (Wezel et al. 2002). An attempt to pave the way for this study was to (a) discuss six sets of CSAP in north-west Nigeria that have the productive potential, (b) evaluate the impact of these CSAP on yields of crops and livestock, and (c) map out factors that affect rural farming households' poverty status. There is no one agricultural practice or production system that can be considered CSA, but rather a set of possible options that under the specific climate change, socio-economic and agro-ecological conditions can increase agriculture's capacity to support food security. That is, the magnitude of the benefits and costs of varying practices, as well as the institutional environment necessary to support adoption vary widely across regions (FAO 2010).

A robust CSA strategy cannot consist of an individual practice to address the food security and climate change challenges in both the short and long run, therefore, a portfolio of mutually supportive approaches including safety nets and other improvements in enabling institutions should be explored. Some scholars argue that the agricultural activities need to be diversified and evaluated in a comprehensive system, one that incorporates CSAP on the farm level, diversity of land use across landscapes, and proper management of the interactions among different landscapes (Scherr et al., 2012). Although there are many research and analytical efforts to minimize the impact of climate change on agriculture and on livelihoods in Africa by various actors, there is however, no coherent documented state of knowledge of CSA practices in Africa. Hence there is a need to determine the drivers, challenges or opportunities that may facilitate or hinder scaling up of CSAP in North West Nigeria.

Furthermore, CSA can also have a reverse influence on poverty because of its ability to improve production and subsequently rural wealth. This constitutes the crux of this study. However, numerous studies have been carried out on the subject at regional and state levels. An instance is the research that was carried out by Ozor et al., (2013). They examined climate change vulnerability and the use of homegrown skills for adaptation among small holder farming communities in SSA. Olawale et al., (2016) surveyed the rainfed agriculture system's vulnerability to climate change effect. They employed time series data and econometric analytical techniques to quantify the differential influences of rainfall and irrigation. Also, Fanen and Adekola, (2014) assessed the applicability of CSA in fighting climate change, desertification and enhancing rural livelihood in an African context; while Branca et al., (2011) looked into CSA as an empirical evidence of food security and mitigation benefits from improved cropland management. Equally,

Anselem et al, (2010) carried out an examination on climate change and its ecological threat to the fight against malnutrition and poverty in Africa. Furthermore, Ekpoh, (2010) evaluated adaptation to the effect of climate discrepancies on agriculture by rural farmers in North-West Nigeria. Oyekale and Oyekale, (2010) and Obayelu, (2010) have also examined the poverty status of farmers in Nigeria. Meanwhile, the analysis of the effects of CSAP and poverty status among smallholder farming households in North-West Nigeria is yet to be investigated, hence the need for this study.

1.3 Research Questions

This study seeks to provide answers to the following research questions:

- i. What are the constraints to the users of climate smart agricultural practices?
- ii. What are the factors influencing indicators of climate smart agricultural practices within different crops and livestock enterprises?
- iii. What are the poverty status of those who are low-users and high-users of climate smart agricultural practices in the study area?
- iv. What are the effects of climate smart agricultural practices on poverty status of farmers?
- v. What are the effects of climate smart agricultural practices on multidimensional poverty index (MPI) of the farming household?

1.4 Objectives of the Study

The broad objective of this study is to examine effect of climate smart agricultural practices on poverty status among smallholder farming households in North-West Nigeria. However, the specific objectives of the study are to:

- i. Analyse the constraints on the use of climate smart agricultural techniques.
- ii. Determine factors influencing indicators of climate smart agricultural practices within different crops and livestock enterprises.
- iii. Decompose poverty levels across low-users and high-users of climate smart agricultural techniques.
- iv. Determine the effects of climate smart agricultural practices on poverty status of farmers.
- v. Determine the effects of climate smart agricultural practices on MPI of the farming household.

1.5 Hypotheses of the Study

The Null hypotheses of the study are stated below:

1. H_0 : Farmers' socio-economic characteristics do not significantly influence indicators of climate smart agricultural practices within different crops and livestock enterprises
2. H_0 : Climate smart agricultural practices do not significantly affect poverty status of farmers.
3. H_0 : Climate smart agricultural practices do not significantly affect MPI of the farming household.

1.6 Justification of the Study

In any country for CSA to be effectively implemented, there must necessarily be clear policies for all the sectors involved (Mnkeni and Mutengwa, 2014). The need for sustainable agriculture in North-West Nigeria cannot be overemphasised. Not only is there a need for quick climate strategies that will address the effect of climate change and its implications in this region, there is also the need to enforce it in order to increase agricultural production and to reduce high poverty incidence rate among the rural farmers. The CSA is therefore very topical especially considering the incidence of droughts in the last decade in the region. The CSA has emerged as the best agricultural development techniques and one of the coherent climate mitigation approaches that has the potential to sustainably enhance agricultural productivity and build resilience by reducing emission of greenhouse gases. This study is conceived on the premises that there is need for such approach to agriculture in Nigeria particularly in the north which is the crux of agricultural production in the nation. The study area is prone to archaic farming methods such as periodic bush burning and deforestation. This has not only led to negative repercussion on farmer's productivity but has also result to depletion of soil nutrients and soil degradation making the soil unsuitable for optimum yield.

There is an empirical assertion according to International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD, 2009) which revealed that CSAP will accelerate nutrient recuperation and improve indigenous agricultural system as well as encourage the practice of agro-ecological system. In addition, in the context of developing countries, there is need to establish the potential applicability of CSA and its ability to create wider uptake by rural farmers and encouragement required for deep transformation within the policies sector. Notwithstanding, these benefits, there is a notable dearth on the studies assessing such potentials in CSA approach in the study area, hence this study is very important.

Nigeria, similar to other parts of the world, is suffering from the simple features of climate change. Through all these abnormalities, all-inclusive tactics on climate change are vital in Nigeria to curtail the tide of the irregular rainfall pattern that is presently bedevilling the country. CSA should be main-streamed into fundamental government strategies and programmes, including policy, disbursement and planning frameworks. Available information shows that Nigeria faces diverse natural problems which are openly connected to recent climate change (Adefolalu, 2007).

According to Garcia et al., (2006), Nigeria's main challenges include, reducing poverty, diversifying its economy from the oil and gas sector towards more labour intensive sectors such as agriculture which involve CSAP and improving health and education. The oil has increased economic volatility and inflation while those living in poverty being most vulnerable to volatility and inflation. The northern region are seriously facing the hazard of desert infringement at a very fast rate prompted by wanton reduction in the quantity of natural water, forest ecosystem and wild-life resources on land (Obioha, 2008). However, it is worrisome that the farmers that are meant to carry out the CSAP may be incapacitated due to their high poverty status. Nevertheless much has been written about climate change, agriculture and poverty as a distinct subject matter, but the link between them has received little or no consideration. Therefore, understanding this relationship is very important for the construction of effective policy responses to climate change. Hence, this makes it imperative to ascertain to what extent poverty and its related characteristics constitute constraints to CSA practices, and to examine if there is a significant difference in practising CSA between deprived and non-deprived households.

It is also vital to find out to what extent CSAP alleviate poverty in this high poverty rate region via its influence on yield improvement. This study will therefore, improve understanding on CSAP, ways of using it to decrease poverty level in the study area and to form policies which border on CSA in North-West-Nigeria. It will therefore be a working document to administrators, policy makers as well as other interested groups that aim at improving CSAP in the region or reducing poverty. It will also contribute to the bulk of existing literatures and also suggest areas for further research where applicable for researchers and students.

1.7 Plan of the Study

Chapter one has been discussed. Chapter two expounds on the theoretical framework, conceptual frame work, and the review of related literatures. The third chapter discusses the methodology of the study. This comprises of the narrative discussion of the study area, the sources for data, the sampling procedure, scope of the study and the analytical techniques used. Chapter four presents

the discussions of the results of data analyses. Chapter five deals with the ordinary least square (OLS) statistical analysis of the factors influencing indicators of CSAP within different crops and livestock enterprises. Chapter six advances the decomposition of poverty status of low-users and high-users of CSAP so as to ascertain the inferential statistical analysis and presents the effects of CSAP on poverty state of farmers in the study area. Lastly, chapter seven concentrates on the summary of the major findings, conclusion, policy recommendations and suggestions for further study areas.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter reviews relevant literature based on the objectives of the study. It commences by the theoretical and conceptual framework, also analysing the various CSAP by the household farmers. Additionally, it identifies and explains some selected CSAP that are commonly practised in the areas under study. It highlights the approaches of CSA activities and the various types of poverty. Lastly, it provides the link between climate change, CSAP and poverty.

2.1 Theoretical Framework

The study applies utility theory which is concerned with households' decisions and choices. The theory provides a methodological framework for estimation of the alternative choices made by persons, companies and governments. Utility refers to the satisfaction that each choice provides to the decision maker. Thus, this theory assumes that farmers' decisions are made for utility maximization. Utility theory is often used to explain the behaviour of distinct farming households who are the consumers. In this case, farmers play the role of the decision maker who must decide how much each of the many available climate smart agricultural activities adaptation strategies to be use so as to secure the highest possible level of total utility subject to the households available income, prices, and other factors of production. CSAP are risk mitigation strategies for which their contributions to farmers' incomes could be evaluated given some expectations of income losses should the farmers fail to make those adaptation decisions.

The traditional framework of utility theory has been extended over the past three decades to multi-attribute cases, in which decisions are taken by numerous principles. The following six major types of CSAP were studied, and they are: the practice of using organic manure, agro-forestry, conservation agriculture, integrated crops and livestock management, the use of improved varieties/hybrid of crops/animals and the use of irrigation for smallholder farmers, each is taken in as X_1 to X_6 :- In all cases the utility that the decision maker either the CSA farmers gets from selecting a specific choice of CSAP adaptation strategy is measured by a utility function U , which is a mathematical representation of the decision maker's the climate smart agricultural system to the farmers household scale of preferences such that: $U(X_1) > U(X_2)$, where choice of CSAP X_1 is preferred over choice X_2 or $U(X_1) = U(X_2)$, where choice X_1 is indifferent from choice X_2 – both choices are equally preferred.

Farmers are assumed to use the combination of CSAP that maximizes their expected utility over their planning horizon. Let U_{ij}^* be the i^{th} farmers expected utility from using the combination of practices j , j ($i=1, \dots, J$), with respect to using alternative combination of practices m :

Where X_i is observed exogenous variables (education, marital status, household size, farmland ownership and experience) and ε_{ij} is unobserved characteristics. The farmer's utility from choosing a combination of CSAP is not observable but the choice is, CSAP combination (j) is chosen if U_{ij}^* the highest is for household size (i). Therefore, the farmer will choose combination of using practices (j) in preference to adopting any other combination of the practices m if

$$\eta_{ij} = \max_{m \neq j} (U_{im}^* - U_{ij}^*) < 0$$

$$\eta_{ij} = \max_{m \neq j} (U_{im}^* - U_{ij}^*) < 0 \quad \dots\dots\dots (2.3)$$

It is assumed that households that have opted for high adaptation strategies have higher utility levels compared to those that have low adaptation strategies:

It is further assumed that farming households adopting two or more strategies have higher utility levels compared to households having adopted only one strategy and so on.

2.2 Conceptual Framework

Universally, agricultural activities and forestry systems are anticipated to change considerably in reaction to prospective climate change (Morton, 2007). Worldwide demand for agricultural goods, be it food and fibre, continues to escalate because of population explosion, variations in diet related to rise in per capita income and the need for marginal energy sources, while there is less extra land accessible for agricultural development. The agricultural system thus needs to produce more on the unchanged aggregated land, while responding to changes in climate and extreme weather such as floods, desertification and droughts. The term CSA represents a set of approaches that can help to meet these tasks by increasing resilience to weather condition excesses, adapting to climate change and decreasing agricultural GHG emissions that contribute to global warming (World Bank, 2011).

However, by the few previous eras, crop yield has been reduced because of global warming and the results of modelling indicated that climate change will decrease crop yield possibly and predominantly in the tropical and mid-latitude nations (Cline, 2008). CSA places emphasis on meeting the prerequisites of the people for food, fibre and timber, and through science-based engagements, reducing poverty and conserving, improving the productivity, food security, adapting to climate change and resilience to both natural and agricultural ecosystem functions. It involves an endless, interactive practice for stakeholders, researchers and policy makers to meet the tasks presented by climate change and jointly alter agriculture and food systems towards sustainability objectives. Increased consciousness and adaptive management are vital mechanisms for the CSA policy (Neufeldt et al., 2013). The relationship between vulnerability, adaptation and resilience is very essential to CSA. While vulnerability is defined as exposure and capacity to respond to the influence of climate change, adaptation involves a process in which farmers are able to reduce their susceptibility to climate change, resilience is on the other hand termed as the capability to bear disturbance, diminish vulnerability and promote adaptation to climate change. It also means to undergo alteration and retain the same necessary utilities, structure, identity and feedback, without reverting to the prior state of uneasiness or disturbance (Walker et al., 2004).

Equally, CSA seeks to add to the mitigation and reduction of greenhouse gas emission, mostly carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) releases. Radiation fluxes at the earth's surface show vital roles in numerous environmental, climatobgical, and hydrological systems. Biotic activity is strongly reliant on radiative transfer both directly, via the interaction between phyto-elements and radiant energy produced by the sun, and indirectly through

micrometeorological controls. Understanding the spatial dissemination of photosynthetically active radiation (PAR) is important for forecasting patterns of ecosystem functioning within a forest (Vierling & Wessman, 2000). Additionally, it aims to stabilise trade-off with food security and livelihoods of individual. However, merging agro-forestry and conservation efforts with agriculture to meet global food demand will help to diminish greenhouse gas emissions, consistently reserve ecosystem services and support biodiversity (Mbow, 2014). CSA is said to be a form of agriculture that sustainably increases agricultural production and incomes, adapts, builds resilience to the impact of climate change, reduces or eliminates greenhouse gas emission which heightens achievement of national food security and developmental goals which include poverty reduction (FAO, 2010).

Additionally, the link between climate change, agriculture and poverty has been registered earlier by NBS, (2013) which affirmed that, North-West Nigeria has the highest rate of poverty, while their major occupation is notably agriculture. Subsequently and meanwhile the major causes of climate change are agricultural activities and one of the consequences of climate change is poverty (Bello et al., 2012). According to IPCC, (2007) agriculture is among the causes of climate change because it involves the process of releasing greenhouse gas emission into the atmosphere. At the same time agriculture is the major solution to climate change through the process of CSA and carbon sequestration, which is the process in which trees, crops and green plants absorbed carbon dioxide into the soil and after decomposition oxygen is been released into the atmosphere through the process of photosynthesis. This is the process through which carbon dioxide and water are converted into oxygen and sugar by the help of sunlight as energy. The oxygen released helps in the reduction of global warming. However, agricultural activities accounts for the larger part of land used in the third world countries and this is perhaps the single most dominant impact on environmental quality. At the same time, farming activities remains the major livelihood of the rural poor household farmers (Malik, 1999).

The relationship between environment and poverty can be traced back to the original Malthusian theory which postulated that the poor subsistence farmers of developing nations over-exploited their environment out of sheer necessity and that, the subsequent degradation further aggravates poverty. Malthus anticipated an impending doomsday situation where excessive human population growth would overtax a limited supply of natural resources (Malthus, 1798). More recently however, the realization of climate change has triggered huge research on its consequences and

remedies. Evident in this research is that, climate change directly or indirectly affects poverty. For instance, OECD, (2016) examined the influence of climate change and came to two conclusions: First, climate change is happening and will progressively affect the poor. Second, adaptation is required and there is a need to incorporate responses to climate change and adaptation measures into strategies for poverty reduction to ensure justifiable development. According to UNDP, (2004) poor nations and people tend to be particularly susceptible to deviations from average climatic extremes. OECD, (2016) further posited that climate change will further reduce access to drinking water, negatively affect the health of poor societies, and will pose a real threat to food security in many African countries, Latin America and Asia. It will also cause fish grounds to deplete, floods, increase droughts, and storms destroying entire annual harvests in affected areas and consequently leading to increased food insecurity and hence poverty. The theoretical relationship between climate change and poverty differs from other theories that establish cause of poverty, such as the poverty theory of individualism which postulates that poverty is caused by the rate of individual hard work and responsibility to acquire basic needs including food, health care and educational facilities (Rank, 2004). Likewise, cultural and neighbourhood theory postulate that different cultural beliefs and life styles are the cause of poverty in some areas, as well as the structural causation of poverty that associates poverty to the economic structures such as capitalism.

Apparently, climate change goes beyond the traditional theories of poverty to explain the causes of poverty, particularly in its multidimensional perspective. Demonstrably, climate change means that the regular trend of the climate is now uncertain; which then impacts on agricultural production. It also directly makes some places hotter and causes droughts in extremes, increase floods and causes acidic rains amongst others that reduce agricultural production or causes disasters that affect life, property and farms. Patently, this might lead to limited food supply or food insecurity in the affected areas. In fact, OECD, (2016) assert that food security is a function of several interrelating factors, including agricultural productivity as well as food purchasing power, and above and beyond, climate change could worsen the prevalence of hunger through direct negative effects on production and indirectly influences on purchasing powers. Therefore, poverty is unequivocally a factor of climate change as evident in our individual abilities, cultural beliefs and structure of the economics, to mention just these few. The CSA addresses the relationship between agriculture and poverty which continues to be the major process of producing food, employment and income for many households in developing countries. Indeed, it is estimated that about 75% of the poor in the world are generally located in the rural areas, with agricultural

activities being their mainstream source of income (Lipper et al., 2014). On account of this, farming activities are uniquely placed to push people out of poverty. Compatibly, it has been observed that agricultural and economic growth is often the most effective and equitable strategy for reducing poverty, as well as a means of increasing food security (CCAFS and FAO, 2014). Practicing CSA is often considered a “no-regrets” approach in that its benefits of sustainable improvements in agriculture will accrue even if climate change impacts turn out not to happen or be as severe as expected. Moreso, it is important to consider climate-smart management of agriculture within a broad socioecological framework, recognizing that climate change is one of the many drivers of change influencing the agricultural sector. Climate-smart interventions have varying costs and environmental economic benefits. So quality decisions in CSA technologies and policies should be based on relevancy in current and future scenarios of climate and economic impacts. However, the seaweed farming is a low-carbon activity that brings many benefits to the community and the environment, and is resilient to climate change.

Adopting CSA options also implies a need for increased investments at the farm level. Extended transition times may be needed to realize the benefits to CSA in the form of productivity or increased resilience. During the transition, the returns to agriculture are low or negative, and thus some form of financing to support this transition is necessary. For instance, if we find that agroforestry practices improve the adaptation indicators more in communities with a higher historical rainfall/temperature variation, we can conclude that CSA provides adaptation benefits in these communities (Branca et al., 2012).

Consequently, CSA should not be regarded as a set of practices and technologies but should be seen as an approach which has plausible and positive numerous entry points, ranging from the development of technologies and practices to the expansion of climate change models and scenarios, information technologies, value chains and the strengthening of institutional and political enabling environments. However, beyond single technology at the farm level, CSA includes the incorporation of multiple interventions at the food system, biodiversity and value chain or policy level. Contrary to conservative agricultural development, CSA analytically incorporates climate change into the development of sustainable agricultural schemes which increase income and in turn reduce poverty (Lipper et al., 2014). Additionally, it endeavours to improve the activities of biodiversity with the hereditary assets and ecological functions which transfer essentials. The active process of biodiversity strengthens food security, increase sustainable livelihoods, ecosystem resilience, the management of biological processes needed for

sustainable agricultural productivity and insurance for the future; CSAP is the best approach to meet these roles of biodiversity target PAR, (2010).

Besides, climate change is likely to affect species' distribution and abundance, aside increasing the risk of total annihilation and loss of biodiversity (IPCC, 2001). Subsequently, vicissitudes in the accessibility and dissemination of the several apparatuses of biodiversity allied with food security will affect home-grown supplies of raw materials vital for improving output of ecosystem facilities. Ultimately, fluctuations in dissemination of pollinators, beneficial and harmful soil micro-organisms may have a perceptive impact on agricultural output. However, the estimated loss of cultivated lands as a result of increase in salinization will make the need for more proficient production on the residual cropland ever more vital.

Additionally, the rural farmers will need to adjust existing agronomic practices, which include how to adapt and mitigate the effects of climate change. These adjustments will also include alterations in water use like irrigation activities, use of improved crop varieties development, better adapted livestock breeds and diversification of production strategies to improve capacity to face risk. There is previously considerable endorsement that rural smallholder farmers in agrarian farming system are adapting to the impact of climate change, predominantly via the use of local varieties and the adaptation of traditional farming practices (PAR, 2010).

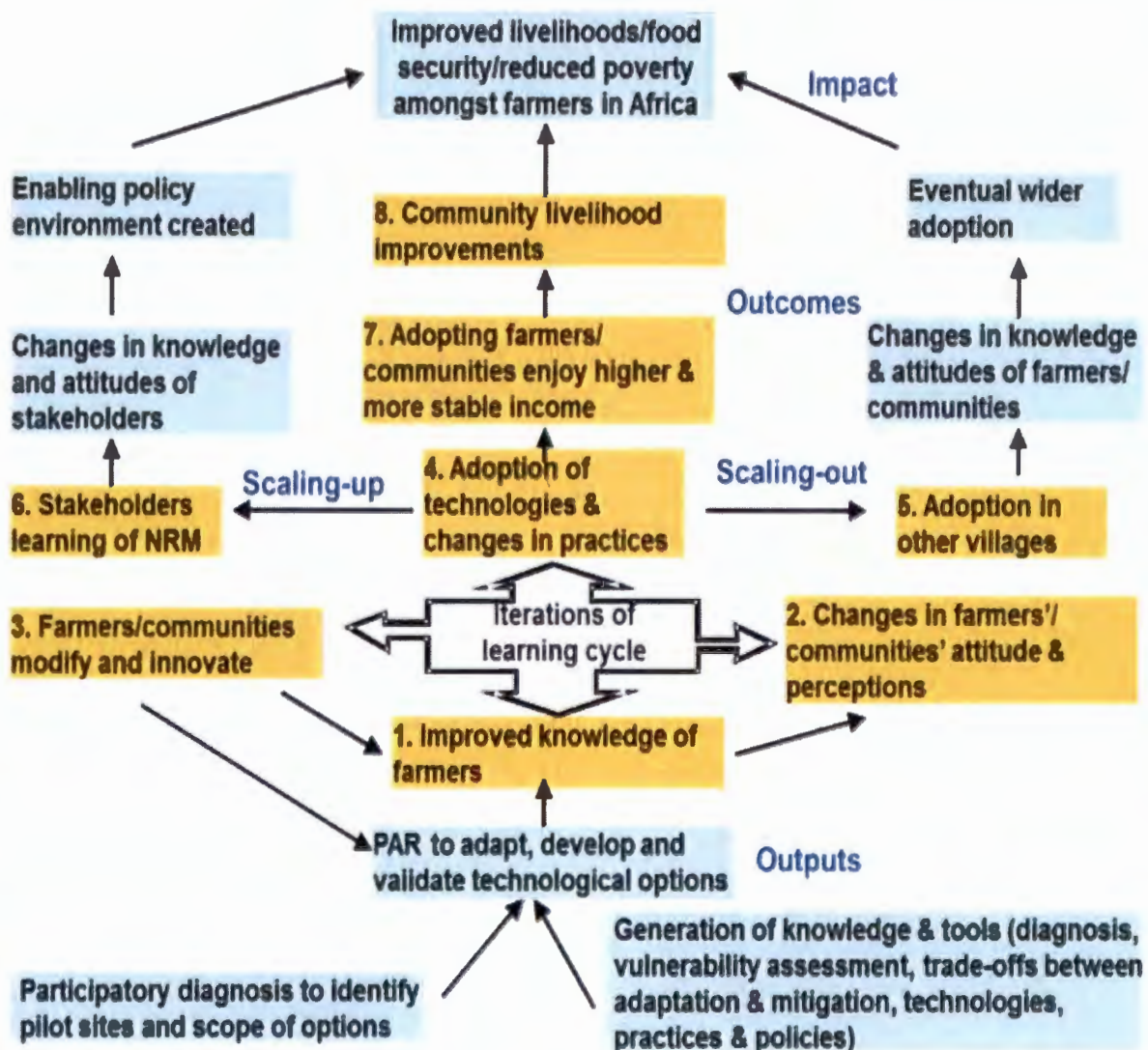


Figure 2.1: Impact pathway of the PAR on climate smart agriculture in West Africa
Source: PAR, (2010).

2.3 Climate Smart Agricultural Practices

The CSAP offer an environmental resilience which assist farmers to move from poverty to prosperity and it also increases the soil nutrient, and simultaneously reduces the negative impact of climate change. In the same vein, CSA also safeguard the defense from vulnerability and unbearable risks for human and environmental influences. This is vital in Nigeria because of the rising concern over the pollution of agricultural lands, an upshot of the influence of inorganic fertilizers' application and organic waste materials, which contributed to a serious damaging effect on biodiversity. However, CSA emphasizes the viable use of the environment particularly ecosystems and forest as an essential sink for carbon fluxes on surface of the earth. There is also emphasis on the role that tree planting can play in mitigating mechanism on climate change

through carbon sequestration processes. Nigerian farmers face myriads of challenges occasioned by vagaries of climate change among other factors. A substantial literature provides empirical evidence on climate-induced choices among crop types and livestock selection with their decision to irrigate under variable climate conditions in different parts of the world (Seo and Mendelsohn 2008). They consider the application of various combinations of CSAP. One salient area for research on technology adoption that has not been very thoroughly studied is that of multiple technology adoption (Teklewold et al., 2013).

Farmers may face technology alternatives that can be adopted either as substitutes or in combination as complements or supplements to deal with their overlapping constraints such as low soil fertility and moisture stress (Moyo and Veeman 2004). That is why, for the purpose of this study, if a respondent used three and more types of CSAP, the researcher classified the farmers as high-users of CSAP, while the respondent who used two or less types of CSAP, the researcher classified the farmers as low-users of CSAP. According to Ngigi et al., (2005) and Arslan et al., (2013) in their studies, they consider three CSAP and their first was the adoption of agricultural water management practices. However, while previous studies of choice and impact of adaptation have focused on either a single practice or a set of practices considered as a single unit (Deressa et al., 2010 and Di Fako et al., 2012). There is a limited information on how adoption of multiple strategies by smallholder farmers responds to climate change or on the synergies between various adaptation practical strategies in improving agricultural productivity and farm income. While individual CSAP provide multiple benefits, there are complementarities and synergies when more than one practice is adopted together. Treating farmers' adoption choices as bundle of practices, rather than as isolated decisions, is important in order to better understand the synergistic effect of inter-related practices.

Furthermore, a joint analysis may still be needed for determining the total effect of the simultaneous application of the practices (Teklewold et al., 2013). This will enable policy makers and development practitioners to promote combinations of practices that perform well together. This however, has imposed greater heights in agricultural production and application of CSAP in developed world to proffered solutions, to farmer's problem in the area of use of improved drought tolerant seeds, and effectually, there has been a significant increase in the number of farmers using irrigation; CSA has enabled expansion in the use of agro-forestry and conservation agricultural techniques. By the same token, it has activated the promotion and the reclamation of

degraded agro-pastoral land, livestock and other high potential value chain while improving smallholder's access to market. In addition, CSA has the potential to reduce hunger, increase agricultural productivity, improve rural people's lives and conserve biodiversity using an innovative whole landscape in the area of study. Considering the aforesaid, this study focuses on the effect of CSAP on the poverty state of farmers. Following this, six major types of CSAP were studied, and they are: the practice of using organic manure, agro-forestry, conservation agriculture, integrated crops and livestock management, the use of improved varieties/hybrid of crops/animals and the use of irrigation for smallholder farmers. A brief discussion on each is taken in turn:

2.3.1 Use of organic manure

Organic manure is essentially livestock waste consisting of organic materials from residues of plants that were digested by animals housed in an enclosure. In addition, inorganic fertilisers require energy and thus increase greenhouse gas emissions. Organic manure is relatively less harmful and expensive compared to inorganic fertilisers. It also stimulates activities of micro-organisms that release nutrients (FAO/WFP, 2007). Though there are some sorts of CSAP such as the use of organic manure, however such practices are not fully mechanised and efficient due to several reasons amongst which is the lack of adequate finance. Manure from cow dung under standard mid-hill farming condition produces 1,825 kg fresh dung and 1,460 litres urine per annum (Subedi et al., 1993). The bulk of nitrogen of about 97% that is consumed by livestock is defecated in the form of organic nitrogen in urine and faeces (Mc-Crory and Hobbs, 2001). In agricultural schemes, some types of microorganisms can carry out Biological Nitrogen Fixation (BNF) as free-living organisms, while other micro-organisms can only fix nitrogen through a shared relationship with plants, mainly leguminous plant species. On the other hand, some elements including adverse temperature and droughts that affect plants (BNF) cannot be controlled.

Also, some legume species are greater at fixing nitrogen than others. In recurrent temperate, forage legumes and Lucerne can fix 200 – 400 kg of nitrogen per hectare (FAO, 2009). Organic resource management practices as part of Integrated Soil Fertility Management (ISFM) offer vital benefits for the water use efficiency of crops by improving water holding and decreasing vaporisation (Bationo, 1996). Agricultural activities are sources and sink for GHG emission notably through the storage of carbon in the top soil organic matter and in biomass. Regarding the sink side of emissions, agriculture and forestry, unlike other economic sectors, have the capacity to fix atmospheric carbon by photosynthesis and to sequester it in the soil and in biomass. Grassland, humid zones and forests in particular can fix carbon in large quantities. However, these carbon

stocks can also be lost. For instance, through land use change either deforestation, ploughing of grassland, drainage of humid zones or by exceptional climatic events either through storms or fire leading to a rapid release of the stocked carbon to the atmosphere as carbon dioxide (CO₂) (Regmi et al., 2009). Biomass produced in agriculture and forestry is used as energy or as raw material which is another way to increase the bio-sequestration of carbon. The nitrogen controlling approaches have to be reassessed in light of the advancement of organic fertilisers which are exceptionally energy demanding for their synthesis and contribute to 12% of the emissions, because it has been a systematically established fact that most crops prefer the N-ammonium form present in manure and biogas digestive instead of the N-nitrate form (inorganic fertilizer) which is highly disposed to be percolated to the water table (Allen et al., 1998).

Organic manure increases soil organic carbon base and also increases the soil organic matter via carbon dioxide (CO₂) in long term by absorption, soil quality and water quality. Practices used to spread organic manure or biogas digestive on the field or in meadow land have extreme influence on GHG emissions. Ideally organic fertilisers should be spread in a liquid form to penetrate rapidly into the soil or if solid, should be rapidly incorporated (FAO, 2010). The advantages of using organic manure as CSAP comprise addition of nutrients to the top soil and the sequestration of carbon dioxide, thus reducing its adverse effects on global warming through the CSAP.

2.3.2 Agroforestry

This is a type of land used for management system, in which trees or shrubs are grown-up around or within crops or pasture land. It is also the practice that involves the growing of perennial trees with arable crops, perennials with livestock or a combination of woody perennials with arable crops and livestock. In summary, agro-forestry is an incorporated land use system merging trees and shrubs with crops and livestock. Like conservation agriculture, it is an old land use system that farmers have practised traditionally, as a necessity, for increasing soil fertility by relying on standing vegetation, mostly trees, through the slash and burn shifting cultivation method in most African countries (World Agroforestry Centre, 2013). Agriculture and forestry expertise combine to create more dynamic, wealthy and sustainable land use system.

The most common types of agroforestry are: agro-sylvicultural (trees with crops) and sylvo-pastoral (trees with pasture and livestock) (Manyatsi, 1999). According to Sileshi et al., (2008), agro-forestry schemes in Africa have increased maize yields by 1.3 and 1.6 tons per hectare per year. Agroforestry epitomises a price effective and viable supplement for the use of inorganic chemical fertilisers (Ajayi et al., 2008). However, the leguminous agroforestry leaves are usually

used as a result of their capability to atmospheric nitrogen fixation in the soil in a form available for plants use. Although agroforestry goes some way towards differing deforestation, estimated in Malawi to occur at a rate of 1.0 to 2.6% annually, but it also offers potential food security aids (FAO, 2005). Agroforestry systems for forage are also lucrative in developed countries. For example, in the northern agricultural region of Western Australia, using tagasaste to improved earnings to rural farmers whose livestock formally foraged on yearly legume grasses (Abadi et al, 2003). However, the use of trees and shrubs in agricultural systems help to tussle the triple challenge of securing food security and decreasing the vulnerability and increasing the adaptability of agricultural systems to climate variation. Agroforestry plants help in the carbon sequestration, a process of absorbing carbon dioxide (CO_2) into the soil by trees, other plants and crops, later after decomposition, releases oxygen (O_2) into the atmosphere through the process of photosynthesis thereby, reducing the adverse effect of climate change and global warming.

2.3.3 Conservation agriculture

Conservation agriculture is a climate resilient, environmentally sustainable and profitable farming technology. This allows nature to regenerate and retain soil structure thus improving water and nutrient availability to plants and reducing soil erosion. Additional benefits include: reduction in the cost of labour and machinery use, reduction in the need for utilising agro-chemicals, reduction in soil compaction, improvement in the yields of crop, as well as improvement in timing of planting (World Bank, 2012 and FAO, 2013). The system involves dry-season on land preparation using minimum tillage methods, using fixed planting stations; preservation of crop residue from the previous harvest in the field or use of other mulches covers; and rotation of crops in the field. Over 180,000 farmers used this scheme at the end of 2010, and this figure was projected to rise to 250,000 farmers by 2011 representing 30% of the populace of small-scale farmers in Zambia.

These practices have been found to be highly profitable and not only because of their effect on soil health but by eliminating the need for labourious land preparation (FAO, 2007). In conservation agriculture, the organic matter in the top 30cm of the earth's soil comprises virtually as much carbon as there is in the whole atmosphere. When poorly managed, soils not only provide meagre crop yields, they also discharge significant quantity of carbon (Fowler et al, 2001). However, farming also has the prospective to sequester vast quantities of carbon through practices such as conservation agriculture, which improves the nutrients and water-holding capability of the topsoil. The agricultural conservation also increases water use efficiency, reduces land and water pollution

and leads to reduction in emission of greenhouse gases (Dumanski et al., 2006). The reduction of the greenhouse gas emissions was achieved through the process of CSAP.

2.3.4 The use of improved varieties and hybrid of crops/animals

The improved crop seed variety and animal hybrid which are drought and disease resistant were as a result of crop technologists and animal breeders who used biotechnology to produce improved seeds and animals, making breeding easier and it produces additional food for the large populace. The livestock breeders can expand the breeding mechanism through the processes like genetic engineering, cloning and artificial insemination. Animals are part of Mother Nature, and hence native breeds of farm animals are often kept in natural parks because several of the world's native livestock breeds are in jeopardy of massive reduction as commercial breeds take over, according to a worldwide record of animal diversity (Mason, 1982). Cultivar testing is an important means of improving crop varieties. A wide series of trials are taking place on sites all over the world, addressing subjects such as drought tolerance, heat stress and soil management. Scientists used 250 open Agricultural Trial Datasets to construct crop models specific to the West African Region. The models are used to project the local effects of climate change, and describe breeding programmes for adaptation (CGIAR, CCAFS, 2015). Growing pulses sideways with cereals leads to nutrient reutilizing. Legumes are productive leaf shredders, and act as a natural manure to preserve soil fertility and sustain soil moisture (Tiwari, 2001).

Exchanging livestock species that are more adapted to water scarcity and resilient to disease can include buying or breeding such animals or even changing the type or species of animals produced. For example, Zebu cattle and small ruminants are more tolerant of water scarcity (Thornton and Herrero, 2010). Livestock are responsible for methane and nitrous oxide discharges from ruminant digestion and manure management and is the largest worldwide source of methane secretions. However, the carbon foot print of livestock varies considerably among production organisations, regions and commodities, mainly due to variations in the worth of feed, the feed conversion proficiencies of different animal species and influences on deforestation and land degradation. The animal breeders scientifically breed animals that will produce less methane emission and increase other elements of organic substances that will accelerate manuring when their waste are decomposed into the soil which help in carbon sequestration, hence decreasing the adverse effect of climate change through the process of CSAP (FAO, 2001).

2.3.5 Integrated crop/ livestock management

The integrated farming scheme comprises of a range of resource, valid practices that target suitable profits and sustainable production levels, while curtailing the negative impacts of climate change through agricultural activities and stabilising the atmosphere. As a principle of improving natural biological processes above and below the ground, the integrated system signify a winning mixture that diminish erosion, improves crop yields, soil biological activity and nutrient recycling, intensifies land use, increases profit and can therefore help reduce poverty and support ecological sustainability (Delgado et al., 1999). The main dairy animals are goats, sheep and cattle; each of these has a habitation in mixed crop-livestock schemes and they share a gastrointestinal system that allows them to consume coarse feeds like hays, pastures and tree leaves. Vegetables can be watered from the fish ponds and their remains can be used for feeding livestock (Chen, 1996).

Practical inventions have connected collaborations between livestock, crops and agroforestry production to improve economic and ecological sustainability of agricultural schemes and at the same time offer a flow of valued ecosystem services. Through improved biological variety, proficient nutrient recycling, enhanced soil health and forest preservation and contribute to climate change adaptation and mitigation. They also heighten livelihood divergence and knowledge by enhancing production inputs, including labour. In this method, incorporated systems also increase producers' resilience to economic strains (FAO, 2011). Livestock nutrition, strengthening through agroforestry, the ruminant diets that are higher in quality result in reduced methane output per unit of milk and meat as flourishing as in higher meat and milk production.

2.3.6 Irrigation for small-holder farmers

Irrigation is the artificial application of water to land with growing crops. Irrigation can be carried out using power rotary sprinklers, spray lines or by channelling water along underground pipes or small irrigation canals from reservoirs or river. Irrigation water can be more successfully used than the corresponding amount of rainfall because a regular supply is confirmed. The benefits of integrated irrigation include increase of crop yields, improved water management, heightened synergies, increased income, moderate environmental friendly and poverty reduction. The main factor preventing farmers from irrigating their crops was the lack of access to water and this was followed by high cost of irrigation. The other factors were lack of funding for developing irrigation for small scale farming, to secure land tenure to warrant investment and soil's not being suitable for irrigation (FAO, 2007). Irrigation request in South Africa is expected to increase over the next few eras under constrained emissions set-ups, as a result of increase in temperature and

vaporisation. Under a warmer and damper climate situation, a modest increase of 4 – 6% in irrigation demand is proposed, with restricted implications for the agricultural sector. For catchments along the eastern coastline, an increase in evaporation is projected to be offset by the increase in rainfall, with no change in irrigation demand. Increases of about 15 – 30% in irrigation demand are possible under a hotter and drier scenario presenting substantial risk for the sector and with important cross-sectorial consequences due to the high proportion of surface water consigned to agriculture in South Africa (FAO, 2013). Appropriate and well-timed water application method, such as drip irrigation, has been acknowledged as one of the paramount approaches to increase water use proficiency. It requires less water than sprinkling. Khanal et al., (2013) reported that drip irrigation, as likened to conventional irrigation, resulted in 31% water saving in cauliflower and improved cauliflower production/area by 46% with the same source of water.

Moreover, average production/plant increased by 14%, it reduced irrigation labour expenses by 40% and that for weeding and earthing-up by 33%. Ngigi, (2009) also revealed that shifting from surface irrigation to drip irrigation enhanced irrigable area by 200%, effective irrigation proficiency by between 25 and 75% using the same capacity of water. Regmi et al., (2009) also recounted that the local societies in Kaski district of Nepal found drip irrigation to protect water, enhance yields and decrease losses during droughts, thereby battling water shortage. Similarly, sprinkling on coffee plants encouraged flowering when the rain failed in the flowering season, and sprinkling warm water on plants in coffee nurseries maintained and reduced warmth which as a consequence reduced the adverse effect of climate change through this CSAP. However, despite all the indicators of CSAP in the study area, our presumption was that, the poverty rate will be reduced drastically or eliminated but that was not the case hence, the need to know why poverty keeps on persisting in North-West Nigeria.

2.4 The Concepts and Nature of Poverty in Nigeria

The concept of poverty does not offer itself to an easy and exact definition. Any logical investigation of the concept of poverty is fraught with a number of complications. This is because poverty touches various parts of the human state of living; comprising psychological, physical and moral life that a concise and generally accepted definition is obscure (Blackwood and Lynch, 1994). A concise and universally accepted explanation of poverty is elusive basically because it affects many phases of the human conditions, including physical, moral and psychologically. However, different benchmarks have been used to conceptualize poverty in various places. Most analyses follow the conventional view of poverty as a result of inadequate income for securing

basic goods and services. Some persons view poverty, in part, as a function of education, health, life expectancy and child mortality. Blackwood and Lynch (1994), identify the poor, using the standards of the levels of consumption and expenditure. Furthermore, Sen (1983), relates poverty to entitlements which are taken to be the various parcels of goods and services over which one has command, taking into perception, the means by which such goods are acquired (for example, money and coupons) and the availability of the needed goods. Hitherto, other experts see poverty in very broad terms, such as being incapable to meet "basic needs" (physical; (food, health care, education, shelter and non-physical; participation and identity) requirements for a meaningful life (World Bank, 1996).

The UNDP, (2006) proposes a multidimensional poverty concept that is causally associated to command over economic resources. They contends for an income poverty line that reflects the cost of realizing basic human need. Poverty is a multifaceted concept, which could be broadly categorized into two groups; absolute and relative poverty. Absolute poverty otherwise referred to as extreme poverty refers to the complete lack of the means necessary to meet basic personal needs such as food, clothing and shelter. The determination of those who are absolutely poor is given by an income threshold; below which one is considered poor. Universally, the most commonly used are \$1, \$1.25 or \$1.9 per day. However, most countries/economies have locally generated thresholds that suit their economies. Relative poverty is perceived more as socially defined and dependent on social context, which is subjective to the society/country one lives in. This occurs when a person in a society/country does not enjoy certain minimum basic necessities as will the rest of the population. Relative poverty is largely regarded as a measure of inequality in a country like Nigeria. The living standards of individuals is generally measured using current consumer spending or income. A measure of current consumer spending is mostly preferred to income as a measure of current living standards for two reasons. First, current consumption is often taken to be a better indicator than current income because immediate utility depends directly on consumption, not on income per-se. Second, current consumption may also be a decent indicator of long-term average well-being, as it will expose information about incomes at other dates, in the past and future. This is because incomes (including those of the poor) frequently vary over time in fairly predictable ways mainly in agrarian economies such as Nigeria. Alderman and Paxson (1992).

A search of the appropriate literature shows that there is no universal agreement on any meaningful explanation of poverty by individuals or households. This is because of its multidimensional

nature. While an economist would approach the subject from the view point of want, needs and actual demand, the psychologist may look at it from the view point of deprivation, appreciation and personality. But from whatever viewpoint it is perceived, it is obvious that, it is not a desirable situation of life. Streeten, (1979); Ogwumike, (1987) and others have defined poverty in very broad terms such as not being able to meet basic needs particularly the physical needs such as food, clothing, health care, education, housing, electricity and transportation for meaningful life. Amaghionyeodiwe and Osinubi, (2004) argued that poverty is not only a term that is commonly used by the generality of the people but also one that has no particular content as concept. Besides, it is a multi-dimensional and cultural state that exceeds economic explanation and investigation. Furthermore, poverty is both existing and relative. For any particular society, poverty and the poor are very existing phenomena and can be easily recognised, that is why poverty is easily recognised than defined (Foster et al, 2010) yet it is also relative. The population that may be categorised as poor in a developed economy would be regarded as materially well off in less developed countries. In spite of the complications, poverty is hereby defined in terms of inadequacy of disposable possessions to support a minor standard of decent living. Ravallion, (1991) nevertheless, upholds that though poverty is a multifaceted concept, its features of poor dietary status and incapability to work are adequately well correlated with income and consumption expenditure to allow us focus on these two variables.

Ajakaiye and Adeyeye, (2001) conceptualised poverty as a function of food, education, health care facilities and other demographic variables. Olaitan et al, (2000) defined poverty as the inadequacy of human basic needs such as food, shelter, clothing and the incapability of an individual or society to obtain human basic needs for existence. He further asserted that poverty could affect individuals or a group or community or nation. Individual poverty is one that results from individual misfortunes or inability to obtain the basic requirements of life expectancy like essential clothing, three meals a day that are nutritious; habitable house and a means of transportation either by land, sea or air (Olaitan et al, 2004). But Anyanwu, (1997) defined poverty as dearth of the means of meeting the basic and customary needs of individuals or households which include good shelter, food, clothing, security, health care, education and freedom to participate in social activities and this group of people are the most exploited economically and manipulated politically.

Likewise, poverty has been classified by some economists as chronic or transitory (Mckay and Lawson, 2002; Oduro and Aryee, 2003). The dissimilarity between the two depends on time frame if the household is poor for the entire reference period; it is referred to as chronic. It is transitory if households move in and out of poverty throughout the reference period. And he further stated

that in the early times, poor people were regarded as those who could not go for weddings, manage large families and own domestic animals like goats, cattle and poultry. Olaitan et al., (2000) also claimed that these are characteristics of affluence on which individuals idolised as wealth. But nowadays, modern generation identifies these attributes to be of short span with low materials and sustainable value when human needs are in question. For example, if somebody at present marries many wives and gets children without work or habitable houses that commensurate to the large families, good education for the children and important means of transportation, he is still regarded as poor. The National Bureau of Statistics (NBS, 2007) reported that poverty as found in Nigeria is basically a rural social phenomenon, the bulk of those in poverty are inexplicably situated in the rural parts, where they are predominantly involved in agricultural activities and the allied accomplishments.

2.5 The Causes and Characteristics of Poverty

Obadan, (1997) acknowledged some elements as the reasons for poverty. These comprised inadequate access to employment prospects, insufficient access to markets, obliteration of natural resources and lack of power to contribute in designed developmental programmes, lack of physical assets and lack of willingness to assist those living at the margin. The characteristics of poverty include: (i) Increase in households' size: The choice to have large family can be a poverty pointer because large household size is a trait of low income per capita in the society. Large number of children facilitates high rate of dropout and malnutrition, and consequential limited resources (Olaitan, 2004); (ii) Low productivity: This is evident that productivity implies efficiency and where there is scarcity of corresponding resources, poverty elements are inevitable (Olaitan, 2000). Still, as stated by Olaitan, (2002), other cases are: lack of appropriate training, poor attitude to work and the use of rudimentary tools. On the other hand, the literature is also full of confirmation that large households are connected with poverty (Lanjouw and Ravallion, 1994; Anyanwu, 2012; and Gang, Sen and Yun, 2004). The absence of well-developed social security systems and low savings in developing countries tends to increase fertility rates, particularly among the poor, in order for the parents to have some economic backing from children when parents reach old age. This is one of the rationales for parents to increase the number of children so that they will have high probability of getting support when they are old; (iii) High rate of dependence ratio: The incapability to produce a commensurate income for the poor except from the generosity of the wealthy individuals to assist via aids in order to eliminate lack, so that the rich produce more for their sustainability (Olaitan et al., 2000). Livelihood resilience of households and communities can also be enhanced through access to diverse sources of food, feed and employment during episodes

of adverse climatic conditions. Wild plant species in farms, forests, savannahs and wetlands contribute significantly to the diets of many of the poor in developing countries, and these food sources, particularly the famine foods such as wild greens, tree fruits, and roots, play an important role in supplementing diets during periods of climate induced scarcity Bharucha and Pretty, (2010).

Poverty is multi-dimensional and even though it is difficult to separate the various dimensions of poverty from the various causes of poverty, in the case of Nigeria, we have shown that unemployment, corruption, the non-diversification of Nigeria's economy, inequality, laziness, and a poor education system are some of the key determinants of poverty. These determinants are many times related to each other and also enforce each other. For example, unemployment, poor education and poverty can be seen as vicious cycle. Today, people who are not educated lack the opportunity of being hired for good jobs, and the poor masses today still cannot afford to go to school which makes them the poor unemployed masses tomorrow. Hence, all these factors are correlated and must all be tackled together if any progress wants to be made Oluwatayo, (2008). The reduction of poverty rate in Nigeria between year 1985 and 1992 was the product of the Structural Adjustment Programme (SAP) which was introduced in 1986 (World Bank, 1996). Some of Nigeria's earlier anti-export prejudice in industry vanished, with the manufacturers in agro-processing and fabric industries swapping from imported materials to local inputs. This made the industrial output dropped annually by 4.8% on average from 1981 to 1986 which grew by 5% per year from 1987 to 1992. However, in the same period, production of traditional food crops and cash crops improved and agricultural productivity grew at 3.5% per year on average, compared with only 0.6% from 1981 to 1986.

2.6 The Consequences of Poverty

It has been noted that poverty has a negative effect on the society, and as well as the government, even the nation's economy. Moreso, Aku et al, (1997) revealed that, there is a universal loss of self-confidence in a society afflicted by poverty and this renders government policies unproductive. Poverty also results in collective uncertainty and vulnerability of members of the society to peripheral impacts. Additionally, poverty makes production remain principally subsistence due to lack of capital required for expansion. Labour becomes exhaustive and marginal productivity remains low. Similarly, the implication of poverty on the people cannot be overstated. The vicious sequences of poverty stated before, means that lasting handicaps and difficulties are passed on from one generation to another. The detriments of poverty include lack of education,

lack of simple hygiene, child labour to help the parents and transmission of infectious diseases. Joblessness and very low earnings produce a situation where parents cannot afford to send their children to school to acquire education. Besides, even those who can really go to school simply do not see how hard work can advance their lives, mainly because they see their parents fail at the task every day.

The future of a developed country for example is the presence of a middle class, but lately we have seen even Western nations gradually losing their middle class, hence the increase number of protests. In the society, poverty is a very hazardous feature that can threaten a whole nation. The Arab demonstration is another noble example, in all the nations concerned, the uprisings started because of the lack of employments and high poverty rates among the people, and this has led to most governments being ousted. In Nigeria, widespread and severe poverty is a reality. It is a reality that depicts a lack of food, clothes, education and other basic amenities. Severely poor people lack the most basic necessities of life to a degree that it can be wondered how they manage to survive. There are several effects and deficiencies associated with poverty in Nigeria. One of the main effects of poverty is poor health, as is reflected in Nigeria's high infant mortality and low life expectancy. Poor people in Nigeria face several health issues as they lack basic health amenities and competent medical practitioners. Most children do not have the opportunity of being immunized and this leads to certain physical defects in some of the children. Their health has become low priority and as they have little or no choices, they live with whatever they are provided with, whether healthy or not Nnandi, (2008).

2.7 The Derivation of Poverty Line and Measurement of Poverty

The poverty line can be seen as worth of consumption expenditure or income essential for at least a standard of diet and other requirements. The specification of the poverty threshold or consumption pattern or norms regarded as basic or minimum for which anybody with income or consumption payments below the line is considered poor while those with income or consumption payments equal to or above it are regarded as non-poor which shows the bench mark to differentiate the poor from the non-poor. The poverty line definition is frequently seen as a standard of consumption expenditure or income, which is estimated to epitomize the least, prerequisite for a productive and active life (Okunmadewa, 1999). Although poverty line can be regarded as the level of individual or household income or consumption expenditure, below which

one is classified as poor according to government standards, that is the estimated minimum level of income needed to secure the necessities of life.

Nevertheless, there is lack of certified poverty line in Nigeria, and as such, previous studies used poverty lines, which were set as magnitudes of the average per capita expenditure (Canagarajah and Thomas, 2001). The poverty line that is realised for any poverty study centres on the kind of investigation that the scholar is concerned with. In a measureable analysis, the poverty lines are objective while for qualitative analysis, it is generally subjectively determined. Objective poverty lines are usually of two types. These are relative and absolute poverty lines. However, some studies are using the relative poverty line technique due to its ease of calculation (Manyong et al., 2009). FOS (1999), used the relative poverty line of 1/3 or 2/3 Mean Per Capita Household Expenditure (MPCHE). The 1/3 MPCHE was referred to as the core poverty lines while the 2/3 MPCHE was the moderate poverty line. The National Bureau of Statistics (NBS, 2007) apart from using the 2/3 MPCHE also used the absolute poverty line required to meet 2,900 calories and a minimum non-food items, US\$1.25 per person per day as poverty lines and subjective poverty measure by means of a self-assessment of poverty. When measuring poverty over time, analysts must choose the value of the income elasticity of the poverty line, which essentially determines whether an absolute or relative poverty line is being used and the choice of this parameter is ultimately a value judgement which has some empirical basis. The absolute poverty denotes a state in which an individual or household lacks resources crucial for subsistence. It is not only lack of income but also not having access to social services such as electricity, water, health care, education and political discrimination (Suleiman et al., 2013). While relative poverty refers to a state in which individuals or households lack assets in comparison to members of another society because definition of poverty in one place is not the same as in another environment. For example definition of poverty in Dutsinma town in Katsina State is not the same as in Abuja or Lagos State capitals. That is why poverty line is considerably higher in developed countries than the developing nations (Witt, 2007). Although relative poverty varies with income or economic growth, the poverty line from this approach is commonly expressed as a fixed percentage of the mean income or expenditure (Awoyemi et al., 2011). Poverty line is also known as threshold. The \$1.25 international standard of poverty line is difficult to set as common international poverty line since different countries have different poverty lines.

Furthermore, some developing countries are blessed with enormous physical, natural resource and human endowments yet the majority of its people live below both the absolute and relative poverty lines. The national survey piloted between 2003 and 2004 indicated that slightly above half of the population in Nigeria 52% live below US\$1 dollar/day and the relative national poverty incidence was found to be 54.4% National Bureau of Statistics (NBS, 2005). According to 2004 Human Development report, the percentage of Nigerians living below the poverty line of one dollar/day has increased radically during the last two decades. The report ranks Nigeria number 151 and places the country among the 26 poorest countries in the world. In the year 2000, the statistic connotes that more than 70% of Nigerian's were projected to be living below the internationally defined poverty line of one dollar/day (World Bank, 1995). This view was sustained by other studies like Soludo, (2006). (NBS, 2005) also set a poverty line at deflated dollar/day. This was conducted using a familiar measure of the 2002 World Bank Purchasing Power Parity (PPP) for 2003 PPP with inflation rates and exchange rate changes. Typically, the per capita expenditure of each household was transformed into an index ranging from greater than zero to less than one using the standard of normal distribution in statistics. Thereafter, the mean of the sum of the probable index was taken to be the vulnerability index (Oyekale and Oyekale, 2010). A lot of models have been designed to measure poverty. These include the Sen Index (Sen, 1976), Pa weighed poverty extent (Foster et al, 1984) the Physical Quality of Life Index (PQLI), (Morris, 1979), Human Development Index (HDI), and Relative Welfare Index (IFAD, 1993). However, of all these, the most obviously used in poverty assessment is the Foster, Greer and Thorbecke (FGT) Pa weighed poverty extent that is based on income or consumption expenditure of the household (Aigbe and Isiorhovoja, 2013). Ravallion, (1996) in support of the income or expenditure method to poverty measurement upholds that though poverty is a multi-faceted concept, its characteristics such as poor nutrition, lack of physical assets and inability to work are sufficiently correlated with income and consumption expenditure to allow us to focus on these two variables. Foster, Greer and Thorbecke offered the weighted measure of poverty in 1984. It is a class of parametric poverty measure that satisfies Sen's axioms and which include fundamentals that are sensitive to changes in disparity among the poor, changes in income deficiency and changes in the number of the poor.

Having established the poverty line, there is the need to carry out poverty analysis decomposed into various indices. According to Foster et al, (1984) and Ravallion, (1996) the most frequently used measurements are poverty headcount, poverty gap and poverty severity.

$$P\check{\alpha} = \frac{1}{N} \sum_{i=1}^q \left(\frac{Z - Y_i}{Z} \right)^{\check{\alpha}} \dots\dots\dots (2.6)$$

Where:

$P\check{\alpha}$ = Foster, Greer and Thorbecke index ($0 < P < 1$)

N = total number of respondents i.e. farm households sampled

q = number of respondents below the poverty line either poor people

z = the poverty line (defined as 2/3 of mean adult equivalent household expenditure of the sample households)

Y_i = per capita household expenditure of the i th respondent

$\check{\alpha}$ = non-negative poverty aversion parameter (0, 1 or 2)

$\check{\alpha} = 0$ gives the head count ratio or the incidence of poverty which is the percentage of respondents in poverty i.e. whose per capita expenditure is below the poverty line

$\check{\alpha} = 1$ gives the poverty gap which adds up the extent to which individuals on average fall below the poverty line, and expresses it as a percentage of the poverty line. It shows how much would have to be transferred to the poor to bring their incomes or expenditures up to the poverty line as a proportion of the poverty line.

$\check{\alpha} = 2$ gives the poverty severity which takes into account inequality among the poor.

- (i) Poverty Headcount Index (HCI): This is the proportion or percentage of an individual or household whose standard of living lies below the national poverty line. Calculation

$$\text{of the Poverty Headcount Index (HCI)} = \frac{1}{N} \sum_{i=1}^q N_i = \frac{N_q}{N} \dots\dots\dots (2.7)$$

Where:-

HCI = Head Count Index

N = Number of total respondents

q = The poverty line (either poor people).

N_i = Number of incidence

N_q = The number of respondents beneath the poverty line (either poor people)

- (ii) Poverty Gap Index (PGI): This is an indicator to determine the extent of an individual or household whose standard of living is below the poverty line. However, the poverty

gap ratio is the difference between the poor' income or consumption expenditure and the poverty line.

$$\text{Calculation of the Poverty Gap Index (PGI)} = \frac{1}{N} \sum_{i=1}^q \frac{(z - y_i)}{z} \dots\dots\dots(2.8)$$

Where:-

PGI = Poverty Gap Index

N = Number of total respondents

q = Number of respondents beneath the poverty line (either, poor people)

y_i = Per Capita Household Expenditure of the ith respondent.

Z = Poverty line.

- (iii) Square Poverty Gap Index (SPGI): This takes into account not only the distance separating the poor from the poverty line, but also the inequality among the poor. This means, a transfer from poor to poorer reduces the Square Poverty Gap Index (SPGI) while a transfer from poor to less poor increases the Square Poverty Gap Index (SPGI).

$$\text{Calculation of the Square Poverty Gap Index (SPGI)} = P = \frac{1}{N} \sum_{i=1}^q \left(\frac{z - y_i}{z} \right)^2 \dots\dots(2.9)$$

Where:-

SPGI = Square Poverty Gap Index (Poverty Severity)

N = Number of total respondents

q = Number of respondents below the poverty line (i.e., poor people)

y_i = Per Capita Household Expenditure of the ith respondent.

Z = Poverty line.

2.8 Multidimensional Poverty Index

The Multidimensional Poverty Index (MPI) has been established by Alkire and Santos (2010) for the 2010 Human Development Report. It is an index of acute multidimensional poverty and is based on the Alkire and Foster (2011) dual cut-off method for poverty identification. The MPI(M) itself then can be believed as the product of the MPI headcount H (measuring the share of the population that is multidimensionally poor), and the weighted deprivation share of multidimensionally poor households A (measuring the weighted percentage of indicators, in which the multidimensionally poor are on average deprived). The measurement of poverty has been under

constant investigation from academics and policy-makers. For many years, income (or consumption/expenditures) has been used as a proxy to comprehend and measure poverty. However, over the last eras, increasingly theoretical and methodological discussions have shifted the attention to what is now called Multidimensional Poverty. Notwithstanding of the method, the measurement of poverty will be full of normative decisions about what institutes poverty, by whom and under which conditions it is considered poverty.

The income model of poverty', as defined by Bourguignon, (2006) has been conventionally dominant in the literature. Poverty is intellectualized following the maximizing utility behavior subject to an economic restriction. The individual choices over a set of goods and services are perceived as an expression of the revealed preferences of the Conceptual Framework of Multidimensional Poverty Measurement. Under this tradition, poverty is defined as a standard of living below a poverty line fixed using monetary resources (income, consumption, expenditure). Conversely, since the late 1970s different authors have acknowledged the limitations not only in the concept of poverty but also of the indicators used. Townsend (1979) was a forerunner arguing that poverty was not a lack of income to purchase goods in the market but the lack of resources to participate in society. He also introduced different indicators, mainly concentrating on the access to goods and services, to account for his concept of poverty.

Under the welfarist method, well-being is measured on the basis of a proxy of utility based on resources like income, consumption or expenditure. Resources are equated with a minimum requirement of goods and services valued in monetary terms or poverty line. This is a simple optimization problem under a constraint in the budget. On the other hand, poverty lines can be defined in absolute, relative and even subjective terms. Absolute poverty lines are based on the construction of a basket of basic goods, and services resulting from nutritional and cultural patterns, mainly in developing countries, while relative poverty lines take into account the distribution of resources. Examples of absolute lines are for instance the national poverty lines or the 1.90 USD used by the World Bank, European Union (ECLAC, 2006). Measurement of multidimensional poverty is a complex subject. Not only because there is no consensus about a conceptual framework but also because of its multidimensionality. The whole is not basically the sum of its parts; to define multifaceted, multidimensional concepts involving of many interrelated elements and patterns for which, generally speaking, the whole cannot be fully understood by separately analyzing its component (Chiappero, 2008). It is precisely this argument of complexity

and vagueness of poverty that ends up being extremely appealing for jointly studying the performance of different dimensions.

The Multidimensional Poverty Index (MPI) was first published in the Human Development Report of 2010 (UNDP, 2010). It is known as the global MPI because it includes more than 100 countries in its sample. It follows the Alkire and Foster (2011) method, especially the Adjusted Headcount Ratio (AHR). In order to create a status of countries from the poorest to the richest, the MPI uses diverse data sources such as: Demographic and Health Surveys (DHS), Multiple Indicators Cluster Surveys (MICS), and World Health Surveys (WHS). It uses the household as the unit of analysis. It distinguishes three different dimensions and uses some indicators such as nutrition, health, attendance in education, water supply and assets in living standards.

2.9 Empirical Literature Review

Empirical evidence thrives on the research studies; and an instance is the research carried out by Fanen and Adekola, (2014). Their study evaluated the applicability of CSA in fighting climate change, drought, desertification, flooding, land degradation and improving rural livelihood in an African context. They also appraised the projections and restrictions to the adoption of this method in northern part of Nigeria. However, the data was collected using crucial informant discussions and field surveillance to consider the current position of agriculture in northern part of Nigeria. The results revealed that CSA was robust in aspects such as involvement and sustainable use of assets but weak in aspects of repayment and equal sharing of benefits. Many smallholder farmers have carelessly taken CSA as part of the traditional farming system. While the existence of CSA in current practices is a major component in its favour, the lack of a coherent climate mitigation approach and poor institutional structures are both unfavourable. Agricultural sustainability will need a broader communal change towards appreciating the equilibrium between agriculture and ecological changes. They suggested four main areas in need of crucial change: human, political commitment, financial investment, incentive and information.

Codjoe et al., (2013) examined the awareness of climate change of cocoa farmers in rural community of Ghana. The study used descriptive statistical tools such as frequencies and percentages as well as Chi-square analysis to demonstrate that all cocoa farmers irrespective of their geographical areas are aware about climate change and its numerous impact on their agricultural activities. They nonetheless, held diverse views about activities of man and nature that causes this change. They explained that farmers depend mostly on past experience, members and

the Ghana meteorological agency for weather information updates but the dependability of this is sometimes in big doubt thereby disturbing agricultural activities.

Additionally, Ozor et al., (2013) surveyed climate change vulnerability and the use of indigenous skills for adaptation among smallholder farming communities in Sub-Saharan Africa. The research was based on field surveys and desk studies which were carried out in the year 2010 in the selected SSA countries of Tanzania, Sierra Leone and Nigeria. Descriptive statistics which includes narratives, frequency tables, percentages, mean scores, correlation and multiple regression analysis were used to appraise the objectives. The most important findings from the study indicated that there was an obvious awareness and campaigning about climate change among the communities studied with most farmers maintaining that they have been experiencing climate irregularity and changes which have intensified in the recent times. As a result and as a coping strategy, they applied numerous native skills to avert the crisis and manage with the changes. The most popular ones being traditional terracing, tree planting, construction of drainages, irrigation, use of local herbicides and prayers to God. However, it remains uncertain on the efficiency of those indigenous technologies, considering the additional climate changes.

Furthermore, Ekpoh, (2010) investigated adaptation to the effect of climatic variations on agriculture by rural farmers in North-West Nigeria. The effect of climatic discrepancies on crop yields and the adaptation by farmers were analysed using the modelling method and farm scrutinises. Accordingly, regression models which relate climate data to crop yields were built. The results revealed that rainfall had a significant positive relationship with crop yields in the region and explained over 70% of the variations in the yields of maize, millet and sorghum, all of which were significant at the 0.05 level. Evaporation also had a significant but opposite relationship with crop yields. Other climatic structures in the experiment provided minimal levels of explanation. The farm surveyed established that rural farmers in the study area were quite innovative as regards adapting to drought. The study concluded that the effect of climatic variations on crop yields in North-Western Nigeria could be considerable, especially under drought conditions. The need to update farmers' adaptive strategies was equally emphasised.

Quite differently, Barau et al., (2016) studied the effective use of CSA for sustainable land use management and discovered that, natural resources is grossly under-utilised in terms of food production, shelter and soil conservation. Most of the activities of rural farmers on land agro-ecosystem contribute to climate change difficulties in terms of burning of bush, cultivation of the soil, desert encroachment coupled with little knowledge about the environmental conservation and

its sustainability via technically enhanced technology such as the CSAP. In view of this, they suggested that the mitigating methods are needed to address matters related to better and effective land resources management and at the same time to maintain greenhouse effect and improve farmers' livelihood.

Comparably, Olawale et al., (2016) examined the rainfed agricultural system, vulnerability to climate change impact, additionally, the impact differ by aggregate and sub-sectoral levels of agricultural production. The impact of climate change and variability on agricultural production would engender suitable policies and practices towards a sustainable agricultural production system. The exploration of the differential effects of rainfall and irrigation on agricultural productivity in Nigeria drew lessons for CSA in Nigeria. Using time series data that spanned forty three years and econometric analytical techniques, Olawale et al., (2016) quantified the differential impacts of rainfall and irrigation on comprehensive production and sub-sectors such as crops, livestock and forestry. Irrigation had positive and significant impact on agricultural production as well as all sub-sectors of agriculture. These findings indexed the need for the minimization of the impact of climate-induced production risks through CSA which would involve corresponding development of more arable land areas under irrigation in Nigeria. Irrigation would also improve complementary agricultural water management for the development of all the sub-sectors of agricultural activities, thereby improving food security and sustainable agricultural production under predominantly climate change and variability.

Anselm et al., (2010) carried out analysis on climate change and its environmental hazard to the fight against hunger and poverty in Africa, mainly through its impact on agricultural productivity. Their discussion was based on the challenges of agricultural adaptation to climate change in Nigeria under the classifications of poverty, deprivation and hunger; agricultural funding for research and technology development; information, traditional agricultural practices; and human capital. The rural populations, who produce more than 70% of the food eaten in Nigeria, are inexplicably poor and face malnutrition and disease. Both government and the private sector, that should motivate the sector through consistent policies, robust funding and infrastructure development, have failed to accord this problem the priority it deserves. Moreover, the estimated benefit from trade liberalization failed to trickle down to the African farmer, coupled with the inefficient local marketing systems. In addition, the farmers are slow in changing their farming practices such as bush burning, deforestation and rainfed agriculture and they lack the basic education, information and training necessary to adapt to climate change. On account of the foregoing, the researchers recommended that the government should not only devolve its

programmes on poverty and agricultural research, funding and activities, but should make them participatory. In addition, there should be an obvious national agricultural policy framework, adequate provision for irrigation, drainage, weather forecasting and other agricultural technology infrastructure, an incentive for training in agriculture, participatory and ongoing capacity building for farmers, drought resistant and short duration high yielding crops development, integration of indigenous and modern knowledge on climate change adaptation, and strengthening of the extension services.

Branca et al., (2011) examined CSA as a synthesis of empirical confirmation of food security and mitigation benefits from improved cropland management. They posited that, meeting the food demand of a global populace expected to reach 9.1 billion in 2050 and over 10 billion by end of the century will require major changes in agricultural production systems. Improving cropland management is important to increase crop productivity without further humiliating soil and water resources. At the same time, sustainable agriculture has the potential to deliver co-benefits in the form of reduced GHG emissions and increased carbon sequestration therefore contributing to climate change mitigation. The paper synthesized the results of a literature review reporting the evidence base of different sustainable land management practices meant at increasing and stabilizing crop productivity in developing countries. To that effect, it was shown that soil and climate characteristics are key tools in interpreting the impact on crop yields and mitigation of different agricultural practices and that technological options which are most promising in enhancing food security at smallholder level are also effective to the attainment of increasing system resilience in dry areas and mitigating climate change in humid areas.

Aslihan et al., (2015) investigated CSA by assessing the adaptation implications in Zambia. They looked into a set of potentially CSAP, which included reduced tillage, crop rotation, legume intercropping and combined with the use of improved seeds and inorganic fertilizer, for their effects on maize yields in Zambia. The researchers used Panel Data from the rural incomes and livelihoods surveys, merged with a novel set of climatic variables based on geo-referenced historical rainfall and temperature data to explore the changing effects of these practices with climatic conditions. Additionally, they estimated the effects on maize yields, and also on the demonstration of very low yields and yield shortfalls from average levels, as indicators of resilience, while controlling for household characteristics. Moreover, they found that minimum soil disturbance and crop rotation had no significant impact on these yield outcomes, but that

legume intercropping significantly increased yields and reduced the probability of low yields even under critical weather stress during the growing season. They also found out that the average positive impacts of modern input used seeds and fertilizers significantly conditioned by climatic variables. Timely access to fertilizer emerged as one of the most robust determinants of yields and their resilience. These results have policy implications for embattled interventions to improve the output and the resilience of smallholder agriculture in Zambia in the face of climate change.

Kehinde et al., (2017) investigated land tenure and property rights impacts on adoption of CSAP among smallholder farmers in Nigeria. They conducted the study in selected farming communities across the six geopolitical zones of Nigeria. The econometric framework used by the researchers was multivariate probit (MVP) regression analysis which they used to analyse the factors that facilitate or impede adoption of CSAP. The model is an extension of probit model used for estimation of several correlated binary choices jointly (Greene, 2003).

$$Y_{ipk}^* = X'_{ip} \beta_k + \varepsilon_{ip} \quad \dots\dots\dots(2.10)$$

$$Y_{ipk} = \begin{cases} 1 & \text{if } Y_{ipk}^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad \dots\dots\dots(2.11)$$

Equation (1) is a system of k equations as shown in equation 3 below:

$$\begin{aligned} Y_{1pk}^* &= \beta'_1 X_{1i} + \varepsilon_{1i} Y_{1pk} = 1 \text{ if } Y_{1pk}^* > 0, Y_{1pk} = 0 \text{ otherwise} \\ Y_{2pk}^* &= \beta'_2 X_{2i} + \varepsilon_{2i} Y_{2pk} = 1 \text{ if } Y_{2pk}^* > 0, Y_{2pk} = 0 \text{ otherwise} \quad \dots\dots(2.12) \\ Y_{Npk}^* &= \beta'_K X_{Ki} + \varepsilon_{Ki} Y_{Npk} = 1 \text{ if } Y_{Npk}^* > 0, Y_{Npk} = 0 \text{ otherwise} \end{aligned}$$

The analysis, via the multivariate probit (MVP) results shows the propensity of adopting green manure increases among the middle age and aged, whereas farmers in their youthful stage show strong understanding for crop rotation. The probability of adopting green manure, farm yard manure/compost and zero tillage is significantly higher among married farmers while farmers with dependants are more likely to adopt green manure. The final outcome of the analysis revealed that land ownership significantly and positively influence the adoption of zero tillage while it negatively influenced the adoption of the green manure. This finding suggested that secured land tenure, impacted positively on adoption decisions of CSAP.

Kalat and Adunni, (2015) examined the family farming and its influence on household poverty in northern Nigeria. The study considered the level of participation in family '*Gandu*' farming and its inducement on the poverty status of farmers in the study area. They used Descriptive statistics, Foster Greer and Thorbecke measures of poverty and the logit regression model for the data analysis. The poverty profile suggested that 57.77% of the farmers were poor while 42.22% of the farmers were non poor. However, the estimates of the logit regression model revealed that participation in family farming, age of farmers, land size, farming experience, household size and extension contacts were variables that significantly influenced the farmers' likelihood of being poor at different levels of significance. Furthermore, the study recommends measures to encourage participation in family farming as a means to improving livelihood of farmers, reduce poverty and enhance food security as well.

2.10 CONCLUSION

Chapter two has presented the processes of using climate smart agricultural practical techniques and the poverty line measurements. CSA emphasises on meeting the fundamentals of the people for food, shelter, clothing and fibre through science-based engagements, contributing to economic growth, poverty reduction and food security, conserving and improving the productivity, adapting to climate change and resilience to both natural and agricultural ecosystem. It involves an endless, interactive process for stakeholders, researchers and policy makers to meet the challenges presented by climate change and jointly renovate agriculture and food schemes towards sustainability objectives.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

This chapter describes and discusses the various techniques used to collect the sampled data. It also presents detailed information on the area where the research was carried out, the population of the study, the data collection techniques used and data analyses methods.

3.1 The Study Area

The research study area is North-West Nigeria and the region includes (7) States which are Katsina, Kano, Kaduna, Kebbi, Jigawa, Sokoto and Zamfara States as shown in figure 3.1: The area is situated between latitude $9^{\circ}10'N$ and $13^{\circ}50'N$, and longitude $3^{\circ}35'E$ and $9^{\circ}00'E$ and covers about $168,719 \text{ km}^2$ of the nation's total land mass. The region has a population of 49,564,917.44 million (NPC 2010). Also known as the North-West zone, it is characterised by rich miniature pastures of about 1.5 – 2m and few undersized trees hardly above 15m. It is by far the most humanly inhabited zone of the nation.

The agricultural sector forms the basis of the overall development pattern of the zone. For administrative purposes, Katsina State is divided into three agricultural zones, namely: Ajiwa, Funtua and Dutsinma zones, while for the same purpose, Sokoto State is equally divided into four agricultural zones, namely: Gwadabawa, Sokoto, Isa and Tambuwa zones. North western region experiences a relatively hot climate, with seasonal rainfall and a marked dry season (Draper and Maureen, 2009). The top soil in the northern region of Nigeria is notably reddish brown, a feature of the semi-arid areas, typically known as tropical ferruginous soils (Harris, 1999). It is therefore evident that changing climates will influence agricultural productivity because of its manifestations through increasing droughts or floods in the region due to its vulnerability to harsh weather. The main source of livelihood of the people in this zone is agriculture. Although variation occurs among the States, off-farm activities include: trading, tailoring and carpeting amongst others. Farming practices used in the study area include shifting cultivation, mixed farming, mixed cropping and pastoral farming.

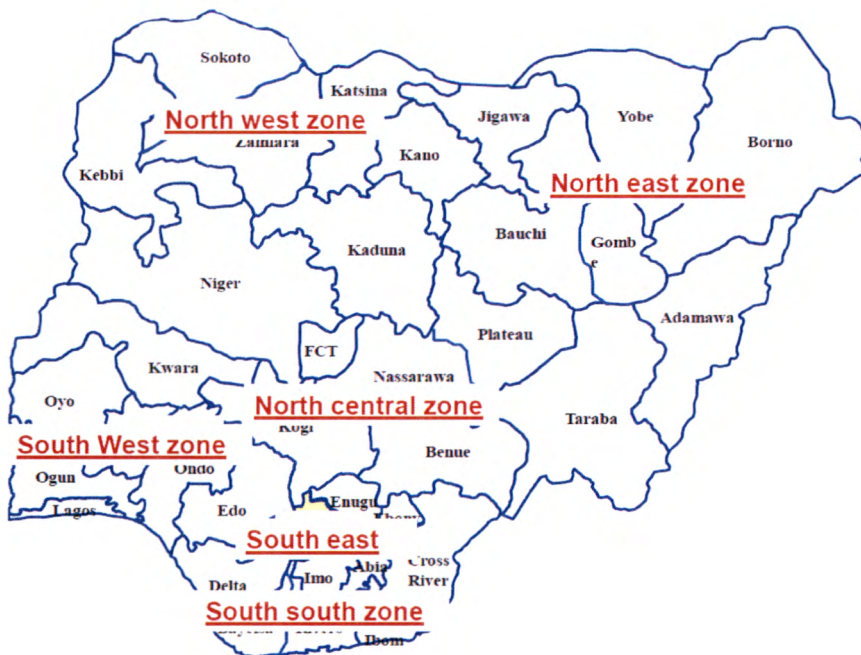


Fig 3:1 Map of Nigeria showing zones geographically (Source: Adapted from Obayelu and Awoyemi, 2010).

3.2 Research Design

This study adopted a cross sectional research plan whereby data were collected at a single point in time. According to Bless and Higson-Smith. (2006) this approach is concerned with the condition that exists, processes that are prevailing, developments that are on-going and trends that are developing. A research plan is a guideline within which an optimal about data collection method has to be made. It is planned and structured to be participatory or action research in nature (Mouton, 2005).

3.3 Population of Study

The population of this study comprises all farmers in North-West Zone of Nigeria. A population is a set of individuals that fits in to specific criteria and to which we intend to generalize the outcomes of the research (McMillan and Schumacher, 2006).

3.4 Sampling Procedure and Sample Size

The multi-stage sampling procedure was employed for the collection of data and information from the rural farming households. The first stage involved a purposive selection of Katsina and Sokoto States due to high prevalence rate of poverty (NBS, 2013). The researcher also selected the two States based on the location which connected the other five States together hence, probably because of similar religion and cultural practices. For example, Sokoto State having boundaries

with Kebbi and Zamfara States while Katsina State shared the same boundaries with Kaduna, Kano and Jigawa States.

The second stages involved a random selection of three (3) Local Government Areas from each of the three agricultural zones in Katsina State, and random selection of three (3) Local Government Areas from three (3) out of the four agricultural zones in Sokoto State, making a total of six (6) Local Government Areas in all. The third stages also involved random selection of ten (10) communities from each Local Government Areas to bring the total to sixty (60) Communities. Lastly, five (5) farming households were randomly selected from each of the communities, making a total of three hundred (300) respondents, who were utilized for this analysis. However, only two hundred and ninety four (294) questionnaires' were returned and used for the analysis.

3.5 Research Instrument and Data Collection

The primary data for the study were collected through well-structured pretested questionnaires. The questionnaires were developed based on the objectives of the study and literature. There were four sections in the questionnaire. However, for the purpose of this study, if a respondent used three and more types of CSAP, the researcher classified the farmers as high-users of CSAP, while the respondent who used two or less types of CSAP, the researcher classified the farmers as low-users of CSAP. There is a paucity of information on the conditions under which multiple climate-smart practices are adopted and on the synergies among such practices in increasing household resilience by improving agricultural income. Some studies analyzed how heat, rainfall, and variability of rainfall affect farmers' choices of a portfolio of potential climate-smart practices – agricultural water management and improved crop seeds with the impact of these practices on farm income in the Nile Basin of Ethiopia.

They used multinomial endogenous switching regression approach by modeling combinations of practices and net farm income for each combination as depending on household and farm characteristics, and on a set of climatic variables based on geo-referenced historical precipitation and temperature data. But this effect is greater when these practices are combined. Simulation results suggest that a warming temperature and decreased precipitation in future decades will make it less likely that farmers will adopt practices in isolation but more likely that they will adopt a combination of practices. Hence, a package approach rather than a piecemeal approach is needed to maximize the synergies implicit in various climate-smart practices (Hailemariam et al, 2016). The questionnaires were administered with the assistance of trained enumerators from both Katsina State Agricultural and Rural Development Authority (KTARDA) and Sokoto Agricultural

Development Project (SADP) to complement field enumerators from the Department of Agricultural Economics and Extension, Federal University Dutsinma in Katsina State.

3.6 Method of Data Analysis

In this study, descriptive statistics were used to analyse the socio-economic characteristics of the farmers. Data were presented in tables and the simple descriptive statistics such as means, proportions, frequency distribution, percentages, chi-square and the Likert scale techniques were used to analyse the constraints on the use of climate smart agricultural techniques, the first objective.

To ascertain factors influencing indicators of climate smart agricultural practices within different crops and livestock enterprises, the second objective, Principal Component Analysis (PCA) and multiple regression analysis using the Ordinary Least Square (OLS) estimation techniques were used with also the verification of the multicollinearity test using the Variance Inflation Factor (VIF).

Meanwhile, while the Foster Greer and Thorbecke (FGT) index which is popular for poverty decomposition as well as the EDE FGT were used to examine the poverty status for low-users and high-users of climate smart agricultural techniques, the third objective.

Moreso, Instrumental Variable (IV)-Probit regression model were used to determine the effects of climate smart agricultural practices on poverty status of farmers, the fourth objective. Lastly, MPI of (2SLS) was used for the fifth objective.

3.7.1 Descriptive Statistics

The socio-economic characteristics were analysed using descriptive statistics which include: means, frequency distribution, percentages, proportion, standard deviation as well as chi-square and paired t-test statistics to measure significant differences between high-users and low-users of CSAP.

3.7.1.1 Paired T-test

According to Landau and Everitt, (2004) a paired t-test is used to compare the means of two populations (high-users and low-users of CSAP) when samples from the populations are available, in which each individual in one sample is paired with an individual in the other sample. The test is used to determine whether the mean difference between two sets of observations is zero. In statistics, a paired difference test is a type of location test that is used when comparing two sets of measurements to assess whether their population means differ. The researcher used the paired t-

test to see the difference between the high-users and low-users of CSAP. If the values of the variables of interest 'y' for the members of the i^{th} pair in groups 1 and 2 are denoted as y_{1i} and y_{2i} , then the differences $d_i = y_{1i} - y_{2i}$ are assumed to have a normal distribution. This study therefore wants to ascertain if there exist a significant difference between high and low users of CSAP by comparing the means of both population which is represented by samples.

The Paired t-statistic is given as:

$$t = \frac{\delta}{s_d / \sqrt{n}} \dots\dots\dots (3.1)$$

where, δ is the mean difference between the paired groups and s_d is the standard deviation of the differences d_i and n the number of pairs. The degree of freedom for examining the null hypothesis is given by $n-1$. Meanwhile the paired T-statistic for a 100 (1- α) % confidence interval can be constructed as shown in the equation (3.2):

$$\delta \pm t_\alpha s_d / \sqrt{n} \dots\dots\dots (3.2)$$

Where t_α is the critical value for a two-sided test with $n - 1$ degrees of freedom was therefore done by ascertaining the statistical difference of frequency of remittance and transaction cost respectively vis-à-vis both transaction channels which can determine the two sided test.

3.7.1.2 Pearson Chi-Square Test for Count Data

The Pearson chi-square test with count data shows estimates between the significant difference between observations that are qualitative or categorical in nature. The Chi-square test also called a "goodness of fit" statistic, measures how well the observed distribution of data fits with the distribution that is expected if the variables are independent. Therefore to investigate the socioeconomic variables for categorical data, the following formula for Pearson Chi-square was used:

$$X^2 = \sum_{i=1}^n \frac{(O_i - E_i)^2}{E_i} \dots\dots\dots (3.3)$$

Where, χ^2 is the Chi-Square computed, 'O' represents the observed frequency, 'E' stands for the expected frequency and 'n' the number of observations. The chi-square value and the degree of freedom is then used to compute the probability value for the decision criteria which- if less than 0.05 considered significant at 5% level of significant and if less than 0.01 then significant at 1% level significant.

3.7.1.3 Model Specification for Likert Scale Techniques

Objective (i) which involved, examining the constraints encountered by the respondents during the process of farming activities was analysed using Likert Scale Technique. To measure the level of constraints facing household farmers using CSAP, Likert scale of five (5) points was implemented. The five points scale was graded as very serious = 5, serious = 4, undecided = 3, not serious = 2 and not very serious = 1.

Osuala, (1982) observed that it is more likely that a researcher would report the mean score on the scale. Based on this grading, the constraints faced by the rural household farmers will be ranked using weighted mean. ($\bar{X}_w$). The weights are assigned to rank responses in order of seriousness; so that the average responses for very serious differ considerably from very un-seriousness.

$$\bar{X}_w = \frac{n_5(5) + n_4(4) + n_3(3) + n_2(2) + n_1(1)}{n} \dots\dots\dots(3.4)$$

Where: $\bar{X}_w$ = Weighted Mean Score of climate smart agricultural farmers.

n = No: of household climate smart agricultural farmers.

The mean score of respondents based on the five points scale is $5 + 4 + 3 + 2 + 1 = 15/5 = 3.0$. Using the interval scale of 0.05, the upper limit cut-off point was $3 + 0.05 = 3.05$; the lower limit is $3 - 0.05 = 2.95$. On the basis of the limit, any mean score below 2.95 (i.e $ms < 2.95$) will be taken as “not serious”, those between 2.95 and 3.05 will be considered “serious” (i.e $2.95 < ms \leq 3.05$), while any means score that is greater than or equal to 3.05 (i.e ≥ 3.05) will be considered “very serious”.

3.7.2 Models Employed to Ascertain Objective Two

The second objective was ascertained with the help of multiple regression techniques using the OLS model estimation methods. Additionally, some definite assumptions must be verified to ensure reliability and robustness of estimated parameters. However, assumptions that pertain more to cross sectional analysis like this one, include multicollinearity and heteroscedasticity. Multicollinearity was used to examine the second objective with the help of Variance Inflation Factor (VIF), while the heteroscedasticity was automatically catered for by the Stata software using the robust option when regressing the model analysis. Multicollinearity is a phenomenon or a situation in which the predictors or independent variables in the multiple regression model are highly correlated or highly linearly related with the explanatory variables while heteroscedasticity is a phenomenon or a situation in which the variance in an error term changes as a response to

changes in the explanatory variable. The VIF measure how much the variance of the estimated regression coefficients are inflated as compared to when the predictor variables are not linearly related. It is used to explain how much amount multicollinearity (correlation between predictors) exists in a regression analysis.

To determine the factors influencing indicators of CSAP within different crops and livestock enterprises, the socioeconomic characteristics are regressed against composite dependent variables, the use of climate smart agricultural techniques in crops/livestock enterprises and the crops which include maize, sorghum, millet and groundnut enterprises. The PCA was used to compute the composite dependent variables that will be estimated with a multiple regression model. The PCA was used to generate the composite variable for the use of CSA for each of the enterprises, namely: maize, sorghum, millet, groundnut and livestock (goat, sheep, cattle, donkey and camel were combined). The PCA as specified by Ifelunini et al, (2013) is presented thus: Given variables (Xs represent the various factors used to develop each of the five composite indices - maize, sorghum, millet, groundnut and livestock) $X_1, \dots, X_p$ measured in ‘n’ farmers, while $Z_1, \dots, Z_p$ are the principal components which are uncorrelated linear combinations of the original variable, $X_1, \dots, X_p$, given as:

$$\begin{aligned} Z_1 &= \alpha_{11}X_1 + \alpha_{12}X_2 + \dots + \alpha_{1p}X_p \\ Z_2 &= \alpha_{21}X_1 + \alpha_{22}X_2 + \dots + \alpha_{2p}X_p \\ &\vdots \\ Z_p &= \alpha_{p1}X_1 + \alpha_{p2}X_2 + \dots + \alpha_{pp}X_p \end{aligned} \dots\dots\dots (3.5)$$

The matrix of equations can be expressed as $z = Ax$, where $z = (Z_1 \dots Z_p)$, $x = (X_1 \dots X_p)$ and ‘A’ is the matrix of coefficients. The coefficients of the first PCA, $\alpha_{11} \dots \alpha_{1p}$, are chosen in such a way that the variance of Z_1 is maximised subject to the constraint $\alpha_{21} \dots \alpha_{2p} = 1$. The five composite variables are derived using the Principal Component Analysis (PCA) that are regressed against the socio-economic characteristics. The multiple regression model analysis is specified thus:

$$Y_{ij} = \beta_0 + \sum_{i=1}^{20} \beta_{ij}X_{ij} + \varepsilon_{ij} \dots\dots\dots (3.6)$$

Where Y_{ij} represents the dependent variables (the two composite CSA variables for different crop and livestock enterprises as dependent models), β_0 represents the intercept, β_i the coefficients of the independent variables, X_i the independent variables listed above and ε_i the stochastic or error

term. The PCA was used to generate the composite variable for the use of CSA for each of the enterprises, namely: maize, sorghum, millet, groundnut and livestock (goat, sheep, cattle, donkey and camel were combined). Thereafter, these composite variables were organised as dependent variable in order to analyse their correlates. The composite indices were constructed from six CSAP, which are the use of organic manure, agro-forestry, and conservation agriculture, use of improved hybrids, integrated crop/livestock management and irrigation. The analyses were carried out for crops and livestock enterprises separately. Y_{ij} is the composite variable for crop CSA indices, X_{ij} are the independent variables defined in Table 3.1 and ε_{ij} is the stochastic error term.

Table 3.1: A Priori Expectation for Regression Model Based on Factors Influencing the use of CSA in Crops Enterprise

Variables	Category	Coding System	Expected Sign	References
Age	continuous	Number in years	-/+	Akinyemi et al., (2009)
Sex	dummy	1 if male, 0 if not.	-/+	Okeke and Onogwu, (2014)
Educational level	dummy	1 educated in Arabic, 0 if not.	+	Isaac, (2009)
Marital status	dummy	1 if married, 0 if not.	+/-	Zitha, (2007)
Religion	dummy	1 if Muslim, 0 if not.	+/-	Macaulay, (2014)
Household size	continuous	Member of households	+/-	Makhura, (2001)
Farm size	continuous	Number in hectares	+/-	Nambuya et al., (2005)
Experience	continuous	Number in years	+	Nil
Ownership of farm land	dummy	1 if yes, 0 if not.	-/+	Nil
Land acquisition	dummy	1 if inherited, 0 if not.	+	Nil
Type of labour	dummy	1 if both, 0 if not.	+/-	Nil
Membership of association	dummy	1 if yes, 0 if not.	+	Nil
Means of transportation	dummy	1 if animal, 0 if not.	+/-	Nil
Housing material	dummy	1 if block zinc house, 0 if not.	-	Stephen, (2010)
Communication kit used	dummy	1 if GSM, 0 if not.	+/-	Okediji, (2014)
Extension contacts	continuous	Number of contacts	+/-	Nil
Lack of access to credit	dummy	1 if access, 0 if not.	+	Oni et al., (2009)
Lack of time to practice CSA	dummy	1 if have time, 0 if not.	-	Okulona and Ikuomola, (2010)

States	dummy	1 if Katsina, 0 if Sokoto	+/-	Saiful, (2014)
Expenditure	continuous	Total expenditure	+/-	Nil

For the livestock model, ε is the stochastic error term

Table 3.2: A Priori Expectation for Regression Model Based on Factors Influencing the use of CSA in Livestock Enterprise

Variables	Category	Coding System	Expected Sign	References
Educational level	dummy	1 if informal Koranic education, 0 if not.	+	Ofuoku and Isife, (2009)
Religion	dummy	1 if Muslim, 0 if not.	+	Nil
Household size	continuous	Number of siblings	+/-	Nil
Farm size	continuous	Number in hectares	+	Philips, (2010)
Land acquisition	dummy	1 if inherited, 0 if not.	+	Nil
Type of labour	dummy	1 if both, 0 if not.	+/-	Nil
Membership of association	dummy	1 if yes, 0 if not.	+	Nil
Communication kit used	dummy	1 if GSM, 0 if not.	+/-	Adamu and Odion, (2000)
Extension contacts	continuous	Number of contacts	+/-	Philip et al, (2009)
Lack of access to credit	dummy	1 if access, 0 if not.	-	Nil
Lack of high quality breeds	dummy	1 if high quality, 0 if not.	-	Philip et al, (2009)
Lack of time to practice CSA	dummy	1 if have, 0 if not.	-	Nil
Lack of processing technology	dummy	1 if have, 0 if not.	-	Nil

3.7.3 Model Specification for Objective Three

The third objective was to analyse the decomposition of poverty using Foster Greer and Thorbecke (FGT) Index and Equal Distribution Equivalent (EDE). These approaches have various advantages and were therefore used to see if the results will be consistent across all the methods. The most popular of them is however the Foster, Greer and Thorbecke, (1984) decomposition method which is widely known as the FGT poverty measurement technique that examines the proportion of poor people amongst farmers who are high-users of CSA and those who are low-users of CSA as well as the poverty gap and the severity of poverty among the farmers.

The study employs two indices as monetary (income) dimensions: per capita expenditure and food expenditure dimension, (total household expenditure divided by household size). Employing per

capita expenditure and food expenditure dimensions of poverty, enables the study to compare the decompositions of general poverty and food poverty. The FGT and Equally Distributed Equivalent (EDE) were employed to decompose the monetary dimensions of poverty also in an effort to ensure that results are not subjective to the type of method used. Poverty decomposition methods necessitate the use of poverty lines. A poverty line has been defined as the least or the cut-off standard beneath which an individual or family is labelled as poor (Anyanwu, 1997). According to FOS, (1999) and Canagarajah and Thomas, (2001) poverty line in Nigeria is not fixed and as such numerous previous studies have used poverty lines which are proportions of the average per capita expenditure, in this study per capita expenditure which is considered more suitable in past studies because of its consistency (reliability) and does not change over a period of time when compared to income. Therefore, the poverty line was well-defined as the two-thirds (2/3) of the mean value for each of the dimensions. Relatedly, Durojaiye, (1995) and World Bank, (1996) characterised farming households into poor and non-poor groups using the two-third mean per capita expenditure as the benchmark. This arbitrary poverty line is not too biased considering that the focus of this study is in comparing the poverty rates between high-users and low-users of CSA. For each dimension, they are grouped into two categories: poor and non-poor on the bases of the poverty line. These decomposition methods are discussed as follows:

The FGT index is given as

$$FGT_{\alpha} = \frac{1}{N} \sum_{i=1}^H \left(\frac{z - y_i}{z} \right)^{\alpha} \dots\dots\dots (3.7)$$

Where:

N = Total number of respondents, i.e. household sampled

H = Number of respondents below the poverty line, i.e. poor people

z = the poverty line or threshold

y_i = Per Capita Household Expenditure of the ith respondent

α = Non-negative poverty aversion parameter (0, 1 or 2)

That is y_i = (y₁, y₂... y_n) which represents the income vector of the farmers both high-users and low-users of CSA with incomes sorted in collective order of magnitude. 'z' is the poverty line which can be used to decide the level of poverty status of the high-users and low-users of CSA, 'H' is the number of poor individuals, 'N' is the total number of individuals in the population under study, 'α' is a weighting parameter that can be regarded as a measure of poverty aversion

and is the most important because it is the index that makes this formula vary in measuring headcount, poverty gap and the severity of poverty. The FGT index takes on the values 0, 1 and 2 for headcount, poverty gap and severity respectively. The head count index is advantageous in that it is simple to construct and easy to understand.

Meanwhile EDE FGT is estimated as:

$$\text{EDE P} = \left[\frac{1}{N} \sum_{i=1}^q \left(\frac{z - y_i}{z} \right)^\alpha \right]^{\frac{1}{\alpha}} \equiv \left(P^{\frac{1}{\alpha}} \right); \text{ for } \alpha > 0 \dots \dots \dots (3.8)$$

EDE FGT is the Equally Distributed Equivalent form of FGT. EDE FGT applies only when $\alpha = 1$ and $\alpha = 2$. This means that it does not measure head count as is the case with the FGT index.

According to Levine et al., (2012) the multidimensional index by Alkire and Foster is made up of two components: the poverty headcount, ‘H’, and an adjustment measure, ‘A’ that represents the number of deprivations suffered, on average, by the poor.

$$\text{MPI} = H \times A \dots \dots \dots (3.9)$$

$$\text{Therefore : } H = \frac{q}{n} \dots \dots \dots (3.10)$$

Where : q = The number of respondents below the poverty line,
n = The total number of respondents sampled.

3.7.4 Model Specification for Objective Four and Five

The Instrumental Variable (IV) - probit regression model was used to ascertain the fourth objective which is to examine the effect of CSAP on poverty status of the rural farmers. The PCA was used to develop composite indices for the practice of CSA which includes: the use of organic manure, agro-forestry, conservation agriculture, integrated crops and livestock management, the use of improved varieties/hybrid of crops/animals and the use of irrigation for smallholder farmers. The Probit function follows a normal distribution. Following the assumptions of the normal distribution where Z_i is the standard normal variable, β_1 is the intercept and β_2 the coefficient of x , while ‘ x ’ represents explanatory variables and $Z \sim N(0, \sigma^2)$, I_i is the unobserved index also known as the latent variable which is determined by the stated explanatory variables (such that, the larger value of I_i , greater the probability of being poor) and ‘F’ is the standard cumulative distribution frontier, which could be written as;

$$F(I_i) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{I_i} e^{-\frac{z^2}{2}} dz \approx \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\beta_1 + \beta_2 X_i} e^{-\frac{z^2}{2}} dz \dots\dots\dots (3.11)$$

Where $I_i = F^{-1}(I_i) = \beta_1 + \beta_2 X_i$

Then to be able to examine the effects of CSA on the probability that a household is poor, we estimate.

$$\frac{dP_i}{dX_i} = f(\beta_1 + \beta_2 X_i) \beta_2 \dots\dots\dots (3.12)$$

dP_i = Differential for the dependent variable

dX_i = Differential for the explanatory variable

f = Standard cumulative distribution frontier

β_1 = Intercept

β_2 = Coefficient

X_i = Explanatory variable

Extending the model and including other socioeconomic variables: use of CSA dummy (ucsad), age, (age), dummy for sex (dsex), dummy for education (deduc), dummy for marital status (dmats), households size (hhsz), farm size (fsz), experience (exp), dummy for ownership of farmland (downfl), dummy for land acquisition (dlq), dummy for type of labour (tlab), dummy for membership of association (dmas), dummy for transportation (dtrns), dummy for housing materials (dhmtrl), dummy for communication (dcomctn), dummy for access to credit (dacc) and dummy for States (dstate). Then the instrumental variables include lack of access to CSA, sources and use of water from borehole for drinking and quantity of millet per yield. The Instrumental variable model was therefore estimated based on the following equations. For each of the crops and livestock climate smart agricultural generated indexes under consideration. All five dimensions were regressed based on the specification as follows:

$$Y_i = \beta_0 + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 \dots\dots X_n\beta_n + \epsilon_i \dots\dots\dots (3.13)$$

$$ucsad = \alpha_1 lacsapi + \alpha_2 suwbd_i + \alpha_3 qymilpyield_i + \mu_i \dots\dots\dots (3.14)$$

Where pov_i represents monetary poverty wherein 1 is assigned to respondents with monthly income less than US\$1.9 and 0 otherwise. The use of CSA dummy is regressed independently in

six estimations for the production of maize, millet, sorghum, groundnut, livestock and crop/livestock.

Table 3.3: A Priori Expectation for Binary Regression Model Based on the Effect of CSA on Poverty Status

Variables	Category	Coding System	Expected Sign	References
CSA Indices	dummy	1 if high users, 0 otherwise	-/+	James et al., (2013)
Age	continuous	Number in years	-/+	Sokoya, (2006)
Sex	dummy	1 if male, 0 if not.	-/+	Nil
Educational level	dummy	1 educated in Arabic, 0 if not.	+	Prasad et al., (2006)
Marital status	dummy	1 if married, 0 if not.	+/-	Aliyu et al., (2016)
Household size	continuous	Member of households	+/-	Mathonze, (2000)
Farm size	continuous	Number in hectares	+	Sadiq et al., (2015)
Experience	continuous	Number in years	+/-	Asogwa et al., (2012)
Ownership of farm land	dummy	1 if yes, 0 if not.	-/+	Nil
Land acquisition	dummy	1 if inherited, 0 if not.	+	Nil
Type of labour	dummy	1 if both, 0 if not.	+/-	Nil
Membership of association	dummy	1 if yes, 0 if not.	+	Agbamu, (2006)
Transportation	dummy	1 if animals, 0 if not	+-	Nil
Housing materials	dummy	1 if concrete/block zinc, 0 if not	+-	Devendra and Chantalakhan a, (2002).
Communication kits	dummy	1 if GSM, 0 if not	+-	Johnson, (1999)
Access to credit	dummy	1 if access, 0 if not.	+	Nil
States	dummy	1 if Katsina, 0 if Sokoto	+/-	NBS, (2013)

3.7.4.1 The Global Multidimensional Poverty Index

In addition, multidimensional poverty assessments aim to measure the non-income based dimensions of poverty, to provide a more comprehensive assessment of the extent of poverty and deprivation. The Global Multidimensional Poverty Index (MPI) was developed in 2010 by the Oxford Poverty and Human Development Initiative (OPHI), and the United Nations Development Programme and it uses different factors to determine poverty beyond income-based lists. It replaced the previous Human Poverty Index. OPHI describes the MPI as a high resolution lens on poverty: it can be used as an analytical tool to identify the most prevailing deprivations. To measure acute poverty, the study looked at the proportion of people who experienced multiple deprivations and the intensity of such deprivations. The MPI is a very versatile methodology that can be readily adjusted to incorporate alternative indicators, cut-offs and weights that might be appropriate in regional, national, or subnational contexts (Alkire and Santos, 2010).

Where MPI represents multidimensional poverty indices wherein 1 is assigned to respondents with monthly income less than US\$1.9 and 0 otherwise. The use of CSA dummy is regressed independently in three estimations for crops, livestock and crops/livestock enterprises.

The utilization of multidimensional poverty index of two stage least square (2SLS) to ascertain the effect of CSAP on the multidimensional poverty index of the respondents in the study area. The post-estimation tools for the multi-dimensional poverty index of 2SLS identified the selected instrumental variables such as expenditure on inorganic manure, education and State to be strong and not weak which can give an expected good result, to instrument CSA for crops, livestock and crop/livestock enterprises. CSA for crops, livestock and crop/livestock enterprises are the key independent variables in each of the three scenarios for testing the effect of CSAP on the multidimensional poverty index of the respondents in the study area, while in contrast, the MPI was developed to be the dependent variable in the regression model. Additionally, CSA for crops, livestock and crop/livestock as the key independent variables which are quantitative variables that have been achieved with the aid of the PCA.

Extending the model and including other socioeconomic variables: use of CSA dummy (ucsad), age (age), dummy for sex (dsex), dummy for marital status (dmats), religion (rel), households size (hhsz), farmsize (fsz), experience (exp), dummy for ownership of farmland (downfl), dummy for land acquisition (dlaq), dummy for type of labour (tlab), dummy for membership of association (dmas), dummy for transportation (dtrnsp), dummy for housing materials (dhmtrl), dummy for communication (dcomctn), number of extension contacts (nextc) and dummy for access to credit

(dacc). Then the instrumental variables include State, education, and expenditure on inorganic manure. The Instrumental variable model was therefore estimated based on the following equations. For each of the crops and livestock climate smart agricultural generated indexes under consideration. All three dimensions were regressed based on the specification as follows:

$$Y_i = \beta_0 + X_1\beta_1 + X_2\beta_2 + X_3\beta_3.....X_n\beta_n + \epsilon_i \quad \dots\dots\dots (3.15)$$

$$ucsad = \alpha_1state_i + \alpha_2dmedu_i + \alpha_3expinorgnicm_i + \mu_i \quad \dots\dots\dots(3.16)$$

Where μ_i represents multidimensional poverty index wherein 1 is assigned to respondents with monthly income less than US\$1.9 and 0 otherwise. The use of CSA dummy is regressed independently in three estimations for the production of crops, livestock and crops/livestock.

Table 3.4: A Priori Expectation for MPI Model Based on the Effect of CSA for Crops/livestock Enterprises

Variables	Coding System	Category	Expected Sign	References
CSA Indices	1 if high users, 0 otherwise	dummy	-/+	
Age	Number in years	continuous	-/+	Rogers, (2003)
Sex	1 if male, 0 if not.	dummy	-/+	Nil
Marital status	1 if married, 0 if not.	dummy	+/-	Nil
Religion	1 if Muslim, 0 if no	dummy	+/-	Apata and Awe, (2014)
Household size	Number of siblings	dummy	+/-	Nil
Farm size	Number in hectares	continuous	+	Nil
Experience	Number in years	continuous	+/-	Nil
Ownership of farm land	1 if yes, 0 if not.	dummy	-/+	Eze et al, (2011)
Land acquisition	1 if inherited, 0 if not.	dummy	+	Nil
Type of labour	1 if both, 0 if not.	dummy	+/-	Nil
Membership of association	1 if yes, 0 if not.	dummy	+	Franklin and Patience, (2014)
Transportation	1 if animals, 0 if not	dummy	+/-	Nil
Housing materials	1 if concrete/block zinc, 0 if not	dummy	+/-	Jadhav et al, (2011)
Communication kits	1 if GSM, 0 if not	dummy	+/-	World Bank, (2006)
Extension contacts	Number of contacts	continuous	-	Nil
Access to credit	1 if access, 0 if not.	dummy	+	Nil

The Instrumental variables of two stage least square (2SLS) estimation is used when the model has an endogenous variables ($Y = \beta_0 + \beta_1 X + u$). The instrumental variable can be used to address the problem of omitted variable bias. In order for a variable z , to serve as a valid instrument for x , the following must be true: The instrument must be exogenous, that is $\text{cov}(z, u) = 0$ and the instrument must be correlated with the endogenous variable x , that is $\text{cov}(z, x) \neq 0$. The general concept is that of the instrumental variables estimator, a popular form of that estimator, often used in the context of endogeneity is known as two stage least square (2SLS). A weak correlation between x and z will bring a sizable bias in the estimator. If there is any correlation between z and u , a weak correlation between x and z will render instrumental variable estimates inconsistent. Although, the researcher cannot observe the correlation between z and u , we can empirically evaluate the correlation between the explanatory variable and its instrument. It should also be noted that an R^2 measure in the context of the instrumental variable estimator is not the percentage of variation explained measure that we are familiar within OLS terms.

3.8 Validity and Reliability

The face validity of the questionnaire was done by a panel of specialists in Agricultural Economics and Extension in order for them to judge the extent to which the instrument measures the highlighted issues regarding CSA and poverty, coupled with the rate at which they conveyed the intended meaning to the farming households. To ensure the reliability of the questionnaire, a split half technique was used to determine the reliability of the instrument. A high reliability coefficient of $r = 0.83$ was derived which showed the instrument was consistent and highly reliable.

3.9 Ethical Considerations

Observations and face-to-face interviews were used to collect data for the study. Interviewees were fully informed of the aims and objectives of the study. Participation was voluntary and interviews were only conducted after oral consent had been obtained not by coercion. Households were approached to obtain consent to carry out research on their premises. All documents and information that were provided by the respondents were kept confidential, and only used for the purpose of this study. As was the case for other vulnerable population groups, there was a need for increased guidance for the ethical conduct of research. This will not only have implications for the people that are being studied, but will also affect the quality of the results being obtained.

3.10 Limitations of the Study

1. There was a deficiency and lack of proper record keeping by the household farmers and as result of this, it was a serious challenge in the course of this research as most of the respondents rely solely on memory recall, hence to minimise error, information on relevant variables were strictly used in this study.
2. The issue of general ability and capacity of the research work, large population randomly sampled size was used, and therefore making the data representative and sufficiently robust to all rural households in the villages, Districts and local government level. This aimed at drawing a general conclusion about the whole processes in the study area.
3. The problems of finance, ethics and time frame were all serious constraints to this research. However, the Author received assistance from North West University, my place of duty. More energy and time were devoted to data collection than the budgeted period in the research time frame.
4. Finally, as a result of all the above challenges and limitations, the output of the research work is worthwhile and greatly reliable.

3.11 CONCLUSION

This chapter has presented an in-depth explication on the research methodology, which includes the data collection procedure and design adopted for this study. Data was collected from the households in the study area, North-West Nigeria. The sampled primary data significantly enabled the development of the appropriate models for CSAP and the poverty status of farmers in the study area. A questionnaire was designed as a tool for data collection. The collected data was coded and entered into Microsoft excel and later transferred to SPSS and Stata for proper analysis through the use of Stata command.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 INTRODUCTION

This chapter presents the results of the analysed data. The chapter covers information on socioeconomic and demographic characteristics, as well as sources/access to water, sources of credit and constraints to climate smart agricultural activities. In addition, the chapter highlights the nature of the utilised sampled data, besides providing and outlining the rationale for the behaviour of some variables as discussed in the interpretation of subsequent results.

4.1 Socioeconomic Characteristics of Respondents in Katsina and Sokoto States

This section is dedicated to the examination of the socioeconomic characteristics of respondents. Summary statistics such as means, percentages, t-tests and chi-square tests were employed to fully understand the socio-economic characteristics of the farmers.

4.1.1 Respondents' Distribution According to Quantitative Variables Employed

Table 4.1 shows the analysis of socio-economic characteristics of the actual variables in relation to farmers who practice CSA in the study area. Considering the actual (continuous) variables for Katsina State, Sokoto State and the pooled data, the high-users of CSA were more in Katsina State than Sokoto State while the low-users of CSA were more in Sokoto State than Katsina State. Nevertheless, there was no significant difference between high-users and low-users across household sizes in Sokoto State and for the whole samples. Other variables were not significantly different between high-users and low-users of CSA as shown by the t-test table. Furthermore, the mean average age of high-users of CSA in Katsina State was 54.6 years old but that of Sokoto State was 51.7 years. This shows that more experienced farmers are into CSAP in Katsina State than Sokoto State which had lower average age. These results aligned with that of experience variable wherein, average mean for high-users of CSAP in Katsina State (27.44 years) was higher than that of Sokoto State which was (24.64) years.

The summary of the statistics revealed that the average mean age was 53 years for both high-users and low-users of CSAP in the study area. Additionally, in terms of expenditure, high-users of CSA had consistently higher expenditure amounts for both Katsina and Sokoto States. The survey suggested that, high-users of CSA spent much more than low-users of CSA. This result apparently supports the findings of Fanen and Adekola (2014) that, there was a wide outcome disparity among the participants of the climate smart agricultural practitioners in Nigeria. This might be due to the fact that the operational level of each farmer differs. The results equally evinced that average farm

size for both States when combined was higher for high-users of CSAP in relation to low-users, though the t-value indicated that this difference was not significant. This scenario was replicated in Sokoto State, contrasting the result recorded in Katsina State, given that in Katsina State, low-users had a higher average farm size than high-users, but again the difference was not significant. Again, average experience was marginally higher for high-users than low-users of CSA, and not significantly different from each other in both States. Katsina State exhibited the same trend with higher experience average for high-users while Sokoto demonstrated higher experience average for low-users of CSA. The results of the analysis also indicated that, the average number of extension service contact was approximately two (2) which is inadequate, especially considering the large population in the North-West Nigeria and the international standard best practices. According to Adetunji, (2013) extension contact in Nigeria is gradually diminishing owing to non-compliance of government to the primary demand of the farmers.

Table 4.1: Summary Statistics of Socioeconomic Characteristics for Actual Variables

Variable	Katsina State		Sokoto State		Pooled		
	Mean high-users n= 127	Mean low-users n = 20	Mean High-users n = 93	Mean low-users n = 54	Mean High-users n = 220	Mean low-users n = 74	t-value (p-value)
Age (yrs)	54.57 (9.51)	52.89 (9.16)	51.67 (8.38)	53.00 (7.90)	52.90 (8.97)	52.92 (8.78)	0.02 (0.98)
Household size (No:)	9.97 (2.29)	8.89 (3.06)	8.24 (2.83)	8.25 (2.83)	8.97 (3.00)	8.72 (3.00)	-0.64 (0.52)
Expenditure (₦)	34,274 (11,523.26)	31,299 (13,698.28)	33,153 (12,986.84)	30,050 (13,007.99)	33,627 (13,374.40)	30,961 (13,438.24)	-1.57 (0.12)
Farm Size (ha:)	7.18 (3.35)	7.45 (3.40)	7.73 (2.99)	6.70 (2.76)	7.50 (3.15)	7.25 (3.24)	-0.59 (0.56)
Experience (years)	27.44 (9.23)	25.67 (8.10)	24.64 (8.39)	26.00 (8.50)	25.82 (8.84)	25.76 (8.15)	-0.06 (0.96)
Extension contacts (No:)	1.59 (1.11)	1.93 (1.43)	1.73 (1.02)	1.75 (1.16)	1.67 (1.06)	1.88 (1.35)	1.34 (0.18)

Source: Field Survey Data (2016) P-Values in bracket and SD in Parenthesis

4.1.2 Respondents’ Distribution According to Gender

The results on Table 4.2 further show that male were more involved in CSAP than female. These results signified that majority (94%) of the respondents were male, while 6% were female. As such, the implication drawn from the investigation is that, there were conspicuously more male farmers practising CSA than their female counterparts in the study area. Therefore male dominated the CSAP. This wide-gap distribution could be attributed to the religious and cultural beliefs in the study area which are not favourable to women. Evidently, socio-cultural and religious values disfavour women, especially in northern Nigeria, where the ‘Purdah’ system is more pronounced (Ojo, 2010 and Adereti, 2005).

Consequently, the result harmonises with the design of household leadership in Nigeria. Similarly, the result corroborates Mtsor and Idisi, (2014) findings; they reiterated that the participation of women in agriculture is very low in some parts of northern Nigeria because of the values and traditions of the people coupled with the religious upholding. Also, Oduwole and Fadeyi, (2013) asserted that ignorance and lack of exposures were the main causes of women indifference to agricultural activities. However, effective sensitization and education can be antidotes to these gender disparity and low involvement.

Table 4.2: Disaggregation of Climate Smart Agricultural Users by Sex

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Sex	Male	119	18	88	50	207	68	275	93.54
	Female	8	2	5	4	13	6	19	6.46
Total								294	100

Source: Field Survey Data (2016).

4.1.3 Respondents’ Distribution According to Educational Level

The practice of CSA can be enhanced by a sound educational attainments of respondents. The levels of education play an important and prominent role in economic development and skill acquisition. It enhances one’s ability to understand and apply new ideas, technological innovations as well as his or her ability to plan and take risk. The results showed that all the respondents were knowledgeable, having one form of education or the other. The result revealed that 56% of the

respondent had Arabic education, 20% had primary education, and 14% had attended secondary school, while 10% had tertiary education. There was no farmer without some level or form of education, although the Arabic education was an informal type of education which every household was expected to attain in the study area being an Islamic environment. This result tallied with Oluade and Seriki's (2013), which reported that majority (57%) of the respondents had only informal education. Accordingly, Appleton and Balihuta, (1996) stated that, it is essential for a farm manager to go through a four-year basic formal education, irrespective of gender. They found out that, education of at least four years of formal schooling engaged in by the investigated farm manager did raise production by 7%. Therefore, the level of education may influence the performance of the respondents if acquired formally. Relatedly, Appleton and Balihuta's (1996), submission maintained a parallel with this current research, because the high-users of CSAP are those who are literates in primary, secondary and tertiary education, than those who had Arabic education. Palpably, this low formal educational level prevalent in the study area is one of the major factors responsible for high-rate of poverty in the area (Aremu, 2011). The importance of education in the process of using CSAP cannot be overemphasised, because according to Adeyemo et al, (2005) education improves the quality of labour and ability to evaluate information which can also expose the farmers to more opportunities and production profitability.

Table 4.3: Disaggregation of Climate Smart Agricultural Users by Education

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Education	Arabic education	66	12	54	32	120	44	164	56
	Primary education	26	5	16	12	42	17	59	20
	Secondary education	23	2	10	5	33	7	40	14
	Tertiary education	12	1	13	5	25	6	31	10
Total								294	100

Source: Field Survey Data (2016)

4.1.4 Respondents' Distribution According to Marital Status

Marital status is classified in this study into five categories: polygamous marriage, monogamous marriage, divorce, single and widow categories. The illustration on marital status distribution presented in Table 4.4 indicates that majority (57%) of the respondents were in a polygamous marriage. 38% were monogamously married giving a total number of married people to be 95% while 2% were divorced, 1% were single and 2% widows. This result showed a parallel with the findings of Umar, (2009) which reported that majority (97%) of sesame organic farmers (CSA) were married. The result implied that majority of the respondents were married in a polygamy form of marriage which was in tune with the religious and cultural beliefs attached to marriage in the study area, however it doubles as a source of increase in labour. It could also imply that majority of the respondents were married probably due to the importance attached to marriage institution in the study area which was a symbol of responsibility and respect in the community hence such responsible farmers can advise others who had respect for them. In this study, the married both monogamy and polygamy system of marriage seems to contributed much to the CSAP than those who are not married hence, it is ideal to encourage the farmers in the study area to get married in order to enhance agricultural productivity.

Table 4.4: Disaggregation of Climate Smart Agricultural Users by Marital Status

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Marital status	Married monogamy	54	12	29	16	83	28	111	38
	Married polygamy	69	6	62	32	131	38	169	57
	Divorced	3	0	0	3	3	3	6	2
	Singled	0	1	1	1	1	2	3	1
	Widowed	1	1	1	2	2	3	5	2
Total								294	100

Source: Field Survey Data (2016)

4.1.5 Respondents' Distribution According to Religious Affiliation

Table 4.5 shows the distribution of respondents in accordance with religious membership. The results show that 8% were Christians while 91% were Muslims and Traditional worshipers attracted just a quotient of 1%. The high proportion of the Muslims in the study area was obviously because of the location of the study area which was situated in the North-West of Nigeria and is predominantly Muslim communities, given that Islam came into the country through the northern region. This result agreed with the findings of Hassan et al., (2015) which stated that, most of the respondents were Muslims, specifically 69% in his study.

Table 4.5: Disaggregation of Climate Smart Agricultural Users by Religion

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Religion	Christian	12	3	7	1	19	4	23	8
	Muslim	113	15	86	53	199	68	267	91
	Traditional religion	2	2	0	0	2	2	4	1
Total								294	100

Source: Field Survey Data (2016)

4.1.6 Respondents' Distribution According to Land Ownership

Farmland ownership refers to the area or location of land portion owned by the farmers for his/ her farm activities. The investigation, as presented in Table 4.6 showed that 94% of the respondents owned the land they are using for farming activities while 6% did not. From the foregoing, it is obvious that most of the respondents are land owners and consequently have access to the land because they were inherited through their parents from their ancestors and also because some of them purchased the land as shown in this particular study. Subsequently, there is a correspondence with Enujeke and Ofuoku's (2012), findings that majority (62%) of the farming households are more or less landlords than tenants. It is significant to note that about 70% of the respondents who are the land owners were high-users of CSAP as expected, so, it is apparent that ownership propels farmers to manage the land carefully and sustainably.

Table 4.6: Disaggregation of Climate Smart Agricultural Users by Farm-land ownership

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Farm-land ownership	Yes	120	20	86	51	206	71	277	94
	No	7	0	7	3	14	3	17	6
Total								294	100

Source: Field Survey Data (2016)

4.1.7 Respondents' Distribution According to Land Acquisition

Table 4.7 shows that farm land ownership are acquired through many processes which include: inheritance, purchase, as a gift or rent by the landlords. The result proved that 68% of the farm land owned by the respondents are acquired through inheritance while, 20% are acquired by purchase, 6% of the farmland are acquired via gifts and 6% as rent. This implied that, most of the farm lands were acquired through inheritance rather than being bought or sold out for other usage. Hence this can lead to land fragmentation among the locals as the population increases. This shows that those who acquired their land through inheritance are found to used CSAP more than those who acquired their own land through other means may be, because much vast available land via inheritance without spending much to acquire the land hence, have enough resources to invest into the CSAP. This result equally substantiated Umar's (2009) work, which postulated that majority (85%) of sesame organic (climate smart agriculture) farmers acquired their farmland through inheritance.

Table 4.7: Disaggregation of Climate Smart Agricultural Users by Land Acquisition

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Land acquisition	Rent	6	2	6	4	12	6	18	6
	Inherited	88	12	63	38	151	50	201	68
	Purchased	26	4	22	7	48	11	59	20
	Gift	7	2	2	5	9	7	16	6
Total								294	100

Source: Field Survey Data (2016).

4.1.8 Respondents’ Distribution According to Major Sources of Labour

As presented in Table 4.8. 10% of the respondents acquired their labour from their families, while 21% of the respondents hired other labourers who were not their family members; while in contrast, 69% used both family and hired labourers. The employment of both family and hired labourers probably hinged on the fact that the farm sizes are usually very large as evident in the average mean farm size of about 7.5 ha. Ipso facto, family labour might not suffice, and therefore the need for hired labourers. This means that, the greater proportion of CASP were been carried out by households that practice both family and hiring labourers. In like manner, the result equalled the findings of Adedeji et al, (2013). They confirmed a high support of the family labour in agricultural production, aside emphasising the negative effect of using child labour and its future detrimental consequences both in the agricultural and socioeconomic status of the nation. In addition, Oluranti et al, (2016) also obtained similar results and explained that the poverty status of the family was the determining factor that demonstrated how effective family labour was utilised in the rural farming households. However, they argued that the composition of the hired and family labour can be more useful in the polygamous setting which characterised Nigerian rural areas particularly in the northern region.

Table 4.8: Disaggregation of Climate Smart Agricultural Users by Sources of labour

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Type of labour	Family	9	2	9	8	18	10	28	10
	Hired	26	3	23	11	49	14	63	21
	Both	92	15	61	35	153	50	203	69
Total								294	100

Source: Field Survey Data (2016)

4.1.9 Respondents’ Distribution According to Membership of Association

Table 4.9 illustrates the disaggregation of membership of an association which refers to a group aimed at cooperating and helping one another in terms of agricultural and financial needs of individuals in the association. The result showed that 53% of the respondents did not belong to any group or association while 47% of the respondents belonged to an association. This implied

that most of the farmers did not belong to any association probably because of mismanagement of resources and corruption of the leaders holding positions in the various leadership offices (portfolio) in the association. This shows that those who are members of one society or the other are found to used CSAP more than those who are not members of any association. And this results maintained a parallel with Obayelu, (2010) which submitted that membership of an association was lower (40%) in North-West Nigeria. Nonetheless, it is imperative for farmers to belong to associations because it creates a forum for information sharing and networking among the farmers.

Table 4.9: Disaggregation of Climate Smart Agricultural Users by Membership Association

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Membership association	Yes	73	8	40	18	113	26	139	47
	No	54	12	53	36	107	48	155	53
Total								294	100

Source: Field Survey Data (2016)

4.1.10 Respondents’ Distribution According to Major Means of Transport

Table 4.10 presents the distribution of farmers’ means of transportation which involved the moving of inputs and products from one place to another. This result depicted that 9.2% of the respondents used bicycle as means of transportation, while 46.3% of the respondents used motorcycle, also 21.8% of the farmers used cars and 10.5% of the respondents used animals as their means of transportation. Those who used CSAP are found to own motorcycle as their major means of transportation. The inference gathered from the evident greater utilisation of motorcycle as means of transportation is as a result of its ease of usage in the rugged terrain of farming; thereby maintaining an equivalent report with Adedeji et al., (2013). They equally observed that majority of rural farmers are poor because of their subsistent nature of farming which was characterised with low income and hence limitation to better means of transportation. It is important to underscore that the means of transportation employed could constitute a bottleneck to farming activities in general and CSAP in particular.

Table 4.10: Disaggregation of Climate Smart Agricultural Users by Means of Transportation

Variable	Categories	Katsina State	Sokoto State	Both States		Pooled		(%)	
		High - users	Low - users	High - users	Low - users	High - users	Low- users		
Means of transportation	Bicycle	11	0	7	9	18	9	27	9
	Motorcycle	53	6	48	29	101	35	136	46
	Car	26	6	24	8	50	14	64	22
	Pick-up van	19	4	8	5	27	9	36	12
	Animals	18	4	6	3	24	7	31	11
Total								294	100

Source: Field Survey Data (2016)

4.1.11 Respondents' Distribution According to Housing Materials

The respondents used different materials for their structural buildings; as such the result showed that 14% of the respondents used mud-thatched houses, while 45% of the farmers used mud-zink housing materials which were the most common in the study area. 24% of the farmers used brick zink materials and 17% of the respondents used concrete block. The results equally showed that the proportion of farmers that are high-users of CSA were considerably higher for those who used mud-zink and concrete materials. However, more than 50% of the respondents had mud/thatched and mud/zinc house materials which equated Egwemi and Odo's (2013) research. Relatedly, they emphasised that rural farmers are poor and their poverty was a reflection of their dwelling place because of their meagre resources, majority of them could not afford a decent building because of the financial constraints. This implied that, as a result of the practices of CSA, the rural farmers were able to pull their resource together to build mud-zink houses unlike the mud-thatched houses they were used to in the past and few of them were being elevated to building of brick zink and concrete block zink houses. Evidence from contextual review of livelihood of the poor in Ghana by Korsi and David, (2001) showed a similar scenario, as majority of the farmers were living in thatched buildings because of the poor financial resource base. The above situation pictured the

primitive level of agricultural production and calls for the intervention of government in all facets of rural development.

Table 4.11: Disaggregation of Climate Smart Agricultural Users by Types of Housing Materials

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Types of housing materials	Mud/thatched	12	4	10	15	22	19	41	14
	Mud/zinc	60	7	42	23	102	30	132	45
	Brick/zinc	30	4	24	13	54	17	71	24
	Concrete	25	5	17	3	42	8	50	17
Total								294	100

Source: Field Survey Data (2016)

4.1.12 Respondents' Distribution According to Communication Equipment Used

Respondents' distribution according to communication equipment used denotes that the respondents used different communication equipment as means of information transfer amongst one another. These results clearly portrayed that 43% of the respondents used radio as their means of communication, while 0.7% of the farmers used television whereas, 55% of the farmers used Global System Mobile (GSM) and 0.3% used videos as their means of communication in the study area. This implied that (GSM) was the most acceptable means of communication in the study area because it possessed almost all the other features of communication like the radio, television and video package in one system called handset hence, those farmers with GSM communication equipment's have more access to information related to CSAP than any other means of communication because the synergy characteristic of the GSM possessing the other features in radios, television and videos. These results aligned with Adeyemi, Alonye and Owolade's (2013) report, for they averred that majority (98%) of the respondents used GSM as their means of communication.

Table 4.12: Disaggregation of Climate Smart Agricultural Users by Communication Equipment

Variable	Categories	Katsina State		Sokoto State		Both States		Pooled	(%)
		High-users	Low-users	High-users	Low-users	High-users	Low-users		
Communication equipment	Radio	40	10	45	32	85	42	127	43
	Television	2	0	0	0	2	0	2	0.7
	GSM	84	10	48	22	132	32	164	56
	Video	1	0	0	0	1	0	1	0.3
Total								294	100

Source: Field Survey Data (2016)

4.2 The Respondents Sources/Access to Water

Table 4.13 revealed the distribution of the rural farmers according to their sources/access to water. Some of the sources include; stream/river, deep well, borehole and public water. These water sources are used for their farming and domestic activities such as irrigation, drinking, washing and watering. A proportion of 25% of the respondents had access to stream/river as their major source of water for irrigation. However, only a minute ratio of 1.4% had access and used public water for irrigation. On a similar note, majority of the respondents (88%) had no access or used public water as their source of drinkable water. Furthermore, 77% of the farmers used borehole as their major source of water for washing their household materials. About 65% of the respondents used borehole water as their major source for watering their farm crops and animals, viz. their crop/livestock enterprise activities. Following these results, it is obvious that, there is lack of public water in the study area while contrastingly, there exist a high rate of the use of boreholes for drinkable water (84%), washing (77%) and watering of the respondents' farm crops and animals (65%), but only a few percentage (16%) used this water source for irrigation purposes. In addition, a high proportion (57%) of the respondents utilised water from streams/ivers to water their farm crops/animals as shown in table 4.13. Hence, it is necessary to complement these sources by introducing more dams which can also encourage their grazing activities.

Table 4.13 Distribution of Respondents by Sources/Access to Water (n = 294)

Source of water	Irrigation		Drinking		Washing		Watering	
	Access	No-access	Access	No-access	Access	No-access	Access	No-access
Stream/ River	73 (25)	221 (75)	86 (29)	208 (71)	122 (41)	172 (59)	167 (57)	127 (43)
Deep Well	22 (8)	272 (92)	111 (38)	183 (62)	119 (41)	175 (59)	127 (43)	167 (57)
Borehole	47 (16)	247 (84)	248 (84)	46 (16)	225 (77)	69 (23)	192 (65)	102 (35)
Public Water	4 (1.4)	290 (98.6)	35 (12)	259 (88)	8 (3)	286 (97)	6 (2)	288 (98)

Source: Field Survey Data (2016) Percentages in bracket

4.3 The Respondents Sources of Credit

As presented in Table 4.14, the respondents' major sources of credit were from co-operatives and family/relations. The average amount sourced from family and relatives as credit for high-users of CSA amounted to ₦23,868, while the low-users added up to ₦19,446. Meanwhile, the average amount sourced from co-operatives society as credit for high-users of CSA was ₦22,955, while for the low-users was ₦6,486. The results also revealed that majority of the high-users of CSA have more funds than the low-users of CSA. In Katsina State, the average mean of the high-users of CSA source of credit from Non-Governmental Organization (NGO) was ₦3,548 while in Sokoto State, it was ₦2,322. It can be inferred that the high-users of CSA could justify their credit request because of their deep involvement in CSAP.

Table 4.14: The Sources of Credit

Source of credit	Katsina State		Sokoto State		Pooled		
	Mean	Mean	Mean	Mean	Mean	Mean	t-value (p-value)
	High- users (₦)	Low- users (₦)	High- users (₦)	Low- users (₦)	High- users (₦)	Low- users (₦)	
	n = 127	n = 20	n = 93	n = 54	n = 220	n = 74	
Commercial Banks	0.00	5,556	8,032	5,000	4,636	5,405	0.19 (0.85)
Micro Finance Banks	3,225	0.00	787	0.00	1,818	0.00	-0.95 (0.34)
Non-Governmental Organisation	3,548	0.00	2,322	2,500	2,841	676	-1.13 (0.26)
Co-operative Society	16,989	7,037	27,323	5,000	22,955	6,486	-2.60 (0.01)
Family/Relations	18,516	20,482	27,787	16,650	23,868	19,446	-0.99 (0.33)

Source: Field Survey Data (2016) P-Values in bracket

4.4 Constraints to the Use of Climate Smart Agricultural Techniques

The first objective aims at investigating constraints faced by respondents in climate smart agricultural activities. Subsequently, the investigation portrayed that the respondents in the study area were faced with numerous constraints. These constraints ranged from lack of access to credit, lack of access to extension agents and many others. A five point Likert rating scale was applied to rank the constraints in the order of their mean sizes. This was essential to enable us identify which of these constraints were major and posed a serious challenge to practice of CSA in the study area.

Table 4.15 showed that lack of processing technology, lack of demonstration of climate smart agricultural techniques, lack of social interaction, cost of input, cost of labour, lack of awareness of CSAP, lack of technical know-how, lack of time to practise CSA, lack of access to high quality hybrid (breeds), lack of access to improved crop varieties, lack of access to education and lack of access to credit were very serious problems in terms of CSAP in the study area and their mean scores were above 3.05. However, lack of demonstration of climate smart agricultural techniques and lack of processing technology were the two major constraints in the study area because their

mean score were 4.03 and 4.04 respectively. This implied that, there are no personnel trained to help the rural farmers in the technical demonstration of CSAP and lack of industrial factories to process the large quantity of agricultural products like the grains and animals produced by the farmers in the study area.

Furthermore, access to market was not a major problem in the study area, because there were many marketing channels to dispose majority of the harvested agricultural products. The processing of these farm products was their major challenge as shown in Table 4.15. Notwithstanding, access to extension services, lack of information from radio, and lack of willingness to practise CSAP were also serious constraints because their mean scores was between 2.75 and 3.03. Although lack of access to market was a problem, but it was not as serious as the mean score indicated, 2.69 that is below 2.95. This was as a result of many of the buyers going to the farm gate to buy their farm products and the availability of daily and weekly markets in the rural communities. For the high-users of CSAP in the study area, lack of access to market was higher among household farmers in Sokoto State than in Katsina States, while the low-users of CSAP experience more lack of access to market in Katsina State than Sokoto State. Additionally, lack of access to extension services for the high-users of CSAP was higher among household farmers in Sokoto State than in Katsina State. This can be credited to their poor educational facilities as observed in Sokoto. Table 4.15 identified lack of the processing technology as a very serious challenge because it had the highest average mean value of 4.04. In Katsina State 40% of the high-users of CSAP faced the problem of lack of processing technology and 7% of low-users. Similarly, in Sokoto State, 29% of the high-users of CSAP faced the problem of lack of processing technology and 17% of low-users faced this problem but considering the pooled data, 69% of high-users saw it as a problem as against 24% for low-users. Hence, the lack of processing technology was the major constraint in the study area; therefore industrialisation of the study area will go a long way as the only remedy.

Table 4.15: Distribution of Higher and Lower Users of CSAP by Types of Farming Constraints

Types of Constraints Perceived	Katsina		Sokoto		Both States		Overall		Mean Extent	Remark
	High-user	Low-user	High-user	Low-user	High-user	Low-User	Yes	No		
Lack of access to market	46 (15.65)	8 (2.72)	30 (10.2)	22 (7.48)	76 (25.85)	30 (10.2)	106 (36)	188 (64)	2.70	Not Serious
Lack of access to credit	102 (34.69)	16 (5.44)	76 (25.85)	40 (13.61)	178 (60.54)	56 (19.05)	234 (80)	60 (20)	3.89	Very Serious
Lack of access to education	86 (29.25)	7 (2.38)	54 (18.37)	32 (10.88)	140 (47.62)	39 (13.27)	179 (61)	115 (39)	3.40	Very Serious
Lack of access to extension services	73 (24.83)	9 (3.06)	40 (13.61)	23 (7.82)	113 (38.44)	32 (10.88)	145 (49)	149 (51)	3.04	Serious
Lack of access to improved crop varieties	89 (30.27)	12 (4.08)	51 (17.35)	33 (11.22)	140 (47.62)	45 (15.31)	185 (63)	109 (33)	3.37	Very Serious
Lack of access to high quality breeds	97 (32.99)	16 (5.44)	74 (25.17)	44 (14.97)	171 (58.16)	60 (20.41)	231 (79)	63 (21)	3.80	Very Serious
Lack of time to practise CSA	74 (25.17)	16 (5.44)	61 (20.75)	39 (13.27)	135 (45.92)	55 (18.71)	190 (65)	104 (35)	3.46	Very Serious
Lack of technical knowledge	108 (36.73)	16 (5.44)	74 (25.17)	47 (15.99)	182 (61.9)	63 (21.43)	245 (83)	49 (17)	3.60	Very Serious
Lack of information from radio	79 (26.87)	11 (3.74)	50 (17.01)	19 (6.46)	129 (43.88)	30 (10.2)	159 (54)	135 (46)	3.02	Serious

Lack of awareness of CSA practices	94 (31.97)	16 (5.44)	77 (26.19)	47 (15.99)	171 (58.16)	63 (21.43)	234 (80)	60 (20)	3.84	Very Serious
Cost of labour is high	116 (39.46)	18 (6.12)	82 (27.89)	45 (15.31)	198 (67.35)	63 (21.43)	261 (89)	33 (11)	3.80	Very Serious
Cost of input is high	114 (38.78)	17 (5.78)	84 (28.57)	43 (14.63)	198 (67.35)	60 (20.41)	258 (88)	36 (12)	3.82	Very Serious
Lack of social interaction	88 (29.93)	17 (5.78)	58 (19.73)	37 (12.59)	146 (49.66)	54 (18.37)	200 (68)	94 (32)	3.26	Very Serious
Lack of willingness	67 (22.79)	12 (4.08)	37 (12.59)	29 (9.86)	104 (35.37)	41 (13.95)	145 (49)	149 (51)	2.97	Serious
Lack of demonstration of CSA techniques	111 (37.76)	19 (6.46)	79 (26.87)	43 (14.63)	190 (64.63)	62 (21.09)	252 (86)	42 (14)	4.03	Very Serious
Lack of processing technology	118 (40.14)	20 (6.8)	85 (28.91)	50 (17.01)	203 (69.05)	70 (23.81)	273 (93)	21 (7)	4.04	Very Serious

Figures in parenthesis are percentages of those who said yes
Source: Field Survey Data (2016)

CHAPTER FIVE

DETERMINANTS OF CLIMATE SMART AGRICULTURAL INDICES ON CROP AND LIVESTOCK ENTERPRISES

5.0 The Empirical Results and Discussion

This chapter advances the results of the analyses on the factors influencing the use of CSAP on crops and livestock enterprises using the PCA and OLS multiple regression model. The PCA was used to generate the composite variable for the use of CSAP for each of the enterprises, namely: maize, sorghum, millet, groundnut and livestock (goat, sheep, cattle, donkey and camel were combined). Thereafter, these composite variables were organised as dependent variables in order to analyse their correlates. The composite indices were constructed from six CSAP, including the use of organic manure, agro-forestry, conservation agriculture, improved hybrids, integrated crop/livestock management and irrigation.

5.1 Factors Influencing Climate Smart Agricultural Practice for the Maize Enterprise

The linear regression analysis was carried out in order to appraise the influence of farmers' socio economic factors on the use of CSAP on maize enterprise. The linear regression was used for this analysis because it is a linear approach for modelling the relationship between a scalar dependent variable "Y" and one or more explanatory variables "X". Multi-collinearity test showed that the mean Variance Inflation Factor (VIF) was 1.52 as shown in table 5.1. The extrapolation garnered from the appraisal is that the model is void of any serious multicollinearity problem while the heteroscedasticity was automatically catered for, by the Stata software using the robust option.

It follows that the results captured in Table 5.2 demonstrated that the whole model was statistically significant ($p < 0.01$), an indicator that the model was well fitted, and per se, the R-Squared value of 0.2119 was obtained. Consequentially then, the 21.19% of the variation in the values of climate smart agricultural indices was ultimately explained by the explanatory variables. Furthermore, Table 5.2 presented the Ordinary Least Square (OLS) results for maize enterprise. A total of nine variables were statistically significant ($p < 0.10$). Also, age, gender, marital status and household size were significant ($p < 0.10$). Thus, the results evinced that a unit increase in age will result in corresponding increase in the CSAP indices on maize enterprise by 0.0264. This, however, contradicted a priori expectation, and consequently suggests that CSAP on maize production might have been used by these farmers for a long period, and so experience tends to give the older farmers an edge over the younger ones. Howbeit, the results are contrary to the findings of Akinyemi et al., (2009) for they submitted that farmers' participation in agricultural activities is inversely related to their age. They argued further that the older the farmers become, the less active they tend

to be in their participation in agricultural activities. Also, the results showed that more male farmers used CSAP in the maize enterprise than their female counterparts. This was in agreement with the findings of Okeke and Onogwu, (2014) which revealed that majority of the respondent farming households were male. The low percentage of women in farming may be as a result of Islamic religion practice which tend to restrict women participation in farming activities. On a similar note, existing and practicing marriages (monogamy and polygamy) significantly augmented increase in the use of CSAP on maize farms than their counterparts who were divorced, widowed or single.

The results equally validated the work of Zitha, (2007) for the researcher found out that married farmers benefitted from stabilised advantage and supportive assistance rendered by their spouses, which in turn provided a lucrative boost in their farming activities. Likewise, the work of Judy, (2007) emphasised the dominance of agricultural activities by men in Sub-Saharan countries, especially in the production of cash crops. Moreso, the result revealed that a unit increase in household size decreases the corresponding CSAP indices on maize enterprises and this was in agreement with the study of Makhura, (2001) who found that, the household size negatively affected the chance of participating in the markets for horticulture and livestock. Education, housing materials, lack of time and State option were significant ($p < 0.01$). Congruently, the results suggest that those who had informal education (Arabic education) had significantly lower indices by (-0.2403) of CSAP for maize production than their counterparts who had formal education in primary, secondary and tertiary levels. This is contrary to apriori expectation and also different from the findings of Isaac, (2009) which asserted that education promoted agricultural activities both among peasant and commercial farmers.

Meanwhile, the farmers with mud/thatched and mud/zinc houses had significantly lower usage by (-0.7796) of CSAP in the production of maize when compared with those with brick/zinc and concrete block zinc houses. The study showed a significant and negative relationship between respondents who professed lack of time, and those who did not in terms of CSAP for the production of maize. Concordantly, the results verified that those who lacked time to practise CSA had significantly lower indices (-0.1462) of CSAP for maize enterprise than their counterparts who had enough time. This is in agreement with Okulona and Ikuomola, (2010). Their study affirmed that farmers who had enough time and experience recorded faster and better changes from the onset of rain, and consequently were spared of the experiences associated with the prevailing pest incidences, desertification threat and poor yields due to drought and flooding. Furthermore, Sokoto State farmers had significantly lower rates of using CSAP for maize production than their

counterparts in Katsina State. This could be as a result of the variation in edaphic and climatic factors across the States. According to Saiful, (2014) there is a variation in the performance of CSAP when considering different agro-ecological zones in Nigeria. He observed the complexity in resilience to adaptation to climatic changes across the farming terrain. The parameter of communication was statistically significant ($p < 0.05$). It connotes that the use of CSA for maize enterprise by respondents who were communicated by handsets (GSM) was significantly lower by (-0.2949) than those who were informed by radios, televisions and videos. Ultimately, it is evident from the result that the farmers were not getting supportive information that will enhance climate smart agricultural activities in the study area through phones. This buttressed the assertion of Okediji, (2014) who posited that, network problems and poor road networking enforced difficulties to farmers' use of handsets as a means of communication in many of the rural communities.

Table 5.1 Multi-Collinearity Test of Variables

Variable	VIF	Tolerance	Eigen Value
Age	2.60	0.3846	13.6796
Gender	2.02	0.4948	1.3705
Education	1.13	0.8864	1.0070
Marital	1.84	0.5442	0.9167
Religion	1.23	0.8153	0.7666
Households	1.67	0.6000	0.6502
Farm size	1.33	0.7545	0.4881
Experience	2.38	0.4197	0.4179
Ownership	1.88	0.5329	0.3874
Land acquisition	1.50	0.6650	0.3274
Labour	1.07	0.9388	0.2417
Membership	1.59	0.6304	0.2287
Transportation	1.15	0.8688	0.1257
Housing material	1.28	0.7829	0.0988
Communication	1.24	0.8080	0.0913
Extension contact	1.05	0.9525	0.0728
Lack of access to credit	1.46	0.6865	0.0524
Lack of time	1.15	0.8660	0.0355
State	1.45	0.6911	0.0227
Expenditure	1.31	0.7650	0.0123
			0.0067
Mean VIF	1.52		

Source: Computer Printout of Multicollinearity Test

Table 5.2 Factors Influencing Indices of Climate Smart Agricultural Techniques on Maize Enterprise

Maize CSA enterprise	Coefficient	Standard error	t-value	p-value
Age	.0263797	.0138967	1.90	0.059*
Gender	.600618	.3175352	1.89	0.060*
Education	-.2403243	.0913511	-2.63	0.009***
Marital	.6383875	.3534255	1.81	0.072*
Religion	-.0795656	.2310621	-0.34	0.732
Households	-.0568359	.0310621	-1.83	0.068*
Farm size	.0328947	.0248263	1.32	0.186
Experience	-.0106109	.0149105	-0.71	0.559
Ownership	-.1908068	.3258319	-0.59	0.559
Land acquisition	.2637486	.3132237	0.84	0.400
Labour	-.0025226	.2715146	-0.01	0.993
Membership	0.331398	.1720026	0.19	0.847
Transportation	.0549571	.2182468	0.25	0.801
Housing material	-.7796276	.2003394	-3.89	0.000***
Communication	-.294856	.144532	-2.04	0.042**
Extension contact	-.0107841	.0637598	-0.17	0.866
Lack of access to credit	.0086644	.1592249	0.05	0.957
Lack of time	-.1461511	.1614057	0.91	0.000***
State	.7709275	.1785835	4.32	0.000***
Expenditure	-2.97e-06	6.23e-06	-0.48	0.634
Constants	-1.684111	.6080197	-2.77	0.006
Number of Obs:	294			
F (20, 273)	4.14			
Prob> F	0.0000			
R-Squared	0.2119			
Root MSE	1.1509			

Source: Computer Printout of Regression Analysis

Note: *, ** and * means 10%, 5% and 1% level of significance respectively**

5.2 The Factors Influencing Climate Smart Agricultural Practice for the Sorghum Enterprise

Additionally, the Ordinary Least Square (OLS) Regression result of sorghum enterprise in Table 5.3 signified that the F-statistics (0.0442) of the regression model was significant ($p < 0.05$), an affirmation that the model was fitting. The multiple coefficient of determination in R-Square of 0.0867 revealed that 8.70% of the variation in sorghum enterprise can be explained by the explanatory variables included in the model

The Ordinary Least Square (OLS) estimation results in Table 5.3 disclosed that education, farm size and housing material were significant ($p < 0.05$). This implied that respondents who had informal education had significantly lower indices of CSA for sorghum production by (-0.1527) than their counterparts who had formal education. These results was contrary to the priori expectation and accentuated the importance of formal education. Correspondingly, Okpachu et al., (2014) emphasised that education could have a positive impact on the farmers if the curriculum is enriched and applicable to their farming activities. Also, Ayinde et al., (2010) found that the educational level of farmers had a significant influence on adoption and Oladele, (2006) noted that introduction of improved maize variety is not enough without a suitable complementary training and practices such as planting distance, seed dressing, weed control method and storage techniques to aid better performance of agricultural technology. Also, the result shows that a unit increase in farm size will decrease the corresponding CSAP indices by (-0.0589) on sorghum enterprises and this was in contrary to the findings of Nambuya et al., (2005) who found that adoption of improved varieties is positively correlated to farm sizes and that most farms with small land holding capacity were not growing improved varieties.

Housing material parameter was significant ($p < 0.01$). This means that the farmers with mud/thatched and mud/zinc houses had their indices of CSA being lower by (-0.5707) when compared with those who owned brick/zinc and concrete block zinc houses. According to Stephen, (2010) on different management practices and approaches that can contribute to the improvement of productivity and economic sustainability, the quality of housing materials was discovered to promote good environment and enhance productivity of the farmers. The farmers in the study area lived in mud/thatched buildings as a result of their poverty level, and this has a consequence on their commitment to CSAP in the study area.

Table 5.3 Factors Influencing Indices of Climate Smart Agricultural Techniques on Sorghum Enterprise

Sorghum CSA enterprise	Coefficient	Standard error	t-value	p-value
Age	-.0033532	.0128667	-0.26	0.795
Gender	.374837	.3812064	0.98	0.326
Education	-.152724	.0776972	-1.97	0.050**
Marital	-.5625115	.4265004	-1.32	0.188
Religion	-.118351	.276596	-0.43	0.669
Households	-.0042876	.0282198	-0.15	0.879
Farm size	-.058918	.0238867	-2.47	0.014**
Experience	.0090153	.0121938	0.74	0.460
Ownership	-.1548924	.4692801	-0.33	0.742
Land acquisition	.0329311	.4313515	0.08	0.939
Labour	-.1803822	.1917326	-0.94	0.348
Membership	.0960629	.169133	0.57	0.571
Transportation	-.0862034	.2165393	-0.40	0.691
Housing material	-.5706555	.1919158	-2.97	0.003***
Communication	.0489703	.1536928	0.32	0.750
Extension contact	-.0473868	.0567902	-0.83	0.405
Lack of access to credit	-.2207313	.1567902	-1.41	0.159
Lack of time	-.0930056	.1473308	-0.63	0.528
State	.099974	.1601718	0.62	0.533
Expenditure	-18600000	581,000,000	-0.32	0.749
Constants	1.244299	.7860683	1.58	0.115
Number of Obs:	294			
F (20, 273)	1.64			
Prob> F	0.0442			
R-Squared	0.0867			
Root MSE	1.1403			

Source: Computer Printout of Regression Analysis

Note: *, ** and * means 10%, 5% and 1% level of significance respectively**

5.3 Factors Influencing Climate Smart Agricultural Practice for the Millet Enterprise

The Ordinary Least Square (OLS) result in Table 5.4 shows that the F-statistics is significant at $p < 0.05$, hence the model was well fitted. The regression results indicated that five variables were significant. Age and education were significant at $p < 0.01$. It implied that a unit increase in age will lead to a corresponding increase in the indices of CSA in millet enterprise by 0.3282. In the same manner, Mohammed, (2008) postulated that age influences farmers' abilities to practice more agricultural farming activities, adding that commercial ability and farm management skills increase with experience; as such a farmer's ability is a function of age. Also, the results advocated that those who had informal education (Arabic education) had their indices of CSAP on millet enterprise being significantly lower by (-0.2862) when compared with their counterparts with formal education. Ismaila et al., (2010) identified non-functional education among the cereal farmers in northern Nigeria and suggested that extension education should be participatory for it to deliver the desired objectives.

Religion and housing materials parameters were significant ($p < 0.10$). Muslims had significantly lower indices of CSAP on millet enterprise than Christians and Traditionalists by (-0.4846). This is in line with Macaulay's (2014) work, who opined that northern farmers' performance fell below potentials because of their episodic religious and ethics problems. The parameter of farmers' lack of access to credit was significant ($p < 0.05$). This is an indication that farmers who lacked access to credit had their indices of CSAP on millet being significantly higher by 0.0779 when compared with those who did not lack access. Per se, it contrasted with the work of Oni et al., (2009) for they avowed that credit facilities contribute to household production efficiency and enhance their farming operations. Nevertheless, there exists a uniformity of results between this current study and Cresensia et al.'s (2013), because they discovered that credit facilities produce a multiplier effect for Tunisian farmers. Housing materials had significantly lower indices of CSAP on millet enterprise. This means that farmers with block/zinc housing materials were being significantly lower by (-0.357765) when compared with those with mud/thatched housing materials. This was in contrary to the apriori expectation that support a good proper housing materials will increase the millet enterprise. And this was in tuned with the findings of Chaipa and King, (1998), which they stated that food gardening in Zimbabwe is predominantly practiced by house owners with regular other income sources and who are in most cases better off and have better access to resources like storage facilities. This illustrates how household production is constrained by poor resource base such as housing type. Household production is also limited by lack of appropriate production infrastructure such as proper constructed building for housing crops and farm animals.

This refers to lack of fencing, irrigation system, on farm electricity and lack of storage and related building facilities. The provision of necessary production infrastructure needs attention. Infrastructure such as fencing, buildings and irrigation systems is needed to facilitate and improve agricultural productivity.

Table 5.4 Factors Influencing Indices of Climate Smart Agricultural Techniques on Millet Enterprise

Millet CSA enterprise	Coefficient	Standard error	t-value	p-value
Age	.0318158	.0118787	2.68	0.008***
Gender	-.3824433	.3884031	-0.98	0.326
Education	-.2861645	.1010043	-2.83	0.005***
Marital	.550824	.4169381	1.32	0.188
Religion	-.48462	.2701536	-1.79	0.074*
Households	-.0306577	.0283781	-1.08	0.281
Farm size	.0055162	.0239478	0.23	0.818
Experience	-.014989	.011696	-1.28	0.201
Ownership	.1757601	.3844383	0.46	0.648
Land acquisition	.1692809	.3350572	0.51	0.614
Labour	.0257794	.2302996	0.11	0.911
Membership	-.0304396	.1652455	-0.18	0.854
Transportation	-.4341823	.232163	-1.87	0.911
Housing material	-.3942465	.2159231	-1.83	0.069*
Communication	-.1610436	.1471098	-1.09	0.275
Extension contact	-.0217481	.058981	-0.37	0.713
Lack of access to credit	.0779438	.1582457	0.49	0.048**
Lack of time	.2922038	.1575878	1.98	0.691
State	.2347578	.1575878	1.49	0.691
Expenditure	2.36-06	5.92e-06	0.40	0.691
Constants	-1.001871	.6347732	-1.58	0.116
Number of Obs:	294			
F (20, 273)	1.67			
Prob> F	0.0374			
R-Squared	0.1092			
Root MSE	1.1231			

Source: Computer Printout of Regression Analysis

Note: *, ** and *** means 10%, 5% and 1% level of significance respectively

5.4. Factors Influencing Climate Smart Agricultural Practice for Groundnut Enterprises

The Ordinary Least Square (OLS) Regression result of groundnut enterprise in Table 5.5 signified that the F-statistics (0.0320) of the regression model was significant ($p < 0.05$), an affirmation that the model was fitting. The multiple coefficient of determination in R-Square of 0.1111 revealed

that 11.11% of the variation in groundnut enterprise can be explained by the explanatory variables included in the model

The results also depicted that age was significant ($p < 0.01$). This implied that a unit increase in age of the farmers will lead to a corresponding increase in the indices of CSA for groundnut farmers by 0.0372. This result maintained a match with that of Zalkuwi et al., (2013). Their study confirmed that the older farmers were more prompt in their perception and response to risk management than younger farmers.

Additionally, the examination demonstrated that education was negatively significant at $p < 0.05$. Evenly, it pointed to the fact that those who had informal education (Arabic education) had their indices of CSAP in groundnut enterprise being significantly lower by (-0.2102) when compared to their counterparts with formal education. For instance, Anselm and Taofeeq, (2010) confirmed that groundnut farmers lack requisite education that can make them productive and effect positive changes in their productive activities. Again, farm size was positively significant ($p < 0.10$), meaning, that a unit increase in farm size will lead to a corresponding increase in the indices of CSAP for groundnut farmers by 0.0487. The result maintained a par with the work of Ani, (2013) who hypothesised that increase in farm size coupled with ecological flexibility, will guarantee productivity in groundnut farming.

Table 5.5: Factors Influencing the Indices of Climate Smart Agricultural Techniques on Groundnut Enterprise

Groundnut CSA enterprise	Coefficient	Standard error	t-value	p-value
Age	.0372305	.0123537	3.01	0.003***
Sex	-.435532	.4039346	-1.08	0.282
Education	-.2101668	.1050433	-2.00	0.046**
Marital	.178331	.4336107	0.41	0.681
Religion	.2281706	.2809566	0.81	0.640
Households	-.0138106	.0295129	-0.47	0.417
Farm size	.0487316	.0249054	1.96	0.051*
Experience	-.0177124	.0121637	-1.46	0.146
Ownership	.2138104	.3998113	0.53	0.593
Land acquisition	.4268788	.3484556	1.23	0.222
Labour	-.1263712	.2395089	-0.53	0.598

Membership	.0719808	.1718534	0.42	0.676
Transportation	-.2455936	.2414468	-1.02	0.310
Housing material	-.3052228	.2245575	-1.36	0.175
Communication	-.0748344	.1529925	-0.49	0.625
Extension contact	-.0685198	.0613396	-1.12	0.265
Lack of access to credit	.0202029	.1645736	0.12	0.902
Lack of time	.0570541	.1531026	0.37	0.710
State	.1558512	.1638895	0.95	0.432
Expenditure	1.99e-06	6.15e-06	0.32	0.747
Constants	-1.393806	.6601566	-2.11	0.036
Number of Obs:	294			
F (20, 273)	1.71			
Prob> F	0.0320			
R-Squared	0.1111			
Root MSE	1.1681			

Source: Computer Printout of Regression Analysis

Note: *, ** and *** means 10%, 5% and 1% level of significance respectively

5.5 Factors Influencing Climate Smart Agricultural Practice for the Livestock Enterprises

Table 5.6 shows the mean Variance Inflation Factor (VIF) of 1.10, denoting that that there was no serious multi-collinearity problem among the independent variables. Also, heteroscedasticity was automatically corrected for, hence robust estimates were used. Table 5.7 presents F-statistics value (0.0002), which was significant at $p < 0.01$, and a consequent indication that the model was apropos. The multiple coefficient of determination R-Square value of 0.1286 revealed that 12.86% of the variability in the indices of CSAP was accounted for by the independent variables.

Regression results show that education and communication equipment's were negatively significant ($p < 0.01$). This implies that those who had informal education (Arabic education) had their indices of CSAP for livestock enterprise being significantly lower by (-0.3359) when compared with their counterparts with formal education. The result was echoed in the work of Ofioku and Isife, (2009) for they found setbacks in livestock production as a result of dominance of informal education among the farmers in the northern part of Nigeria. The study further suggested that the use of CSA for livestock by respondents who were communicated by handsets

was significantly lower by (-0.4830) than those who were informed by radios, televisions and videos. In the same vein, Adamu and Odion, (2000) observed that lack of communication caused a great loss in animal output.

Farm size was positively significant ($p < 0.05$). Thus, this connotes that a unit increase in farm size will lead to corresponding increase in the indices of CSAP by 0.0664 for livestock farmers. A similar result was registered in Philips, (2010) research, who concluded that livestock production is directly linked with competition of animal for space, natural resources and food and feeding supplement which was a function of farm size. Extension contact and lack access to high quality hybrid were negatively significant ($p < 0.05$). It denoted that respondents who had no extension contact, besides experiencing lack of access to high quality hybrid had significantly lower use of CSA for livestock by (-0.1887) and (-0.4626) respectively. Philip et al., (2009) obtained a similar result and attributed the poor performance to lack of funding in the extension delivery system to the farmers and paucity in coordination of the extension programme in Nigeria.

Table 5.6: Multi-Collinearity Test of Variables

Variable	VIF	Tolerance	Eigenvalue
Education	1.08	0.9260	8.5056
Religion	1.12	0.8950	1.0884
Households	1.17	0.8513	0.9528
Farm size	1.20	0.8339	0.8854
Land acquisition	1.06	0.9430	0.6006
Labour	1.03	0.9693	0.4165
Membership	1.16	0.8632	0.3597
Communication	1.19	0.8377	0.3422
Extension contact	1.02	0.9768	0.2737
Lack of access to credit.	1.04	0.9652	0.2335
Lack of high quality hybrid.	1.08	0.9228	0.1604
Lack of time to practice CSA.	1.05	0.9556	0.0971
Lack of processing technology	1.12	0.8902	0.0669
			0.0170
Mean VIF	1.10		

Source: Computer printout of Multicollinearity Test

Table 5.7 Factors Influencing Indices of Climate Smart Agricultural Techniques on Livestock Enterprise

Livestock CSA enterprise	Coefficient	Robust Standard Error	t-value	p-value
Education	-.3358789	.1258248	-2.67	0.008***
Religion	.2011503	.3282965	0.61	0.541
Households	.0294844	.0303353	0.97	0.332
Farm size	.0663634	.0290053	2.29	0.023**
Land acquisition	-.376809	.3582446	-1.05	0.294
Labour	-.2778648	.2885837	-0.96	0.336
Membership	-.1244127	.1798012	-0.69	0.490
Communication	-.483034	.1839629	-2.63	0.009***
Extension contact	-.1887444	.0741602	-2.55	0.011**
Lack of access to credit.	-.1012549	.21064	-0.48	0.631
Lack of high quality hybrid.	-.4625896	.2115944	-2.19	0.030**
Lack of time to practice CSA.	-.2073913	.1784449	-1.16	0.246
Lack of processing technology	.0799576	.3432333	0.23	0.816
Constant	.6366101	.583967	1.09	0.277
Number of Obs:	294			
F (13, 280)	3.18			
Prob> F	0.0002			
R-Squared	0.1286			
Adj R-Squared	0.0881			
Root MSE	1.4301			

Source: Computer Printout of Regression Analysis

Note: *, ** and * means 10%, 5% and 1% level of significance respectively**

CHAPTER SIX

POVERTY DECOMPOSITION AMONG USERS OF CLIMATE SMART AGRICULTURE

6.0 The Empirical Results and Discussion

This chapter expounds on the result on poverty rates for high-users and low-users of CSA. The study computes relative poverty indices with Foster Greer and Thorbecke (FGT) and Equally Distributed Equivalent (EDE) using households' expenditure. The expenditure dimensions include overall per capita expenditure as well as expenditure on food. All the results illustrated the headcount of poverty $\{P(0)\}$, poverty gap $\{P(1)\}$ and the poverty severity $\{P(2)\}$ in every decomposition techniques that was considered.

6.1 Evaluation of Poverty Rates for High-Users and Low-Users of CSAP

Several forms of expenditure shall be used to ascertain the income dimension of poverty; per capita expenditure and food expenditure. Expenditure is often used as a proxy to income for two key reasons: First, experience has shown over time that individuals are more comfortable and hence more likely to be truthful about their expenditures than their incomes. Secondly, expenditure captures all streams of income other than just the salary that is usually thought of when posed with the question of income earned. It is on this note therefore that this study employs various expenditure profiles to analyse poverty. Preponderantly, the essence of poverty, in relative term, is 'inequality', an implication that poverty can also be described as relative deprivation (Bradshaw, 2006). The general popular poverty line was one US dollar (\$1) per day, although according to Pound, (2016) one dollar per day using the exchange rate of naira to dollar in 2016 which was \$1 to ₦199.28 at the commercial bank rate while the parallel market rates, referred to as the black marketers operate a black market rate at \$1 to ₦201.68. However, the report of Vanguard News in August, 2017 shows that the exchange rate of one naira to a dollar was \$1 to ₦359.70, that is, commercial bank rate; while the parallel market rates was \$1 to ₦364.90. According to World Bank, (2016) the current international poverty line is (\$1.9) per day.

Table 6.1 International Poverty Line in Two Different Periods

Poverty Line	Date (Year)	International poverty line (\$)	Vendor (parallel market rates) (₦)	(\$)	Government rate (₦)	(\$)
	February, 2016	1.00	201.68	1.5883	199.28	1.6077
	August, 2017	1.00	364.90	0.8780	359.70	0.8907
	February, 2016	1.90	383.23	0.8360	378.10	0.8473
	August, 2017	1.90	693.31	0.4621	683.43	0.4688

Source: Newspapers and bulletins

6.2.1 Poverty Rates for High-Users and Low-Users of CSAP for Per Capita Expenditure

Table 6.2 represented the total expenditure per head of each household which was calculated as total household expenditure divided by household size. Per capita expenditure therefore represents overall expenditure per head in the household. The results for all the two measurements of poverty evidenced that poverty head count was higher for low-users of CSA than high-users, despite the fact that these varying techniques of measurements have different formulations. Poverty head count according to the FGT index for the total population was 9.13% for relative poverty. The scrutiny of the poverty rate showed that, low-users and high-users of CSA were deprived of basic human needs such as food and health care services; subsequently, the FGT relative poverty values of 10.23% and 8.76% for low-users and high-users of CSAP respectively were recorded.

Consequently, as represented by the individualised percentages, the deduction is that both low-user and high-users of CSA were poor. In the case of FGT relative poverty index, when disaggregated, the low-users of climate smart agricultural farmers were relatively 2% poorer than high-users of climate smart agricultural farmers. This was resonated in the work of Olowa and Olowa, (2010) that the major cause of poverty in Nigeria was the reluctance of the farmers to adopt new farming techniques that will enhance their productivity, and CSA was one of such new farming techniques. A related thought was also pointed out in the research carried out by Samuel et al., (2014). They attested that the archaic farming methods of rural farmers make them to be

vulnerable to poverty and that the situation needs government’s intervention for them to escape the scourge of poverty.

This trend could be explained in two ways. First, poor farmers are unable to practise CSA due to the extra costs for irrigation, organic manure and procurement of high quality hybrids. Second, the avoidance of CSA could further impoverish farmers since CSAP are the only sustainable means of farming in this era of climate change. Poverty depth and severity as shown for FGT and EDE-FGT followed the same trend as the poverty head count, therefore implying that low-users of CSAP were worse off than high-users. This further buttressed the need for conscious efforts to be made to enforce the practice of climate smart agricultural activities, principally as a means of alleviating poverty.

Table 6.2: Poverty Measurements of Per Capita Expenditure for Low-Users and High-Users of CSA

Measurement Technique	Population	P(0)	P(1)	P(2)	Poverty line (₦) per/month	Poverty line (\$1) per/day	Poverty line (\$1.9) per/day
FGT Relative Index	Low-user CSA	0.102326	0.024100	0.011050	6520.62	0.5966	0.3135
	High-user CSA	0.087639	0.018310	0.005462	6504.63	0.5942	0.3127
	Total Population	0.091256	0.019732	0.006838	6508.57	0.5945	0.3129
EDE-FGT Relative Index	Low-user CSA		0.024100	0.105120	6520.62	0.5966	0.3135
	High-user CSA		0.018310	0.073906	6504.63	0.5942	0.3127
	Total Population		0.019732	0.082693	6508.57	0.5945	0.3129

Source: Author’s Computation

6.2.2 Poverty Rates for High-Users and Low-Users of CSA for Food Expenditure

Table 6.3 presented the food expenditure poverty wherein we consider only a portion of household expenditure on food per head. The results for food dimension of poverty manifested the same trend as with that of per capita expenditure. It pictured a wider gap between low-users and high-users, with low-users of CSAP having consistently higher poverty head count than high-users of climate smart agricultural farmers. Also, poverty gaps and poverty severity for food dimension followed

the same trend with equally higher gaps than those of per capita expenditure. The results for all the measurements of poverty status shows that poverty head count is higher for low-users of CSAP than the high-users, despite the fact that, all these various techniques of measurement have different formulations. Poverty head count according to the FGT index for the total population is 12.87% for relative poverty. It connotes that the average CSAP farmers have deprivation of food. However, in the case of FGT relative poverty index the relative poverty values of 17.83% and 9.88% indicate that 18% and 10% of low-users and high-users of CSA were poor respectively. And when disaggregated, the low-users of CSAP farmers were relatively 8% food poorer than high-users of climate smart agricultural farmers. This was in consonance with the results of Robert et al., (2016) that CSA will be impactful when the strategies of the farmers brings development and this will be visible and evident on the farmers productivity. Additionally, this result was confirmed in the Obayelu and Orosile, (2015). The study contended that food poverty is more pronounced among rural livelihood farmers who are basically subsistence farmers. This again aptly proved that low-users of CSAP farmers have higher poverty rates than the high-users for food expenditure and per capita expenditure. This is the same for relative poverty measurements of FGT and EDE-FGT.

Table 6.3: Poverty Measurements of Food Expenditure for Low-Users and High-Users of CSA

Measurement Technique	Population	P(0)	P(1)	P(2)	Poverty line (₦) per/month	Poverty line (\$1) per/day	Poverty line (\$1.9) per/day
FGT Relative Index	Low -user CSA	0.178295	0.079972	0.044431	993.41	0.0905	0.0478
	High-user CSA	0.098784	0.035594	0.020157	1152.03	0.1052	0.0554
	Total Population	0.128675	0.048499	0.027527	1112.96	0.1017	0.0535
EDE-FGT Relative Index	Low -user CSA		0.079972	0.210787	993.41	0.0905	0.0478
	High-user CSA		0.035594	0.141974	1152.03	0.1052	0.0554
	Total Population		0.048499	0.165914	1112.96	0.1017	0.0535

Source: Author's Computation.

6.3 Effect of Climate Smart Agricultural Practices on Poverty Status

6.4 Empirical Results and Discussion

To ascertain the fourth objective which is to determine the effect of CSAP on poverty status of rural farmers, the researcher used an instrumental variable (IV) probit regression model. The post-estimation tools for IV-Probit analysis identified these selected instrumental variables (lack of access to CSAP, sources and use of water from borehole for drinking and quantity of millet per yield) to be strong and not weak for the analysis which were meant to cater for the potential problem of endogeneity in the analysis. In addition, the choice of instrument was hinged on the need to allow consistent estimation as required when the explanatory variables (covariates) are correlated with the error terms in a (2SLS) probit regression relationship. The study employed variables such as lack of access to CSAP, sources and use of water from borehole for drinking and quantity of millet per yield to instrument CSAP for maize, sorghum, livestock, and crop/livestock enterprises, while lack of access to CSAP, quantity of sorghum per yield and use of irrigation were used to instrument CSAP for millet and groundnut (which are the key independent variables in each of the six setups for testing the effect of CSAP on poverty status of farmers). It is worth noting that, CSAP for maize, sorghum, millet, groundnut, livestock and crop/livestock (the key independent variables) are quantitative variables that have been achieved with the aid of the Principal Component Analysis (PCA). In addition, the test for multi-collinearity among the variables was carried out with Variance Inflation Factor (VIF), the mean VIF was found to be 1.55 in the analysis and the high level of tolerance computed for the variables indicates that there was absence of serious multi-collinearity in the analysis. Variables with negative parameters imply a negative relationship with dependent variable while those with positive ones indicate a positive and direct relationship with dependent variable. Meanwhile, the dependent variables represent poverty status wherein one represents farmers whose monthly income is less than \$US 1.9 and zero otherwise. To that end, this chapter shows to what extent CSAP for maize, sorghum, millet, groundnut, livestock and both crop/livestock enterprises affect poverty status of farmers in the study area.

6.4.1 Effect of CSAP on Poverty Status of Farmer's Maize Enterprise

The study examined the effect of CSAP for maize enterprise on poverty status of farmers in the study area and the results have a probability chi-square of 0.000, showing that the overall model is significant. The findings validated the fact that CSAP for maize enterprise, age, education, housing materials and State were significant determinants of poverty status, given that their z-values are greater than 1.96 and their probability values are less than 0.05. Table 6.5 presents the

outcomes of analyses for the effect of CSAP on poverty status of the respondents using Two-Stage Least Square (2SLS) Probit model. The instrumented results were meant to correct for the likely problem of endogeneity. Additionally, Wald test of exogeneity was statistically significant ($p < 0.01$) in the fitted model. The result indicates that the inclusion of maize climate smart agricultural enterprise as an endogenous variable was reasonable and the selected instruments satisfied the necessary conditions (Gujarati, 2004). The Wald chi-square statistics was also statistically significant ($p < 0.01$), showing that the model produced was a good fit and estimated parameters were jointly unequal to zero. The results showed that CSAP was significant and had a negative relationship with the odds of being poor for farmers involved in maize enterprise. In fact, the result suggests that a unit increase in CSAP reduces the probability of farmers involved in maize production to be poor by 0.7582123. This is expected a priori, as CSAP should generally improve production and consequently reduce poverty. This was expected because CSAP had impacted greatly to the farmers' means of livelihood and also changed their poverty status. This findings was confirmed in the research carried out by FAO, (2013) that agricultural policies such as CSA are the basis for achieving food security and improving livelihoods and that an effective combination of sustainable agriculture and climate change policies can boost green growth, protect the environment and contribute to the eradication of hunger and reduce high poverty rate in the rural areas.

Equally, education was significant and inversely related to the probability of being poor. Possession of informal education, decreases the probability of being poor by 0.2624578. This is in agreement with Prasad et al.'s (2006) study. The researchers discovered that cereal farmers who practiced CSA in Tanzania had higher yield compared with their counterpart because education accelerated the rate of comprehension of the technicality associated with the used of climate smart agricultural techniques. On the other hand, age was significant and had positive relationships with the probability of being poor. The result shows that a unit increase in age, increases the probability of farmers being poor by 0.0328457. Then, it follows that the older the farmers become, the higher the possibility for them to be poor. This corroborated the findings of Sokoya, (2006) that farmers tend to be less productive as they advance in age because their natural strength diminishes, likewise their mental capability.

The results showed that housing materials was significant and had a negative relationship with probability of being poor for farmers in maize enterprise. The analysis indicated that a unit increase in the number of farmers that used bricks or concrete (cement)/zinc materials for building reduces the probability of the respondents being poor by 0.7496268. This is equally articulated in the

findings of United Nation, (2007) which stated that households are considered to be “above standard” if their dwelling place do meet the predetermined standards such as suitability, adequacy, and affordability norms that means a house built with concrete block and modern roof for a comfortable living. Additionally, the result illustrated that State was significant and had a positive relationship with the probability of being poor for farmers engaged in maize enterprise. This result also established the fact that the poverty rate in Katsina State is higher than Sokoto State, cinching a match with the report of National Bureau of Statistics (NBS, 2013) and Sabina et al., (2015). They discovered that poverty increased at the rate of 8.7 and 4.1 in Katsina and Sokoto respectively, between 2013 and 2015.

Table 6.4: Multi-Collinearity Test of Variables

Description	VIF	Tolerance	Eigen Value
Age	2.54	0.3931	11.3794
Sex	1.95	0.5115	1.2463
Education	1.08	0.9241	0.9948
Marital status	1.76	0.5695	0.8250
Households size	1.53	0.6552	0.6612
Farm size	1.31	0.7618	0.4625
Experience	2.36	0.4230	0.4009
Ownership farmland	1.81	0.5526	0.3420
Land Acquisition	1.49	0.6701	0.2466
Labour	1.06	0.9436	0.1287
Membership	1.58	0.6333	0.0946
Transportation	1.14	0.8781	0.0751
Housing materials	1.25	0.8008	0.0619
Communication kits	1.21	0.8245	0.0365
Access to credit	1.41	0.7086	0.0252
State	1.32	0.7571	0.0125
			0.0068
Mean VIF	1.55		

Source: Computer printout of Multicollinearity Test

Table 6.5: IV-Probit Regression Results Determining the Effect of CSA Practices on Poverty Status of Farmer's Maize Enterprise

Description	Coefficient	Standard Error	Z-value	P>/z/-value	Marginal Effect {dy/dx}
Maizecsaindex	-.7582123	.105982	-7.15	0.000***	-.7582123
Age	.0328457	.0120891	2.72	0.007***	.0328457
Sex	.2774317	.3951599	0.70	0.483	.2774317
Education	-.2624578	.1299249	-2.02	0.043**	-.2624578
Marital status	.0686225	.4565479	0.15	0.881	.0686225
Households size	.0739883	.0545875	1.36	0.175	.0739883
Farm size	-.0077441	.0277985	-0.28	0.781	-.0077441
Experience	-.0170221	.0119261	-1.43	0.153	-.0170221
Ownership farmland	-.3644852	.3898637	-0.93	0.350	-.3644852
Land Acquisition	-.0119436	.3542807	-0.03	0.973	-.0119436
Labour	.0905952	.2345065	0.39	0.699	.0905952
Membership	-.1971802	.1846458	-1.07	0.286	-.1971802
Transportation	.2167461	.243268	0.89	0.373	.2167461
Housing materials	-.7496268	.2162328	-3.47	0.001***	-.7496268
Communication kits	-.1668879	.1530503	-1.09	0.276	-.1668879
Access to credit	-.0918715	.1603149	-0.57	0.567	-.0918715
State	.9221478	.1641148	5.62	0.000***	.9221478
Constant	-2.274299	.6531988	-3.48	0.000	
Number of Observation	294				
Rho	.8822057				
Sigma	1.092749				
Wald $\chi^2(17)$	224.00				
Prob > χ^2	0.0000				
Log likelihood	-587.57785				

Source: Computer Printout of IV-Probit Regression Analysis.

Note: *, ** and *** means 10%, 5% and 1% level of significance respectively

6.4.2 Effect of CSAP on Poverty Status of Farmer's Sorghum Enterprise

The Table 6.6 has expanded upon the effect of CSAP for sorghum enterprise on poverty status of farmers in the study area. The probability chi-square of 0.000 shows, that the overall model is significant; given that at least one of the regression coefficients in the model is not equal to zero. The results disclosed that CSAP for sorghum enterprise, marital status, farm size and housing materials were significant determinants of poverty status, considering that their z-values were greater than 1.65, hence they were significant, at least 10% significant level.

Again, the results of the Table 6.6 attested that CSAP was significant and had a negative relationship with the probability of being poor for farmers involved in sorghum enterprise. Apparently, the inspection divulged that a unit increase in CSAP resulted in a reduction of the probability of farmers involved in sorghum production to be poor by 0.8615877 as expected a priori and consequently maintaining a parallel with the output of James et al.'s (2013) work, for they asserted that CSA has a multiplier effect on farming household's livelihood and the community in which they are living. Contrary to the previous case, farm size had a significant and negative relationship with the probability of being poor. This is in accordance with the expected assumption, given that as farm size increases, production should increase thereby reducing the odds of being poor. A unit increase in farm size, reduces the probability of the farmer being poor by 0.0679061, thus, portraying a compatible upshot with Sadiq et al.'s (2015) research. They avowed that, farm size produced the incremental effect on sorghum production in Niger State because the process involved the employment of more input factors. Also, the results depicted that marital status was significant and has a negative relationship with the probability of being poor for farmers involved in sorghum enterprise. It was recorded that a unit increase in the number of farmers that are married reduces the probability of farmers involved in sorghum CSAP to be poor by 0.7033051. This was analogous to the report presented by Aliyu et al., (2016) they voiced that majority of the respondents were married and this may be due to the fact that married respondents are more engaged in the strategies because they have to farm in order to feed their family.

Therefore they have to go to the farm and engage in these activities to prevent the effect of agricultural deforestation on their farms and concurrently improve their productivity, and invariably leading to increase in their income, social and economic requirements. Additionally, housing materials was significant, posing a negative relationship with the probability of being poor for farmers in sorghum enterprise. The result indicated that a unit increase in the number of farmers that used bricks or concrete zinc reduces the probability of the respondents being poor by 0.5943448. A matching result was ascertained in the findings of Devendra and Chantalakhana,

(2002). The analysts reported that capital investment in housing materials such as iron sheets (zinc) and concrete cement blocks improves agricultural farming income and productivity.

Table 6.6: IV-Probit Regression Results Determining the Effect of CSA Practices on Poverty Status of Farmer's Sorghum Enterprise

Description	Coefficient	Standard Error	Z-value	P>/z/-value	Marginal Effect {dy/dx}
Sorghumcsaindex	-.8615877	.0584338	-14.74	0.000***	-.8615877
Age	.0017924	.0114586	0.16	0.876	.0017924
Sex	.239223	.3573523	0.67	0.503	.239223
Education	-.1547731	.1009767	-1.53	0.125	-.1547731
Marital status	-.7033051	.385484	-1.82	0.068*	-.7033051
Households size	.0559366	.0424006	1.32	0.187	.0559366
Farm size	-.0679061	.0229405	-2.96	0.003***	-.0679061
Experience	.0043374	.0110189	0.39	0.694	.0043374
Ownership farmland	-.2399118	.3519926	-0.68	0.496	-.2399118
Land Acquisition	-.0717922	.3140232	-0.23	0.819	-.0717922
Labour	-.0953503	.2147268	-0.44	0.657	-.0953503
Membership	-.0271669	.1681772	-0.16	0.872	-.0271669
Transportation	.0008668	.2208	0.00	0.997	.0008668
Housing materials	-.5943448	.1989946	-2.99	0.003***	-.5943448
Communication kits	.0688813	.1341723	0.51	0.608	.0688813
Access to credit	-.2317755	.1444702	-1.60	0.109	-.2317755
State	.2674109	.1636097	1.63	0.102	.2674109
Constant	.5237744	.6514246	0.80	0.421	
Number of Observation	294				
Rho	.9725071				
Sigma	1.095577				
Wald $\chi^2(17)$	410.00				
Prob > χ^2	0.0000				
Log likelihood	-587.08602				

Source: Computer Printout of IV-Probit Regression Analysis.

Note: *, ** and *** means 10%, 5% and 1% level of significance respectively

6.4.3 Effect of CSAP on Poverty Status of Farmer's Millet Enterprise

Table 6.7 attempt to estimate the effect of CSAP on poverty status, the study then introduced the climate smart agricultural index for millet enterprise. The results eventually showed a probability chi-square of 0.000, a token that the overall model was significant. The results also indicated that CSAP for millet, age, education, housing materials and State were significant determinants of poverty status, considering that they were all significant at 10% significant level.

The results from the Table 6.7 show that CSAP was significant and manifested a negative relationship with the odds of being poor for farmers involved in millet enterprise as that of maize and sorghum. In point of fact, the result suggests that a unit increase in CSAP for millet, reduces the probability of farmers involved in millet production being poor by 0.8618127. This was equivalent with the report of World Bank, (2011) the body affirmed that, experience has shown that growth in the agricultural sector which include CSAP are highly effective in poverty reduction and increasing food security. In the meantime, age had a significant and positive relationship with the probability of being poor. The result inferred that a unit increase in age, increases the probability of farmers being poor by 0.0333073. Hence, it tallied with the studies of Maurice, (2005); Amaza et al, (2006) and Zalkuwi, (2013) for they reported a significant relationship between farmers' age and efficiency in agricultural production, and that younger farmers have the tendency to operate more efficiently than older ones.

Furthermore, the result presented State as significant and also with positive relationship and the probability of being poor for farmers that participated in millet enterprise. Additionally, education is significant and inversely related to the probability of being poor. Respondents who had informal education, decreases the probability of being poor by 0.2404237. This is probably because education contributed to knowledge in the area of technical know-how, hence more productivity and income. This is in conformity with the work of Mohammed et al, (2014) who stated that climate change adaptation is greater for those who have higher educational fulfilment compared to illiterate farmers. Patently, it is evident that educated farmers have more knowledge and respond to anticipated changes promptly, are better able to forecast future scenarios and overall, have greater access to information and opportunities than others, which might inspire adaptation to climate change. Moreover, several studies found out that education also positively and significantly affects agricultural productivity and the adoption of new technology (Quayum and Ali, 2012). Additionally, the examination evinced that housing materials was significant and a resultant negative relationship with the probability of being poor for farmers in millet enterprise. The result indicated that a unit increase in the number of farmers that used bricks or concrete zinc

reduced the probability of the respondents being poor by 0.357765. This result revealed that the rate of poverty in Katsina State is higher than Sokoto State as a result of high population in the former; hence the State with high dependency ratio tended to be more vulnerable to poverty than the one with less dependency ratio. This was in agreement with the findings of Achem et al., (2013) which stated that farmers are faced with family welfare and other living expenses for such a large dependants and these expenses justified the low saving at the end of every harvest season aside the fact that most farm produce are consumed by the large household members.

Table 6.7: IV-Probit Regression Results Determining the Effect of CSA Practices on Poverty Status of Farmer's Millet Enterprise

Description	Coefficient	Standard Error	Z-value	P>/z/-value	Marginal Effect {dy/dx}
Milletcsaindex	-.8618127	.0746003	-11.55	0.000***	-.8618127
Age	.0333073	.0112111	2.97	0.003***	.0333073
Sex	-.2310507	.3492081	-0.66	0.508	-.2310507
Education	-.2404237	.0932965	-2.58	0.010***	-.2404237
Marital status	.1385795	.4241677	0.33	0.744	.1385795
Households size	.0253905	.0521846	0.49	0.627	.0253905
Farm size	-.0105633	.0251334	-0.42	0.674	-.0105633
Experience	-.0155156	.0108839	-1.43	0.154	-.0155156
Ownership farmland	.2115872	.3581873	0.59	0.555	.2115872
Land Acquisition	.0531429	.3274727	0.16	0.871	.0531429
Labour	.1024686	.213681	0.48	0.632	.1024686
Membership	-.0993023	.1693368	-0.59	0.558	-.0993023
Transportation	-.2986372	.227099	-1.32	0.189	-.2986372
Housing materials	-.357765	.1970982	-1.82	0.069*	-.357765
Communication kits	-.1078572	.1340477	-0.80	0.421	-.1078572
Access to credit	-.0396649	.1485683	-0.27	0.789	-.0396649
State	.3212522	.1746636	1.84	0.066*	.3212522
Constant	-1.278858	.6282223	-2.04	0.042	
Number of Observation	294				
Rho	.9817122				
Sigma	1.092558				
Wald $\chi^2(17)$	393.09				
Prob > χ^2	0.0000				
Log likelihood	-583.41157				

Source: Computer Printout of IV-Probit Regression Analysis.

Note: *, ** and * means 10%, 5% and 1% level of significance respectively**

6.4.4 Effect of CSAP on Poverty Status of Farmer's Groundnut Enterprise

The study further investigates how CSAP for groundnuts enterprise affect poverty status of farmers in the study area. The estimation results in Table 6.8 show that the overall model is significant given the probability chi-square of 0.000. The results also indicated that CSAP for groundnut enterprise, age, education, households' size, experience, housing materials and State were significant determinants of poverty status at 10% level of significance. This is very similar to the maize scenario but differs from that of the sorghum and millet scenario. The results further show that CSAP for groundnut is inversely proportional with the probability of being poor for farmers involved in groundnut enterprise. As such, the results suggest that a unit increase in CSAP reduces the probability of farmers involved in groundnut production to be poor by 0.719364. Again, education is significant and inversely related to the probability of being poor. This time, it is significant at 10% level of significance. The respondents who had informal education, decreases the probability of being poor by 0.2350159. This was in consonance with Okunmadewa and Omonona's (2005) submission, that extension education was good machinery through which education can be implemented on the farmers for their sustainable agricultural productivity.

Additionally, age had positive relationship with the probability of being poor. The result shows that a unit increase in age, increases the probability of farmers being poor by 0.0428294. This was in line with the findings of Rekwot, (2014) who discovered that older groundnut farmers were poor and were not able to optimize their production efficiency because of their inability to update useful information that are pertinent to groundnut production. The results show that household size was significant and had a positive relationship with the probability of being poor for farmers involved in groundnut enterprise. Subsequently, a unit increase in farmer's household size increases the probability of farmers involved in millet CSAP to be poor by 0.1262777. This is not surprising given that the larger the household size, the higher the dependency ratio. This was in line with the report of Mathonze, (2000) who stated that the size of the household was found to have a negative impact on farm income. A large household size which is actively involved in farming is useful to provide farm labour but household size that is big and most members are just dependants, makes the farming household to be vulnerable to poverty, a view supported by Nganga, (2009). The study attributed large household sizes to the desire to have enough family labour which in most cases end up having more children to care for their daily needs. This may be understood from the view point of the African's polygamous tendencies and also the extended family setting. In fact, most of the respondents are Muslims and polygamy is not abhorred by its adherents. Experience was another variable that exhibited a significantly inverse relationship with the probability of being

poor with groundnut enterprise. Obviously, a unit increase in experience reduces the probability of being poor by 0.0236805. This is expected a priori given that experience should improve expertise and consequently optimize production. A similar knowledge was noted in Asogwa et al.'s (2012) findings, for the researchers discovered that experienced farmers were more productive because they were able to learn from their past experience and a consequent ability to solve present challenges and boost their production and income.

As regards the analysis on housing materials, the investigation depicted that it was significant, aside manifesting a negative relationship with probability of being poor for farmers in groundnut enterprise. The result indicated that a unit increase in the number of farmers that used bricks or concrete zinc reduces the probability of the respondents being poor by 0.4015493, demonstrating a uniform outcome with the study of Ajibefun, (2006). According to Ajibefun (2006), lack of proper management in terms of housing and health care used by farmers among other factors are responsible for the low agricultural productivity, adding that inadequate housing is one of the major problems detrimental to the improvement of production and productivity in Nigerian agricultural sector.

Finally, the coefficient of respondents State of origin is positive (0.4897395) and significant at $p < 0.01$ level of significance. This indicated that farmers had significantly high rates of poverty in Katsina State for groundnut climate smart agricultural enterprises than their fellow farmers in Sokoto State.

Table 6.8: IV-Probit Regression Results Determining the Effect of CSA Practices on Poverty Status of Farmer's Groundnut Enterprise

Description	Coefficient	Standard Error	Z-value	P>/z/-value	Marginal Effect {dy/dx}
Groundnutcsaindex	-.719364	.1192245	-6.03	0.000***	-.719364
Age	.0428294	.0124203	3.45	0.001***	.0428294
Gender	-.4463375	.3956314	-1.13	0.259	-.4463375
Education	-.2350159	.1351789	-1.74	0.082*	-.2350159
Marital status	-.3865291	.4566571	-0.85	0.397	-.3865291
Households size	.1262777	.0519257	2.43	0.015**	.1262777
Farm size	-.0041589	.0299557	-0.14	0.890	-.0041589
Experience	-.0236805	.0121905	-1.94	0.052*	-.0236805
Ownership farmland	-.1640579	.4174058	-0.39	0.694	-.1640579
Land Acquisition	-.0363482	.3786044	-0.10	0.924	-.0363482
Labour	.0475729	.2445703	0.19	0.846	.0475729
Membership	-.1953063	.1906244	-1.02	0.306	-.1953063
Transportation	.001493	.2571589	0.01	0.995	.001493
Housing materials	-.4015493	.218418	-1.84	0.066*	-.4015493
Communication kits	-.0253465	.1526643	-0.17	0.868	-.0253465
Access to credit	-.1185087	.1671323	-0.71	0.478	-.1185087
State	.4897395	.1884638	2.60	0.009***	.4897395
Constant	-1.93956	.6765611	-2.87	0.004	
Number of Observation	294				
Rho	.8341323				
Sigma	1.103418				
Wald $\chi^2(17)$	186.97				
Prob > χ^2	0.0000				
Log likelihood	-590.92947				

Source: Computer Printout of IV-Probit Regression Analysis.

Note: *, ** and *** means 10%, 5% and 1% level of significance respectively

6.4.5 Effect of CSAP on Poverty Status of Farmer's Livestock Enterprise

This segment explicates the effect of CSAP for livestock on poverty status of the rural farmers. To that effect, the study in Table 6.9 shows that the chi-square probability is 0.000, hence the overall model was significant. The results authenticated the fact that CSAP for livestock, education, household size, farm size, membership of association and extension contact were significant determinants of poverty status of farmers in the study area at 10% significant level. The negative sign of the climate smart agricultural livestock index pointed to an inverse relationship between the practices and probability of being poor. This means that for all the crops (maize, millet, sorghum and groundnut) considered and then the livestock, CSAP significantly and inversely relates with the probability of being poor as expected a priori. The practice of CSA for livestock production reduces the probability of being poor by 0.6438993. This further buttresses the need for farmers in crops and livestock enterprises to take the practice for CSA more seriously, in order to minimise poverty and this was in agreement with the report of FAO, (2015) which revealed that livestock productivity increases the efficiency of soil and other agricultural inputs which offers higher returns to farmers, hence increasing food availability and reducing high poverty rate in rural community.

Education is equally significant and inversely related to the probability of being poor. Respondents who had informal education, reduces the probability of being poor by 0.312885. This was in relation to adoption of agricultural innovations which is also easier and faster among the educated farmers, as orchestrated by Njoku, (1991) and Amaza et al., (2006) and thus, moves them closer to the frontier of agricultural output. Household size and farm size had a significant and direct relationship with the probability of being poor. A unit increase in household size significantly increased the probability of being poor by 0.1447581. This is not surprising given that the larger the household size, the higher the dependency ratio. This was in line with the findings of Anyanwu, (2013) who reported that poverty is high for a large household's size because of the high rate of dependency ratio with little or no resources to care for the larger households' size. Membership association was another variable that indicated a significantly inverse relationship with the probability of being poor with livestock enterprise. This implies that a unit increase in membership association will reduce the probability of being poor by 0.338705. This is expected a priori given that membership of an association by the respondent will be more knowledgeable than other members as a result of the interaction, and this was in agreement with the findings of Agbamu, (2006) who argued that the greater the participation of a farmer in social organization and the more interaction with others farmers, then the earlier his adoption of innovations. Furthermore,

communication equipment also illustrated a significant inverse relationship with the probability of being poor with livestock enterprise. The inspection manifestly depicted that a unit increase in communication equipment will reduce the probability of being poor by 0.2586087. It is also an expected a priori, knowing that proper information is a stimulant that affects and naturally eventuates in proper transformation of resources such as agricultural productivity. This was also in agreement with the findings of Johnson, (1999) who reported that, Tele-communication opportunities allow spatially parted production, using information technology to synchronize production activities, splits the traditional workshop and E-commerce, which can lead to rapid economic growth and brings about more output and income. The results show that State is significant and has a positive relationship with the probability of being poor for farmers engaged in livestock enterprise. This result indicated that poverty rate in Katsina State is higher than Sokoto State as earlier discussed due to the high rate of dependency ratio.

Table 6.9: IV-Probit Regression Results Determining the Effect of CSA Practices on Poverty Status of Farmer's Livestock Enterprise

Description	Coefficient	Standard Error	Z-value	P>/z/-value	Marginal Effect {dy/dx}
Livestockcsaindex	-.6438993	.0680927	-9.46	0.000***	-.6438993
Age	.0154656	.0127362	1.21	0.225	.0154656
Gender	-.3072264	.3845474	-0.80	0.424	-.3072264
Education	-.312885	.1343072	-2.33	0.020**	-.312885
Marital status	-.3376178	.4333781	-0.78	0.436	-.3376178
Households size	.1447581	.047361	3.06	0.002***	.1447581
Farm size	.0149597	.0282894	0.53	0.597	.0149597
Experience	-.0117404	.0121103	-0.97	0.332	-.0117404
Ownership farmland	-.3235444	.39463	-0.82	0.412	-.3235444
Land Acquisition	-.4923594	.3450545	-1.43	0.154	-.4923594
Labour	-.0522675	.2392773	-0.22	0.827	-.0522675
Membership	-.338705	.1816927	-1.86	0.062*	-.338705
Transportation	.2153821	.2494875	0.86	0.388	.2153821
Housing materials	-.2649417	.2175976	-1.22	0.223	-.2649417
Communication kits	-.2586087	.1544379	-1.67	0.094*	-.2586087
Access to credit	-.0711528	.1628259	-0.44	0.662	-.0711528
State	.3921002	.1874637	2.09	0.036**	.3921002
Constant	-1.024671	.7029864	-1.46	0.145	
Number of Observation	294				
Rho	.8695716				
Sigma	1.397093				
Wald $\chi^2(17)$	260.40				
Prob > χ^2	0.0000				
Log likelihood	-659.79176				

Source: Computer Printout of IV-Probit Regression Analysis.

Note: *, ** and * means 10%, 5% and 1% level of significance respectively**

6.4.6 Effect of CSAP on Poverty Status of Farmer's Crop/Livestock Enterprise

This section articulates the effect of CSAP for the combination of the two major enterprises, namely, crop and livestock enterprises in the study area. In this case of crop/livestock CSAP, the researcher tried to use separate enterprise as an endogenous variable to run the instrumental variable for the probit model analysis but the analysis was not converging, which means the continuous output results was not concave; hence the need for combining the individual CSAP for each crop and livestock for the Principal Component Analysis (PCA) to generate the crop/livestock climate smart agricultural index. Table 6.10 displayed the results of the analysis for the effect of CSAP on the poverty status of farmers using (2SLS)-probit model. The instrumented results were intended to correct the possible problem of endogeneity. However, Wald test of exogeneity was statistically significant at 1% in the fitted model. The result extrapolated that the presence of crops/livestock climate smart agricultural enterprise as an endogenous variable was satisfied and the selected instruments justified. The Wald chi-square statistics was also statistically significant 1%, showing that the model produced a good fit and estimated parameters were jointly unequal to zero.

The probability chi-square of 0.0000, shows that the overall model is significant for the combined analyses. The results demonstrated that CSAP for crop/livestock enterprises, age, education, household size, experience, housing materials, communication equipment and State were significant determinants of poverty status of farmers in the study area at 10% significant level. The negative sign of the climate smart agricultural crop/livestock index shows an inverse relationship between the practices and probability of being poor. This means that for all the crops and livestock considered, the CSAP significantly and inversely relates with the probability of being poor as expected a priori. The practice of CSA for crop/livestock production reduces the probability of being poor by 0.5121226. This was in line with the report of FAO, (2013) which stated that, agricultural sectors such as crops and livestock have transformed themselves in order to feed a growing global population and provide the basis for economic growth and poverty reduction and this transformation accomplished natural resource base such as organic manure from agricultural waste. Furthermore, age, households' size and farm size had a positive relationship with the probability of being poor. The result shows that a unit increase in age of the farmers increases the probability of respondents being poor by 0.0318688. This aligned with the findings of Magxinga et al., (2005) which stated that as a farmer's age increases, it becomes more difficult to respond to opportunities including accessing the local market. Age can, to a large extent, also affect the response to modern innovations in farming activities such as the CSAP. Similarly, this result

coincided with the findings of Anyanwu, (2013) which reported that the level of poverty increases as we go up the age ladder. Additionally, Gan, Sen and Yun, (2004) put forward a life-cycle hypothesis, which stated that poverty is relatively high at young ages, decreases during middle age and then increases again at old age when the law of diminishing returns start to manifest. The households' size presented a similar categorization with respect to age; an increase in households' size will also lead to a corresponding increase in the probability of farmers being poor by 0.1177648. This result also agreed with the a priori expectation because as dependency ratio increases in the family, the household becomes poorer due to the number of family members to be fed, in addition to taking care of their well-being. This was in agreement with Gan, Sen and Yun, (2004) that large households are associated with poverty. Yet still, according to Achem et al., (2013) large family size can sometimes be an asset to the farmers in terms of available work force/labour, even though often times a farmer is faced with the challenges of providing social and welfare facilities such as feeding, education, shelter, health care and other living expenses for such a large number of dependants. Ultimately, these expenses account for low saving at the end of every harvest season, aside the fact that most farm produce are consumed by the large household members.

Furthermore, education is significant and inversely related to the probability of being poor, the farmers who had informal education decrease the probability of being poor by 0.3717899, showing a correspondence with Joseph and Baye's (2014) study. They stated that majority had attended Arabic education and could read and/or write in Hausa or Fulani language. This can be attributed to the fact that the Arabic education is usually taught to the youth at tender ages, thus enabling an improvement in terms of agricultural activities, and a resultant reduction in poverty. In addition, on the word of Anyanwu, (2013) the level of education is an important determinant of poverty. The research he carried out in 2010 was a proof that Nigerians who had little or no education experienced greater poverty. He also stated that education increases the stock of human capital, which in turn increases labour productivities and wages; hence a decrease in education will result in a corresponding increase in the poverty level of an individual.

Moreover, the survey showed that experience was significant and had a negative relationship with the probability of being poor for the crop/livestock enterprise. Thus, a unit increase in the number of farmers' years of experience decreases the probability of the respondents being poor by 0.0192952. The implication is that, the farmers will be more knowledgeable due to the experiences

they acquired from various past events. Evenly, Olayemi, (1998) verified that experience is proportional to age because as the ages of the farmers increase, simultaneously years of experience also increases. It is believed that the higher the years of farming experience of a farmer, the more the ability of such farmer to make good farm management decisions giving him all the necessary funding at his disposal. Equally, housing materials was significant and has a positive relationship with probability of being poor for farmers in crop/livestock enterprise. The result indicated that a unit increase in the number of farmers that used bricks or concrete zinc increases the probability of the respondents being poor by 0.5346467. This may be as a result of the high cost of the building materials such as cements and zinc which sometimes the rural farmers cannot afford due to inadequate income from their agricultural productivity. The result maintained a uniformity with the findings of Okoli *et al.*, (2009) and Ajala, (2007) who reported that 62 % of livestock farmers in northern Guinea Savannah of Nigeria constructed their livestock house (pens) with brick and roofed with thatches. The floor spacing per animal was found to be inadequate and insufficient good roofing with iron zinc could expose the animals to ill health and facilitate the spread of contagious diseases leading to high livestock mortality rate and poor performance (Bastianelli *et al.*, 2002).

Additionally, the result of the analysis indicated that communication equipment was significant and has a negative relationship with probability of being poor for farmers of crop/livestock enterprise. The result revealed that a unit increase in the number of communication equipment will reduce the probability of the respondents being poor by 0.2776469. It harmonized with the report of World Bank (2008), which stated that promoting modern technology in information and communication systems helps enabling producer groups or farmers to access market information and acquire professional advice necessary for modern supply chain management and effective participation in the policy discussion. Also BNARDA, (2005) reported that after the implementation of National Special Programme for Food Security (NSPFS) in selected communities in Benue State, beneficiaries enjoyed GSM communication handsets bought through increased income from NSPFS intervention and which in turn helped rural farmers in their agricultural productivity. Equally, the result revealed that poverty rate in Katsina State is higher than Sokoto State as shown by previous indicators, especially the high-dependency ratio.

Table 6.10: IV-Probit Regression Results Determining the Effect of CSA Practices on Poverty Status of Farmer's Crop/Livestock Enterprise

Description	Coefficient	Standard Error	Z-value	P>/z/-value	Marginal Effect {dy/dx}
Crops/Livestockcsaindex	-.5121226	.0548524	-9.34	0.000***	-.5121226
Age	.0318688	.0119232	2.67	0.008***	.0318688
Sex	-.2957636	.3746506	-0.79	0.430	-.2957636
Education	-.3717899	.1238905	-3.00	0.003***	-.3717899
Marital status	-.0938366	.4288513	-0.22	0.827	-.0938366
Households size	.1177648	.0467431	2.52	0.012**	.1177648
Farm size	.0131584	.0274241	0.48	0.631	.0131584
Experience	-.0192952	.0116287	-1.66	0.097*	-.0192952
Ownership farmland	-.1925776	.3822434	-0.50	0.614	-.1925776
Land Acquisition	-.0663599	.341614	-0.19	0.846	-.0663599
Labour	.0018454	.2306574	0.01	0.994	.0018454
Membership	-.173865	.1799275	-0.97	0.334	-.173865
Transportation	.0120589	.242582	0.05	0.960	.0120589
Housing materials	.5346467	.2090827	-2.56	0.011**	.5346467
Communication kits	-.2776469	.1501989	-1.85	0.065	-.2776469
Access to credit	-.1027178	.1563716	-0.66	0.511	-.1027178
State	.6562722	.169357	3.88	0.000***	.6562722
Constant	-1.725303	.6554086	-2.63	0.008	
Number of Observation	294				
Rho	.9067014				
Sigma	1.721423				
Wald $\chi^2(17)$	270.20				
Prob > χ^2	0.0000				
Log likelihood	-721.00893				

Source: Computer Printout of IV-Probit Regression Analysis.

Note: *, ** and *** means 10%, 5% and 1% level of significance respectively

6.4.7: The Multidimensional Poverty Index of (2SLS) Analysis for Crops and Livestock CSA Enterprises

This section of the study focuses on the utilization of multidimensional poverty index of two stage least square to ascertain the effect of CSAP on the multidimensional poverty index of the respondents in the study area. The post-estimation tools for the multi-dimensional poverty index of 2SLS identified the selected instrumental variables such as expenditure on inorganic manure, education and State to be strong and not weak, to instrument CSAP for crops, livestock and crop/livestock enterprises. CSAP for crops, livestock and crop/livestock enterprises are the key independent variables in each of the three scenarios for testing the effect of CSAP on the multidimensional poverty index of the respondents in the study area, while in contrast, the MPI was developed to be the dependent variable. However, CSAP for crops, livestock and crop/livestock (the key independent variables) are quantitative variables that have been achieved with the aid of the Principal Component Analysis (PCA). The estimation results show a high R-Square of 75% for both crop and livestock enterprises, and 77% for crops/livestock enterprises, suggesting a very high predictability level of the dependent variables by the independent variables. Also, all the three probability chi-square of 0.000 shows that the overall models were significant at 1% level of significance.

6.4.8: Effect of CSA on Multidimensional Poverty Index of (2SLS) Analysis for Crops Enterprise

This study examined the effect of CSAP of crops enterprises on the multidimensional poverty index using (2SLS), and Table 6.12 showing the probability chi-square of 0.000, meaning that the overall model is significant, and the mean VIF is 1.52, which implies that the model is void of any serious multicollinearity problem. The result of the analysis showed that CSAP for crop enterprises, age, religion, ownership of farmland, membership of association, housing materials and communication equipment were significant determinants of deprived multidimensional poverty index of the respondents in the study area, given that their z-values were greater than >1.96 and their probability values were less than <0.05 .

The results of the Table 6.12 depicted that CSAP with crops enterprise was significant and had a negative relationship with MPI. In fact, the result suggests that a unit increase in climate smart agricultural practice, reduces MPI of farmers involved in crop production by 0.3007364. This is expected because CSAP should generally improve agricultural productivity and consequently reduced poverty. This was expected because CSAP had impacted greatly to the respondents'

means of livelihood and also changed their poverty status. This was in support of Aggarwal et al. (2000) who in their research work titled, 'Economic benefits for CSAP to smallholder farmers in the Indo-Gangetic Plains of India' stated that CSAP improve crop yields as well as net returns. The econometric analysis indicates that implementations of CSAP and technologies in smallholder farms in the IGP of India, have significant impacts on the changes in total production costs and the yield of crops. However, the age of the respondents who engaged in crops enterprise was significant and had positive relationships with MPI. The result showed that a unit increase in the age of the farmers increases the MPI by 0.0211582. This implied that the older farmers become, the higher their MPI. This was not in consonant with the findings of Rogers, (2003) who upheld that the perceived attributes of an innovation in agricultural activities such as agricultural techniques would vary according to individuals different personal characteristics such as age, experience and communication channels. Perception about these attributes of innovation will influence adoption of behaviour and the perception about such new techniques, the age and experience are major factors that play out.

In addition, the result showed that religion was significant and had a negative relationship with MPI for farmers in crop enterprises. The result indicated that practicing Islamic religion, had their MPI being reduced by 0.3908004; when compared with non-Muslims. This goes in line the findings of Apata and Awe, (2014). They stated that religion is significant to production and their coefficient of significance was negative implying thus, people that belong to Islamic religion are more productive than those that belong to other religion. This may be due to different level of access to production inputs and opportunities given to the major religious sect in the study area.

Additionally, the result of the analysis demonstrated that ownership of farmland was significant and had a positive relationship with MPI. The result revealed that a unit increase in the number of farmlands' ownership increases the MPI by 0.6637031. In the same way, Eze et al., (2011) confirmed that greater than half of the rural farmers in his study area had full ownership of farmland. By implication, because of the less practices of the land tenure system in the area, land ownership is obviously by inheritance and purchase among other forms. This revealed the fact that, constant transfer of land rights via inheritance led to land fragmentation thereby reducing farm size, and a following reduction in productivity and income. However, membership of an association was also significant and had a negative relationship with MPI for the respondents in crop enterprises. The result indicates that a unit increase in the number of membership of an association reduces the MPI by 0.874686. Relatedly, the findings of Franklin and Patience, (2014)

confirmed that membership in farmers' cooperative societies is very high among farmers in their study area. This was attributed to the benefits that members derived from their cooperatives' organization. The most common benefits include financial assistance, access to essential and scarce production inputs, and a form of insurance cover against crop failure on the members' farms.

Furthermore, housing materials was significant and had a positive relationship with MPI for farmers in crop enterprises. The result of the analysis revealed that a unit increase in the number of farmers that used bricks or concrete cement/zinc materials for building increases the MPI by 1.732706. This was in contradiction to the findings of Jadhav et al., (2011) for they stated that majority of the farmers dwelled in stone and mud houses (81%) and nearly 18% owned houses constructed with cement and bricks. The flooring of the houses made with stone slaps ranked 60% of the farmers' houses, while the ones made with mud was 40%. Likewise, the roofing of the houses was mainly clay tiles, thus attracting a ratio of 45%, while houses with mud roof was a fraction of 18%, 5% had metal sheets and only 3% had modern roof.

Equally, the results ascertained that communication kits was significant and had a positive relationship with MPI for respondent, in crop enterprises. A unit increase in the use of GSM for communication will increase the MPI by 1.109964, which however contravened the report submitted by World Bank, (2006). Contrariwise, the findings (World Bank, 2006) revealed that the importance of using targeted public and private research investments in communication to resolve technological bottlenecks in the supply chain, the presence of social media and environmental sustainability criteria, a focus on outcomes in terms of poverty reduction and an emphasis on collaboration among actors are functionally a driver of competitiveness. Additionally, the consistent provision of key infrastructure services such as communications, roads, water and electricity is a central element of an enabling environment, as they are relevant public policies to maintain sustainable market competitiveness.

Table 6.11: Multi-Collinearity Test of Variables

Description	VIF	Tolerance	Eigen Value
Age	2.52	0.3966	11.0655
Sex	1.99	0.5035	1.3194
Marital status	1.76	0.5684	0.9841
Religion	1.16	0.8641	0.8954
Households size	1.54	0.6500	0.7467
Farm size	1.14	0.8810	0.6124
Experience	2.37	0.4222	0.3974
Ownership farmland	1.84	0.5433	0.2757
Land Acquisition	1.50	0.6689	0.2434
Labour	1.06	0.9431	0.1329
Membership	1.55	0.6451	0.1071
Transportation	1.12	0.8941	0.0778
Housing materials	1.17	0.8521	0.0620
Communication kits	1.21	0.8258	0.0363
Extension contacts	1.03	0.9689	0.0243
Access to credit	1.44	0.6963	0.0127
			0.0068
Mean VIF	1.52		

Source: Computer printout of Multicollinearity Test

Table 6.12: Multidimensional Poverty Index (2SLS) Analysis for Crops CSA Enterprise

MPIindex	Coefficient	Standard Error	Z-value	P>/z/-value
Cropscsaindex	-.3007364	.0663187	-4.53	0.000***
Age	.0211582	.0079913	2.65	0.008***
Sex	-.2358375	.2434869	-0.97	0.333
Marital status	.3059399	.2591988	1.18	0.238
Religion	-.3908004	.1658785	-2.36	0.018**
Households size	.0069469	.0172686	0.40	0.687
Farm size	.0172747	.016104	1.07	0.283
Experience	-.0081623	.0075621	-1.08	0.280
Ownership farmland	.6637031	.24074	2.76	0.006***
Land Acquisition	.0286285	.2182321	0.13	0.896
Labour	-.0365408	.1453235	-0.25	0.801
Membership	-.8746846	.1032507	-8.47	0.000***
Transportation	-.0426148	.1450852	-0.29	0.769
Housing materials	1.732706	.1357505	12.76	0.000***
Communication kits	1.109964	.0972432	11.41	0.000***
Extension Contacts	-.0453184	.0379546	-1.19	0.232
Access to credit	.142326	.0994695	1.43	0.152
Constant	-2.015972	.4231245	-4.76	0.000
Number of Observation	294			
Wald $\chi^2(17)$	923.28			
Prob > χ^2	0.0000			
R-Square	0.7484			
Root MSE	.70989			

Source: Computer Printout of MPI (2SLS) Regression Analysis

Note: *, ** and *** means 10%, 5% and 1% level of significance respectively

6.4.9: Effect of CSA on multidimensional poverty index of (2SLS) Analysis for Livestock Enterprise

The examination of the effect of CSAP of livestock enterprises on the multidimensional poverty index using 2SLS and the Table 6.13 showing probability chi-square of 0.000 meaning that the overall model is significant, and the mean VIF is 1.52, which implies that the model is void of any serious multicollinearity problem. The result of the analysis ascertained that CSAP for livestock, religion, ownership of farmland, membership of an association and housing materials were significant determinants of deprived poverty status of the farmers in the study area.

CSAP was significant and had a negative relationship with MPI for farmers involved in livestock enterprise in the Table 6. 13. In fact, the result suggests that a unit increase in climate smart agricultural practice reduces MPI by 0.2420245. This is in line with the findings of Callaway, (2004) who substantiated in his research work that many empirical studies conducted in the IGP region, also indicated that the implementation of CSAP increases livestock production, crop yields, farm income and input use efficiency which was as a result of crops/livestock integrated management. And this was also validated with the findings of FAO of the United Nations, (2015) which reported that farmers needed a collective action to adopt most of the CSAP so as to achieve discernible impact on agricultural production in the face of climate change and enhance resilience of rural livelihoods because the adoption of CSAP will help to entrench and harness more economic and environmental benefits to be realized by many farmers.

Also, the result showed that religion was significant and had a negative relationship with MPI for farmers in livestock enterprises. The result revealed that a unit increase in the number of farmers that practice Islamic religion will reduce their MPI by 0.3101763. An equivalent result was noted by Ekong, (1988). The study confirmed that the institutions of family religion, morality, marriage, state, and property have been altered and the adoption of technology led to the transformation in the economy with the evolution of new social classes which has altered modes of life, institutions of family religion, morality, marriage and property. Many functions of the family have been taken away by other agencies, religious and traditional believers have lost hold over their members. Conflicts or disequilibrium has crept in between the new technology and the old social organization resulting in social lag in the rural communities. On the other hand, the result of the analysis show that farmland ownership was significant and had a positive relationship with MPI for respondents in livestock enterprises.

It was also observed that a unit increase in the number of farmland ownership increases the MPI by 0.6308056. This is in agreement with the findings of Fasona and Omojola, (2005). They noted that, the guinea savannah farmers who were already farming close to the margins of cultivation would naturally resist any attempt of invasion of their farmlands by cattle herdsman who were continually in search of greener pastures that were only in existence within the limit of arable farmland. These conflicts led to burning and destruction of farmlands and houses which in turn had tremendous adverse effect on the environment; hence, the more farmland a farmer has, the more conflict with herdsman. Congruently, Oyekale, (2012) observed that land conflict increased unsustainable land use in Niger Delta region of Nigeria, as well as noted that where there is land conflicts, investment in sustainable land management practices cannot be promoted. It is therefore evident that land conflict promotes environmental degradation.

Similarly, membership association was also significant and had a negative relationship with MPI for the farmers in livestock enterprises. The result revealed that a unit increase in membership societies will increase MPI by 0.9119656. This is in consonant with the findings of Adefila, (2012) who piloted a study on the factors influencing the performance of farmers' cooperative organizations in Gurara area, Niger State of Nigeria. The outcomes from the regression analysis indicated that famers' cooperative organizations are involved in agricultural development and that factors influencing their role performance include annual income, experience in farming and leadership training. The study concluded that cooperatives in whatever form are seriously viewed as catalyst in the process of rural socioeconomic development and the law should empower cooperatives to perform certain functions, such as strengthening their negotiating power as effective agents of socio-economic rural transformation.

Likewise, housing materials was significant and had a positive relationship with MPI for respondent in livestock enterprises. The result indicated that a unit increase in the number of farmers that use bricks or concrete/zinc materials for the construction of their houses increases the MPI by 1.868803. Contrariwise, the findings of Attah, (2012) asserted that housing cooperatives is involved in the building of low cost houses or even renting them on behalf of members, and they rent these buildings on owner occupier basis. This makes it possible for members to become eventually the landlords of their own houses without spending a huge amount of money.

Table 6.13: Multidimensional Poverty Index (2SLS) Analysis for Livestock CSA Enterprise

MPIIndex	Coefficient	Standard Error	Z-value	P>/z/-value
Livestockcsaindex	-.2420245	.0712911	-3.39	0.001***
Age	.0071547	.0073537	0.97	0.331
Sex	-.2505577	.2424615	-1.03	0.301
Marital status	.201189	.2564993	0.78	0.433
Religion	-.3101763	.1661474	-1.87	0.062*
Households size	.0221361	.0173994	1.27	0.203
Farm size	.0027504	.0153043	0.18	0.857
Experience	-.0010308	.007332	-0.14	0.888
Ownership farmland	.6308056	.2393362	2.64	0.008***
Land Acquisition	-.2931967	.2110767	-1.39	0.165
Labour	-.0670254	.1453036	-0.46	0.645
Membership	-.9119656	.1032153	-8.84	0.000***
Transportation	.0248209	.1439458	0.17	0.863
Housing materials	1.868803	.1303798	14.33	0.000***
Communication kits	1.130305	.0983726	11.49	0.000***
Extension Contacts	-.0470573	.0386808	-1.22	0.224
Access to credit	.1315647	.0988692	1.33	0.183
Constant	-1.387317	.3927443	-3.53	0.000
Number of Observation	294			
Wald $\chi^2(17)$	924.07			
Prob > χ^2	0.0000			
R-Square	0.7511			
Root MSE	.70605			

Source: Computer Printout of MPI (2SLS) Regression Analysis

Note: *, ** and * means 10%, 5% and 1% level of significance respectively**

6.4.10: Effect of CSA on multidimensional poverty index of (2SLS) Analysis for Crops/Livestock Enterprise

The effect of CSAP of crop/livestock enterprises on the multidimensional poverty index using 2SLS, and the Table 6. 14 showing probability chi-square of 0.000 which was obtained, meaning that the overall model is significant, and the mean VIF is 1.52, an index that the model is void of any serious multicollinearity problem. The result of the analysis ascertained that CSAP for crop/livestock enterprises, age, ownership of farmland, membership of association, housing materials and communication kits were significant determinants of MPI of the respondents' in the study area given that their z-values were greater than >1.96 and their probability values were less than <0.05 .

In addition, Table 6. 14 shows that CSAP was significant and had a negative relationship with MPI for farmers involved in crops/livestock enterprise. In fact, the result suggests that a unit increase in climate smart agricultural practice reduces the MPI by 0.2177158. An equivalent submission was made by Aggarwal et al, (2013) they upheld that the implementation of CSAP and technologies could improve crop yields, livestock productivity, bring abandoned land under cultivation and increase the income of smallholder farmers. Besides, CSAP revolve around seed, water, energy, nutrients and some risk averting instruments that help farmers in reducing climatic risks in agricultural activities. Additionally, the age of the farmers who are into crops/livestock enterprise was significant and had positive relationships with the MPI. The result shows that a unit increase in the age of the respondent, increases the MPI by 0.014705. This implies that the older farmers get to, the more possibility for their MPI to increase. This was in agreement with the finding of Yusuf et al (2011), that age is positively related to participation in '*gandu*' and it significantly influenced participation in '*gandu*'. Thus, as the age of the farmer increases, the tendency to participate in '*gandu*' also increases and vise-versa.

Pertaining to religion, it was discovered that religion was significant and had a negative relationship with MPI for farmers in crops/livestock enterprises. The result indicated that a unit increase in the number of farmers that practice Islamic religion, will reduces the MPI by 0.3279175. This was however contrary the findings of Ukeje, (2008) who stated that the frequent communal/religious crisis in some region of the country is a major constraint to food security in Nigeria. The crises occur either during planting, weeding or harvesting period and with the flight of farmers from the areas irrespective of the stage of farming, food security is threatened as most, if not all the crops are lost.

Unlike religion that portrayed a negative relationship with MPI for farmers in crops/livestock enterprises, the examination of the ownership of farmland was significant and had a positive relationship. The result revealed that a unit increase in the number of farmland ownership increases the MPI by 0.6637031. The findings contrasted the a priori expectation because according to the study of Raufus, (2010) in Nigeria's agriculture, the excellence factor stands out as a major cause of land productivity. This is due to the problems related with sourcing artificial amendments that can improve the productivity of land especially by majority poor subsistent farmers that dominate the arable crop production landscape. The alternative structures to this, are the intensive use of the plots of land which typically would result in farmland nutrient degradation, low yield restricted farms and continuous poverty following low output. However, increase in farmland use intensity without corresponding plans to complement the soil with sustainable nutrients could be detrimental to the national policy on self-food sufficiency in the long run. Also, loss of ecosystem functioning could be other consequences of irrational use of agricultural land (Geist et al., 2005).

However, membership of an association was also significant and had a negative relationship with MPI for the respondents in crops/livestock enterprises. A unit increase in the number of membership of an association, reduces the MPI by 0.874686. This is in consonant with the findings of Veerakumaran, (2005) who revealed that cooperatives serve as essential tool for achieving food security at household level. Co-operatives are the best influential intervention for achieving food security in any country. The developed nations like United States of America, Canada, almost all European countries have attained food self-sufficiency through cooperatives (Chambo, 2009). Furthermore, housing materials was significant and had a positive relationship with MPI for farmers in crops/livestock enterprises. The result of the analysis revealed that a unit increase in the number of farmers that used bricks or concrete cement/zinc materials for building increases the MPI by 1.732706. Differently, Breisinger et al., (2008) avowed that homegrown manufacturing and service sectors take full advantage of the country's comparative advantage in the expansion process and are also likely to lead to a broad-based growth in order to accommodate the raw materials such as blocks, roofing sheet, flooring and other building materials in order to make the building materials easily accessible to the middle class..

The results showed that communication kits was significant and had a positive relationship with MPI for respondent, in crops/livestock enterprises. It was ascertained that a unit increase in the use of GSM for communication will increase the MPI by 1.109964. Nevertheless, this study's result negated the findings of World Bank, (2011) because the organization reported that many

developing countries have been registering real progress in the last few years by expanding ICT infrastructure and universal access of communication technologies. For instance, the report made by ITU, (2010) on mobile phone coverage of Africa revealed that, only the mobile penetration rates alone will reach an estimated 41 % growth at the end of 2010 (compared to 76 % globally) leaving a significant potential for growth. This can be counted as a promissory development in dropping down the existing gap of ICT application level known as “digital divide” between countries. Oppositely, the spread of these technologies might worsen the digital divide as companies might become too dependent on the technology and service they are providing. Per se, this must be addressed by a well-organized and effective ICT policy. Generally, it is considerably important to expand ICT infrastructures as this advancement improves the overall economic, social and political transformation of the poor living in the rural areas.

Table 6.14: Multidimensional Poverty Index (2SLS) Analysis for Crop/Livestock CSA Enterprise

MPIindex	Coefficient	Standard Error	Z-value	P>/z/-value
Crop/livestockcsaindex	-.2177158	.0492873	-4.42	0.000***
Age	.014705	.0073017	2.01	0.044**
Sex	-.2678662	.2345769	-1.14	0.253
Marital status	.243013	.2483791	0.98	0.328
Religion	-.3279175	.1599406	-2.05	0.040**
Households size	.018677	.0166469	1.12	0.262
Farm size	.0113607	.0151013	0.75	0.452
Experience	-.0050341	.0071642	-0.70	0.482
Ownership farmland	.6675424	.2316268	2.88	0.004***
Land Acquisition	-.1172788	.2044856	-0.57	0.566
Labour	-.0529275	.1399946	-0.38	0.705
Membership	-.8823083	.0993309	-8.88	0.000***
Transportation	-.0096466	.1392061	-0.07	0.945
Housing materials	1.783062	.1284655	13.88	0.000***
Communication kits	1.107219	.0944422	11.72	0.000***
Extension Contacts	-.0551526	.0372423	-1.48	0.139
Access to credit	.1185266	.0955386	1.24	0.215
Constant	-1.727015	.3903677	-4.42	0.000
Number of Observation	294			
Wald $\chi^2(17)$	995.02			
Prob > χ^2	0.0000			
R-Square	0.7671			
Root MSE	.68289			

Source: Computer Printout of MPI (2SLS) Regression Analysis

Note: *, ** and * means 10%, 5% and 1% level of significance respectively**

6.5 Hypotheses Statement

The study employs three of the hypotheses which are the second, fourth and fifth objectives because they can be statistically measured:

The null and alternative hypotheses for objective two are specified thus:

H₀: Farmers socio-economic characteristics do not significantly influence indicators of CSAP within different crops and livestock enterprises.

H₁: Farmers socio-economic characteristics significantly influence indicators of CSAP within different crops and livestock enterprises.

6.5.1 Evaluation of the Hypotheses for objective two

The probability value of education socio-economic characteristics: 0.005, 0.008, 0.009, 0.046 and 0.050 for millet, livestock, maize, groundnut and sorghum enterprises respectively, are all less than 0.05 and absolute t – value greater than 1.96 shows that CSAP are significant at the standard of 1% except 5% for the sorghum enterprises significant level. Therefore, the researcher rejected the null hypothesis and accepted the alternative hypothesis which stated that farmers' socio-economic characteristics such as education significantly influence indicators of CSAP within different crops and livestock enterprises.

The null and alternative hypotheses for objective four are specified thus:

H₀: Climate smart agricultural practices do not significantly affect poverty status of farmers in the study area.

H₁: Climate smart agricultural practices significantly affect poverty status of farmers in the study area.

6.5.2 Evaluation of the Hypotheses for objective four

The probability value of 0.000 for maize, sorghum, millet, groundnut, livestock and crop/livestock climate smart agricultural indices which are all less than 0.05 and absolute t – value greater than 1.96 shows that CSAP are significant at the standard of 1%. Therefore, the researcher rejected the null hypothesis and accepted the alternative hypothesis which stated that CSAP are significant and determinant of poverty status of farmers in the study area.

The null and alternative hypotheses for objective five are specified thus:

H_0 : Climate smart agricultural practices do not significantly affect MPI of the farming household in the study area.

H_1 : Climate smart agricultural practices significantly affect MPI of the farming household in the study area.

6.5.3 Evaluation of the Hypotheses for objective five

The probability value of 0.000 for crop CSA indices, livestock CSA indices and crop/livestock climate smart agricultural indices which are all less than 0.05 and absolute t – value greater than 1.96 shows that CSAP are significant at the standard of 1%. Therefore, the researcher rejected the null hypothesis and accepted the alternative hypothesis which stated that CSAP are significant and has an effect on MPI of farming household in the study area.

CHAPTER SEVEN

SUMMARY OF MAJOR FINDINGS, CONCLUSIONS AND POLICY RECOMMENDATIONS

7.0 Introduction

This is the concluding chapter of the study and it gives a complete summary on the objectives investigated and the outcomes observed. This chapter has five sections: the summary of the study, conclusion, policy implications of the findings, policy recommendations and suggested areas for further studies.

7.1 Summary of the Findings

This research work was motivated and encouraged by the increasing consequences of climate change and its bearing on the poverty status on the rural farmers. The current poverty situation in Nigeria is alarming, and it is exacerbated by food insecurity, an upshot of climate change. This necessitated the examination of CSAP and poverty level of the smallholder farming households in North-West Nigeria. The selected research questions addressed were: what are the socio-economic characteristics of farmers in the study area? What are the constraints to the high-users and low-users of CSAP in the study area? What are the factors influencing indicators of CSAP within different crops and livestock enterprises? What is the poverty status of those who are high-users and low-users of climate smart agricultural techniques in the study area? And what are the effects of CSAP on poverty status of farmers? The study employed descriptive statistical analysis, likert scale technique, PCA, ordinary least square regression analysis, Foster, Greer and Thorbecke, EDE-FGT index, IV-Probit and MPI of Two Stage Least Square (2SLS) models to address these research questions.

The results showed that the high-users of CSAP are more in Katsina State than Sokoto State. The study further showed that males (94%) are more involved in CSAP than the females, and that the high-users of CSAP are mostly knowledgeable through informal education. Many of the respondents who are high-users of CSAP were married as against those who are low-users of CSAP with a significant difference between the groups. Additionally, 91% of the respondents were Muslims. Furthermore, the study evinced that land was principally owned through inheritance and about 69% of the farmers employed both family and hired labour. Likewise, it was discovered that streams/rivers as well as deep well water were mostly used for watering crops, animals and washing their household items, while bore holes were mostly used for drinking and washing. The research showed that public water was seldom used by the respondents as not up to (13%) used it

for irrigation, drinking, washing and watering crops/animals. This result depicted a parallel with Adekoya's (2014) findings, that majority (70.9%) of the farm households did not have access to potable water. The findings further showed that only 48% had access to credit and the credit source with the highest average credit received was from family/relations, followed by cooperative societies and then microfinance banks.

In terms of constraint, the results showed that more than 50% of the respondents agreed that the lack of access to credit, lack of access to education, lack of access to improved crop varieties, lack of access to high quality breeds, lack of time to practise CSA, lack of technical knowledge, lack of information from radio, lack of awareness of CSAP, cost of labour was high, cost of input was high, lack of social interaction, lack of demonstration of climate smart agricultural techniques and lack of processing technology were constraints to the practice of climate smart agriculture, and majority of them said they were very serious constraints.

The study indicated that age ($p<0.10$), gender ($p<0.10$), education ($p<0.01$), marital status ($p<0.10$), households ($p<0.10$), housing material ($p<0.01$), communication ($p<0.05$), lack of time ($p<0.01$) and State ($p<0.01$) were significant determinants of the use of CSAP for the maize enterprise. Also, education ($p<0.01$), farm size ($p<0.05$), communication equipment ($p<0.01$), extension contact ($p<0.05$) and lack of access to high quality hybrid ($p<0.05$) were significant determinants of the use of CSAP for the livestock enterprise.

The study employed several decomposition techniques, and consequently, the investigation demonstrated that as regards all the monetary dimensions (per capita expenditure and food) low-users of CSA had higher poverty rates and higher poverty severity than high-users of climate smart agricultural farmers. In the case of FGT relative poverty index for per capita expenditure, when disaggregated, the low-users of climate smart agricultural farmers were relatively 2% poorer than high-users of climate smart agricultural farmers. Also in the case of FGT relative poverty index for food, when disaggregated, the low-users of climate smart agricultural farmers were absolutely 8% food poorer than high-users of climate smart agricultural farmers. Finally, the CSAP in all the crops (maize, sorghum, millet and groundnut) livestock and crop/livestock enterprises decreases the odds or probability of being poor significantly.

7.2 Conclusion of the Study

The research work was motivated by the increasing popularity of climate alteration consequences being witnessed all over the world. Projections show that developing countries who are least prepared for this changes in the climatic situations will be the most affected. However, the present poverty in Nigeria is frightening and climate change brings about food insecurity and poverty to a large extent. It was on this note that the study assessed CSAP and its implication on poverty status of small holder farming households in North-West Nigeria. The findings showed that lack of access to credit, lack of access to education, lack of access to improved crop varieties, lack of access to high quality hybrid, lack of time to practice CSA, lack of technical knowhow, lack of information from radio, lack of awareness of CSAP, cost of labour was high, cost of input was high, lack of social interaction, lack of demonstration of climate smart agricultural techniques and lack of processing technology were constraints to the climate smart agricultural activities and majority of them said they were very serious constraints.

Additionally, the study showed that age, education, farm size and type of housing materials were the significant determinants on the use of CSA for most of the enterprises under consideration. Furthermore, the results also showed that poverty rate was higher for low-users of CSAP than for high-users for all dimensions and using all the decomposition techniques. The findings also showed that high-users of CSAP had reduced odds of being food poor significantly. It is worth noting that while some of the techniques measure all the poverty status of the farmers, others such as the EDE FGT measure only the poverty gap and severity. The poverty line in each case is two-third of the mean of each dimension as discussed in chapter three. This arbitrary poverty line is not completely bias as the focus is to compare poverty status between farmers of high-users and low-users of CSAP. And CSAP in all the crops (maize, sorghum, millet and groundnut) and livestock enterprises decrease the odds or probability of being poor significantly. Also training and integration on climate change adaptation tactics at the various national levels will bring about a wider ownership of climate response and allow sketches on a wider pool of human resources and financial implementation, with supporting institutional structures and extensive dimensions. Following this, agriculture system must therefore include climate change effects as a benchmark to safeguard sustainable production in agricultural activities. As a result, farmers, particularly the younger generation who are anticipated to be future agriculturalists, need to be equipped not only with CSA knowledge, but climate threat management approaches such as timely atmospheric information, crop and livestock insurance, credit facilities and institutions, such as farmers'

cooperative societies. CSAP has been proposed as an approach that can combat climate change and desertification comprehensively by emphasizing adaptation to climate change. Having assessed the approach through the prism of the framework, we found that broadly speaking it fits with what can be termed as a sustainable technology. Admittedly, there are many aspects, such as the emphasis on cultural functions that will need to be addressed and that is why CSAP in a societies like Nigeria where the poor are often cheated out of programmes should integrate all the needs of the disadvantaged into the policy before its final adoption. Such a review has become necessary because the approach, as currently conceived, does not do enough justice to some of the critical issues in the agricultural sector in Nigeria.

There is need for an all-inclusive approach that would not only enhance environmental protection for the country but also respect social values. The outcomes of some of the current practices adopted to manage adverse environmental impacts were found to provide coping strategies that fit with the concepts of CSAP although, still not very widespread enough. However, here we contribute to the existing empirical literature on whether a combination of multiple CSAP is more resilient against climate change and to reduce poverty. In addition, we simulate the possible effects of CSAP on poverty based on both the choice of practices. Our results indicated that the current choices of alternative combinations of practices influenced poverty status of rural households' farmers in the study area. The study therefore recommends that massive campaigns be made by government, civil societies and the media to create awareness about CSAP and to proffer indigenous solutions that address the significant constraints being faced. There is equally a need to boost the role of financial institutions in terms of the volume and frequency of credits given out and to reduce or eliminate their interest rate for the farmers, especially for those that practise CSA.

7.3 Policy Implication of Findings

The findings of the study suggest several policy implications as follows:

- (i) The socio economic characteristics show that majority of the respondents are old matured farmers with an average age of fifty three (53). This implies that youths in the study region were not really involved in CSAP which might create an age gap in farming activities. This could be due to the fact that the business was not lucrative enough and hence it did not attract their business acumen, or there was a misconception about the farming enterprises, and as such they might prefer white collar jobs. Notwithstanding the stardpoints of the youths, there was a need for the ageing generation to handover to the younger generation.

- (ii) The study equally shows that majority (94%) of the farmers were male and this was not surprising as the study area has a clear male dominance that stems from their culture and religion believed. There was still need for policy formulation so that even the women whose husbands are involved in other sectors could delve into farming and in the long run can increase productivity and profitability.
- (iii) The statistics infers that education was very low in the study area given that only 24% had post primary education and 56% had Arabic education which was an informal system of education. Therefore, it is needful to stimulate policies to encourage an advancement in education which will in turn reflect on their acceptability of CSAP.
- (iv) The study shows that only 47% of the respondents are involved in membership associations in form of cooperative societies as against 53% who are not members of any. This was alarming considering the relevant information that was circulated in these associations that could be of benefit to the farmers. Moreover, the highest source of credit was from cooperative societies which was one of those associations that could help them expand their farming enterprise if given the required credit facilities and could enable them better their farming activities in the CSAP.
- (v) The report shows that public water was seldom used by the respondents as not up to 13% used it for irrigation, drinking, washing and watering animals. This will definitely increase the cost of production and restrain the farmers from employing irrigation which was one of the CSAP, given that the farmers may not be able to afford boreholes or may not be around or near streams. Public water was generally perceived to be better because it was considered to be subsidised by the government and properly distributed to all households at a moderate price rate.
- (vi) The study examined sixteen (16) indicators to check the extent to which they are constraints and concluded that lack of access to credit, lack of access to education, lack of access to improved crop varieties, lack of access to high quality hybrids, lack of time to practice CSA, lack of technical knowledge, lack of awareness of CSAP, cost of labour was high, cost of input was high, lack of demonstration of climate smart agricultural techniques and lack of processing technology were very serious constraints to CSAP in North- West of Nigeria.
- (vii) The results show the significant determinants of the use of CSAP for five enterprises (maize, sorghum, millet, groundnut and livestock). The most recurring significant variables were age, education, farm size and type of housing materials. These

determinants could therefore constitute the benchmark for adequate policies aimed at improving CSAP for each enterprise.

- (viii) Furthermore, the finding shows that poverty rate was higher for low-users of CSAP than for high-users. This implies that the practice of CSA was an antidote to poverty elimination in the study area. Farmers should make conscious efforts to practice climate CSA regardless of their poverty status due to the fact that poverty resides more with low-users. It could also be as a result of the fact that high-users make their production sustainable by practising CSA and consequently accrue high yields that might in turn reduce their poverty status.
- (ix) Finally, CSAP in the selected crops (maize, sorghum, millet and groundnut) and livestock enterprises decrease the odds or probability of being poor significantly.

7.4 Policy Recommendations

Recommendations based on the policy implications are outlined:

- (i) The study recommends that massive campaigns be carried out in educating the youths regarding the importance of agriculture production activities and how sustainable it can be when using CSAP. The importance could equally be emphasised in the school curriculum so as to diffuse the misleading urge for white collar jobs and focus on where the talents lead you. Formal education and Arabic educational curriculum should be enriched with climate smart agricultural information and should be agriculturally focused. This will serve as bait for household farmers in the study area because education was one of the major significant variables.
- (ii) Government, Non-Governmental Organizations (NGO) or Civil Society Groups can advance campaigns promoting and encouraging women to develop interest and their involvement in climate smart agricultural farming in the North-West Nigeria; disclosing the advantages of having both heads of the family earn income from various agricultural activities. The media also have a huge role to play in encouraging women to set up associations and unite to break off from the 'purdah' system being practised in the study area and this limitation is caused by male dominance in the study area because marital status was one of the significant variables.
- (iii) There is need to invent new ways of encouraging education in the study area. The government has done a considerable work in this aspect, the most significant being the universal basic education. Nonetheless, it is still necessary to make such considerations for post primary educational levels so as to get those who eventually become farmers

more knowledgeable about the business which is becoming more lucrative and scientific with CSAP and not just planting and then wait for harvest time activities. In the educational sector, there is very urgent need to re-orientate the thinking and value system of both parents and their children through mass educational campaign regarding the importance of education and the need for parents to insist on their children going to school at least up to first degree before seeking employment or going into business because majority were found to be informally educated.

- (iv) There is equally a need for public water to be provided to farmers. If getting pipe borne water will be difficult, dams and canals could be built and water circulated across the farms to encourage irrigation and settle other forms of water needs in the study area. Investing in the agricultural sector to reduce poverty should be a matter of great priority and there is also need to encourage productivity and access in both farm and non-farm occupations through direct input to strengthening the agricultural research and extension facilities, adapting agricultural technology and taking extension services to poor farmers, and by improving physical infrastructure such as rural roads and irrigation. Since poverty in Nigeria does have important spatial implications, geographic targeting especially in the North West and rural areas can play an important role in government anti-poverty efforts. Moreover, geographically targeted programmes are attractive partly because they are more cost-effective than untargeted programs. Thus, making financial capital, physical infrastructure especially roads, water supply, electricity and technological innovation available in poor zonal and rural areas will lead to important contribution to government's efforts to reduce poverty in the study area.
- (v) There is need for massive campaigns in creating awareness about existing CSAP and ways to domesticate these practices by using their immediate environments to show them ways of keying into CSAP. Lack of awareness was seen to be a very serious constraint and therefore clearly needs increased efforts in that direction. And extension delivery system services should emphasise on household education and training of farmers on how to practise CSA because extension contact was one of the significant variables.
- (vi) There is the need for birth rate to be controlled even among farming households. This is because, contrary to expectation, poverty level increases with a rise in the number of children in the households, if the birth rate is reduced, the child dependency ratio

will be reduced and the farming households will be better off. Hence, it is suggested that farming households should be educated on the need and on how to use contraceptive measures and devices to control explosive population which is growing geometrically on daily and yearly basis in the study area. Given that poverty increases with the number of household size, there is urgent need to intensify family planning services efforts and activities in Nigeria so as to improve knowledge and practice of family planning. Our results and analyses above suggest that policy interventions are necessary to reduce poverty in Nigeria because monogamous marriages tend to reduce poverty although government cannot legislate marriage structure given the heterogeneous nature of the country and the need to promote freedom of choice, public and private sector policies can be used to increase the proportion of high quality monogamous marriage rates among rural farmers, which will be an important strategy for poverty reduction in the study area.

- (vii) It is equally needful to address all the identified challenges or constraints of practising CSAP as they stand as stumbling blocks and until they are addressed, the practice will not be encouraged. The study therefore recommends that conscious efforts be made at the three tiers of government to address all the constraints highlighted in this study.
- (viii) There is need for significant empowerment of the farmers. Some of the CSAP have cost implications and require extra money to fund it. Insufficient credit facilities will not encourage farmers to practice CSA as some of them can barely afford seeds and tools more or less of hybrid seeds and other forms of CSAP. It is important that the rural capital market be opened up to the poor to allow them to borrow money on regular market terms. In addition, the difficulties and bureaucracies (like suitable collateral and education of the applicants involved in formal lending procedures must be removed). In line with this, formal financial institutions should be ready to collect and invest the small amount of potential savings that are available in the rural areas. This is to curb the pronounced tendency to consume conspicuously which is evident in connection with birthday ceremonies, marriages or burial activities of the farmers in the study area.
- (ix) Government and farmers' organisations should create an environment to motivate the low-users of CSA to increase and improve on the level of their usage of CSAP because CSA was one of the significant variables that needed to be improved for more productivity and profitability.

- (x) The practice of CSA can be greatly encouraged to the rural farmers since they are getting involved in the practices gradually. Moreover the consequences of climate change effect, on all and sundry, has been alleged to increase poverty levels among farmers. It is therefore only logical to practise CSA so as to be sustainably increasing in agricultural productivity, income, adapt and build resilience to climate change, reduce or eliminate green-house gas emission which enhances achievement of national food security and reduce poverty in the long run.

7.5 Suggestions for Further Studies

- (i) Studies on CSA are very intriguing and following current trends and so many more, empirical studies need to be done in this line. Studies could relate CSA and other indicators besides poverty such as output productivity and input materials amongst others.
- (ii) The study for CSAP could equally be done for small and medium sized enterprises or large scale agro-based firms especially to investigate if the economies of scale enjoyed by these firms permit or ease the practices of CSA.
- (iii) This study was done in North-West Nigeria but could be done for other regions and nations. It could equally be scaled down to States and Local Government Areas.
- (iv) Other studies could equally broaden the scope of the CSAP under consideration to include more and considering mostly indigenous CSAP of that particular study area.
- (v) Other studies could investigate the level of awareness as it affects output or yields, efficiency of CSAP and its challenges vis-a-vis output amongst others.

References:

- Abadi, A., Lefroy, T., Cooper, D., Hean, R. and Davies, C., (2003). "Profitability of medium to low rainfall agroforestry in the cropping zone". Barton, Australia, Rural Industries Research and Development Corporation Publication No. 02.
- Achem, B.A, Mohammed, B.T, Aduba, J.J, Muhammad-Lawal, A. and Abdulquadri, F 1. (2013). "A Comparative Assessment of the Profitability of Cassava Processing Enterprises in Kwara State, Nigeria" *Global Journal of Current Research*. Vol 1 No. 2: pp. 57-61.
- Action Aid Nigeria, (2009). "Fighting Poverty in the midst of Plenty II. *Country Strategy Paper* 2009–2013, Action Aid Nigeria.
<http://africanajournal.org/poverty-reduction-attainment-mdgs-nigeria-> (Retrieved 2016).
- Adedeji, O.S., Du, H. and Opoku A., (2013). "Inclusive Growth: An Application of the Social Opportunity Function to selected African Countries IMF-Working Paper (139). Washington, DC.
- Adefila J. O. (2012). "Spatial assessment of farmers' cooperatives organizations in agricultural development in Gurara area of Niger State" *Nigeria. Journal of Ecology and Natural Environment*. Vol. 4(2): pp 51-57.
- Adefolalu, D.O.A., (2007). "Climate Change and Economic Sustainability in Nigeria". *Paper presented at the International conference on climate change, Nnamdi Azikiwe University, Awka* 12-14 June 2007 Vol1 (1): pp. 36 – 49.
- Adamu, A.M and Odion E.C., (2000). "Improving Crop-Livestock Systems in the Dry Savannas of Nigeria".
- Adereti, F. O., (2005). "Coping Mechanisms of Rural Women in Poverty Alleviation in Osun State" In a Democratic and Deregulated Economy: *Implications for Agricultural Extension as a Discipline in Journal of Agricultural Extension*, 8. (2005).
- Adetunji, M. A., (2013). "Assessment of the Quality of Urban Transport Services in Nigeria" *Academic Journal of Interdisciplinary Studies (AJIS)*. Sapienza University of Rome, Italy. Vol 2 (1): pp. 49 – 58.
- Adeyemi, V.A., Alonye G.O. and Owolade E.O., (2013). "Awareness and usage of Modern Information and Communication Technology by Agricultural Extension Workers in Oyo State, Nigeria.
- Adeyemo R., and Bamire A.S., (2005). "Saving and Investment Patterns of Cooperative Farmers in Southwestern Nigeria. *Journal of Social Science*. Vol 8(3): pp. 183-192.
- Adger, N. W., Arnell, N. W., Tompkins, E. L., (2005). Successful Adaptation to Climate Change across Scales. *Global Environmental Change* Vol 15: pp 77–86.

- Aggarwal, P.K., Talukdar K.K. and Mall R.K. (2000) "Potential Yields of the Rice Wheat System in the Indo Gangetic Plains of India" Rice-Wheat Consortium Paper Series 10, Rice-Wheat Consortium for the Indo-Gangetic Plains, New Delhi and Centre for Applications Systems, Indian Agricultural Research Institute, New Delhi.
- Aggarwal, P. K., Zougmore, R. and Kinyangi. J., (2013). "Climate-Smart Villages: A Community Approach to Sustainable Agricultural Development. CGIAR Research Program on Climate Change" Copenhagen, Denmark.
- Agbamu, J.U, (2006). "Essential of Agricultural Communication in Nigeria". Malthouse Press Limited, Lagos.
- Ahmed, S. A., Diffenbaugh, N. and Hertel, T., (2009). "Climate Volatility Deepens Poverty Vulnerability in Developing Countries". *Environmental Research Letters* Vol. 4 (3): pp. 1–8.
- Aigbe, F. O. and Isiorhovoja R.A., (2013). "Crop Productivity, Land Degradation and Poverty Nexus in Delta North Agricultural Zone of Delta State, Nigeria" *Journal of Agricultural Science*.
- Ajibefun, I.A. (2006). "Linking Socio-Economic and Policy Variables to Technical Efficiency of Traditional Agricultural Production: Empirical Evidence from Nigeria" *Poster paper*.
- Ajakaiye D., O and Adeyeye V.A., (2001). "The Nature of Poverty in Nigeria". Technical Report, NISER, Ibadan.
- Ajala, M.K., Adeshinwa, A.O.K, and Bawa G.S, (2006). "Socio-Economic Characteristics Influencing Swine Management Practices among Women in Jama'a Local Government Area of Kaduna State, Nigeria" *Institute of Agricultural Research and Training, Obafemi Awolowo University, Ibadan, Nigeria. Pp 43 – 48*, Retrieved January 31, 2011, from <http://www.ccba.uady.mx/publicaciones/journal/2006-2/80-socio.pdf>
- Ajayi, O., Akimmifesi, F., Mullila-Mitti, J., Dewolf, J., Matakala, P. and Kwesiga, F., (2008). "Adoption, Profitability, Impacts and Scaling-up of Agroforestry Technologies in Southern African Countries". In Batish, D., Kohli, R., Jose, S. and Singh, H., (Eds.). "Ecological basis of Agroforestry". Taylor and Francis Group, Boca Raton, Florida.
- Akinyemi, G. O., Adebagbo, C. A., Tayo, O. S., Akinyemi, I. G and Ige, P. O., (2009). "Effective Environmental Management" A Recipe for Sustainable Food Production in Nigeria, pp. 775-778.
- Akor, G. (2012). "Exploring the Link between Climate Change and its Impact on the Livelihoods of Farmers and Agricultural Workers in Nigeria". A Paper Presented at the Conference on Climate Change Impact on the Livelihoods of Farmers and Agricultural Workers Organized by Friedrich Ebert Stiftung (FES), Ghana, pp. 1-33.
- Aku, P.S., Ibrahim, M.J. and Bulus, Y.D., (1997). "Perspective on Poverty Alleviation Strategies in Nigeria". *In Proceedings of the Nigeria Economic Society Annual Conference on Poverty Alleviation in Nigeria 1997. Ibadan: NES: 41-54*. Prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18.

- Alderman and Paxson. (1992). "Do the Poor Insure? A Synthesis of the Literature on Risk and Consumption in Developing Countries" mimeo, World Bank and Woodrow Wilson School, Princeton University.
- Aliyu A., Ibrahim S.U., and Abdulhameed A.G. (2016). "Effect of Socio-Economic Characteristics of Farmers on Deforestation Adaptation Strategies in Mubi-South Local Government Area of Adamawa State, Nigeria. (*IJRD*) *Journal of Agricultural and Research*. Vol2 issue 7.
- Alkire, S., and Santos. M.E. (2010). "Acute Multidimensional Poverty: A New Index for Developing Countries." Background paper for the 2010 *Human Development Report*. UNDP (United Nations Development Programme).
- Alkire, S and Foster J, (2011). "Counting and Multidimensional Poverty Measurement. *Journal of Public Economics*, Vol 95: pp 476-487.
- Allen, R.G., Pereira, L.S., Raes, D. and Smith, M., (1998). "Crop Evapotranspiration, Guidelines for Computing Crop Water Requirements". *Irrigation and Drainage. Paper*, No. 56, FAO, Rome, Italy.
- Amaghionyeodiwe, L.A. and Osinubi, T.S., (2004). "Poverty in Nigeria". The Nigerian Economic Society, Ibadan.
- Amaza, P.S. and Maurice, D.C., (2005). "Identification of Factors that Influence Technical Efficiency in Rice-Based Production Systems in Nigeria" Working Paper, Policies and Strategies for Promoting Rice Production and Food Security Workshop, Cotonou (Benin).
- Ani, D.P., Umeh J.C. and Weye E.A., (2013). "Profitability and Economic Efficiency of Groundnut Production in Benue State, Nigeria. *African Scholarly Science Trust*. Vol 13 (4).
- Anselm A.A. and Taofeeq A.A., (2010). "Challenges of Agricultural Adaptation to Climate Change in Nigeria: A Synthesis from the Literature" Field Actions Science Reports. *Journal of Field Actions Vol. 4*. Department of Agricultural Economics, University of Nigeria, Nsukka, Nigeria. [Http://factsreports.revues.org](http://factsreports.revues.org)
- Anyanwale, K.C., (2007). "Climate Dynamics of the Tropics". KAP: Dordrecht. p. 488.
- Anyanwu, J.C., (1997). "Poverty in Nigeria: Concepts, Measurement and determinants". In: *Proceedings of the Nigerian Economic Society Annual Conference on Poverty Alleviation in Nigeria*. Nigerian Economic society, Ibadan. pp. 93-120.
- Anyanwu, J. C. (2012), "Accounting for Poverty in Nigeria: Illustration with Survey Data from Nigeria". African Development Bank Working Paper, No. 149.
- Anyanwu J.C (2013). "Marital Status, Household Size and Poverty in Nigeria" Evidence from the 2009/2010 Survey Data. African Development Bank Group Working Paper Series No: 180. <http://www.afdb.org>

- Apata O. M and Awe Y, (2014). "Traditional Beliefs and Practices of Women Involvement in Agricultural Activities in South-Western Nigeria" *Sky Journal of Agricultural Research* Vol 3(1), pp 031 – 036. Available online <http://www.skyjournals.org/SJAR>
- Appleton, S. and Balihuta, A. (1996). "Education and Agricultural Productivity: Evidence from Uganda", in *the Journal of International Development*, Vol. 8, No. 3, pp 415-443.
- Aremu, M. A., and Adeyemi, S. L., (2011). "Small and Medium Scale Enterprises as A Survival Strategy for Employment Generation in Nigeria" *Journal of Sustainable Development* Vol. 4, (1).
- Aslihan, A. Nancy, M. Leslie, L. Solomon, A. Andrea, C, and Misael, K, (2015). "Climate Smart Agriculture Assessing the Adaptation Implications in Zambia" International Conference of Agricultural Economic (ICAF). Agriculture in an Interconnected World. *Journal of Agricultural Economics (JAE)*. Doi 10.1111/1477-9552.12107.
- Assunção, J. and Chein F.F., (2009). "Climate Change, Agricultural Productivity and Poverty." Working Paper, Department of Economics, and PUC-Rio de Janeiro, Brazil
- Attah, Chinasa Priscillia (2012). "Assessment of Rice Farmers Cooperative in Enugu State, Nigeria" Department of Agricultural Extension Faculty of Agriculture University of Nigeria, Nsukka.
- Awoyemi, T. T; Falusi, A. O.; Idowu A. .O. and Omonona B. T. (2011). "Non-Farm Income Diversification and Poverty among Rural Farm Households in Southwest Nigeria" *Journal of American Science*. Vol. 8, (1) pp. 77 – 82.
- Ayinde, O. E., Adewumi M. O., Olatunji G.B., and Babakola, O. A., (2010). "Determinants of Adoption of Downy Mildew Resistant Maize by Small-Scale Farmers in Kwara State, Nigeria. *Global Journal of Science Frontier Research*, 10.
- Barau, B., Ibrahim M.H., Idris, Y.D., Abdullahi, I.D., Kaka, A.A., Wakili, A., Mai Wada A.A., Jaafar, S., Zainab, A.M. and Solomon, R., (2016). "Effective use of Climate Smart Agriculture for Sustainable Land use Management in African Dry Land. *Proceedings of the 1st International conference on Drylands* 218.
- Bastianelli D., Derail L., Klotz S, (2002). "L'élevage porcin. Mémento de l'Agronomie CIRAD-GRET Ministère des Affaires étrangères, pp. 1487-1527.
- Bationo A, Christianson C.B. and Klaj M.C., (1996). "The Effect of Crop Residue and Fertilizer use on Pearl Millet yields in Niger". *Fertilizer Research* Vol.34, 251-258.
- Bello O. B., Ganiyu O. T., Wahab M. K. A.1, Afolabi M. S., Olukye F., Ig S. A., Mahmud J., Azeez M. A., and Abdulmalik S. Y., (2012). "Evidence of Climate Change Impacts on Agriculture and Food Security in Nigeria". *International Journal of Agriculture and Forestry*. Vol 2 (2): pp. 49-55.
- Benue State Agricultural and Rural Development Authority (BNARDA) (2005). "Implementation Completion Report on National Special Programme for Food security (NSPFS), Makurdi Benue State Nigeria.

- Bharucha Z, and Pretty J, (2010). "The roles and Values of Wild Foods in Agricultural Systems. Phil Trans Royal Socio Biological Science: Vol 365; pp 2913 – 2926.
- Blackwood, D.L. and Lynch, R.G., (1994). "The Measurement of Inequality and Poverty": A Policy makers' Guide to the Literature. *World Development*. Vol 22(4): pp. 567 – 578.
- Bless, C., Higson-Smith, C. and Kagee, E., (2006). "Fundamental Social Research Methods" An African Perspective. (3rd edition.) Cape Town: Juta and Company.
- Boke, M., Niang, I., Nyong, A., Vogel, C, and Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R, and Yanda, P. "Africa", In Parry, M., Canziani, O., Palutikof, J., Van-der Linden P, and Hanson C. (eds.), (2007). "Climate Change" Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report (AR4) Cambridge University Press, Cambridge, UK: UN Inter-governmental Panel on Climate Change (IPCC), pp. 433 – 467.
- Bourguignon, F. (2006). "From Income to Endowments" The difficult task of expanding the income poverty paradigm. In Grusky, D. and Kanbur, R., editors, *Poverty and Inequality*. Stanford University Press.
- Bourguignon, F., M. Fournier, and M. Gurgand. 2007. Selection Bias Corrections Based on the Multinomial Logit Model: Monte-Carlo Comparisons. *Journal of Economic Surveys* Vol: 21: pp 174-205.
- Breisinger, C., X. Diao, J. Thurlow, B. Yu, and Kolavall, S. (2008). "Accelerating Growth and Structural Transformation: Ghana's Options for Reaching Middle-Income Country Status. IFPRI Discussion Paper 00750. Washington, DC: IFPRI.
- Bradshaw, T.K. (2006) "Theories of Poverty and Anti-Poverty Programs in Community Development", RPRC Working Paper No. 05-06.
- Branca, G., Nancy, M., Leslie, L. and Maria C.J., (2011). "CSA: A Synthesis of Empirical Evidence of Food Security and Mitigation Benefits from Improved Cropland Management". Mitigation of Climate Change in Agriculture (MICCA) Programme, FAO, Rome Funded by the Government of Finland.
- Branca, G., Lipper L. and Sorrentino, A. (2012). "Benefit-Costs Analysis of Climate-related Agricultural Investments in Malawi: A Case Study. Paper presented at First Conference of Italian Association of Agriculture and Applied Economics. Trento, Italy.
- Callaway, J. M, (2004). "Adaptation Benefits and Costs: are they important in the Global Policy Picture and How can we Estimate them? *Global Environmental Change* Vol: 14, pp 273–282.
- Canagarajah, S.J., Ngwafon, and Thomas S., (2001). "Poverty in Wealthy Economy: The case of Nigeria". *Journal of African Economic* Vol. 10 (2): pp. 143 - 17.
- CCAFS, FAO. (2014). "Climate-Smart Agriculture" What is it? Why is it needed? Rome, Italy: Food and Agriculture Organization of the United Nations.

- CGIAR, CCAFS, (2015). "Agricultural Trials helps repurpose Data for Adaptation Research". <http://ccafs.cgiar.org/AgTrials>, accessed 15/05/15.
- Chakravarty, S.R., Mukherjee D. and Ranade, R., (1998). "On the Family of Subgroup and Factor Decomposable Measures of Multidimensional Poverty". *Research on Economic Inequality* Vol. 8: pp. 175-194.
- Chambo, S. (2009). "Agricultural cooperatives: Role in Food Security and Rural Development" Paper presented to expert group meeting on cooperatives New York.
- Chen, H., Hu, B., and Charles, T., (1995). "Chinese Integrated Fish Farming". *A Comparative Bio Economic Analysis. Aquaculture Research* 26, 81 – 94.
- Chaipa, I. and King, B., (1998). "Urban Agriculture in Zimbabwe". *Nature, Significance and Prospects*.
- Chiappero, E. (2008). "Complexity and Vagueness in the Capability Approach" *Strengths and Weakness? In Comim, F., Qizilbash, M., and Alkire, S., editors, The Capability Approach*, pages 268{309. Cambridge University Press.
- Cline, W.R, (2008). "Global Warming and Agriculture". *Finance and Development*, Vol. 45(1) pp. 23–27.
- Cresencia, A., Boris E. B. U., Mukherjee, D., Nasambu, O., Nelson, K., Mike, D. and Naveen, P., (2013). "Productivity Gaps Among Smallholder Groundnut Farmers: A Comparative Analysis for Uganda and Kenya" 4th *International Conference of the Africa Association of Agricultural Economists*, Hammamet, Tunisia.
- Codjoe F. N., Ocansey C.K., Boateng O.D. and Ofori J., (2013). "Climate Change Awareness and Coping Strategies of Cocoa Farmers in Rural Ghana". *Journal of Biology, Agriculture and Healthcare* Vol3 (11). www.iiste.org
- Dankelman I, (2008). "Gender in Climate Change Adaptation". Workshop for the Development of Policy Guidelines on Mainstreaming Gender into Disaster Risk Reduction. Geneva. United Nations/International Strategy for Disaster Reduction www.unisdr.org
- Delgado, C. M., Rosegrant, H., Steinfeld, S. E., and Courbois, C., (1999). "Livestock to 2020: The Next Food Revolution". Food, Agriculture and the Environment Discussion Paper 28, Washington, D.C. International Food Policy Research Institute.
- Deressa, T.T., Hassan, R.M and Ringler C. (2010). "Perception of and Adaptation to Climate Change by Farmers in the Nile Basin of Ethiopia. *Journal of Agricultural Science*. Published online on August 23, 2010.
- Devendra, C., and Chantalakhana, C. (2002). "Animals, Poor People and Food Security. Opportunities for Improved Livelihoods through Efficient Natural Resource Management. *Outlook on Agriculture*, Vol31, pp.161-175.
- Di Fakó, S; Yesuf, M; Köhlin G., and Ringler C. (2012). "Estimating the Impact of Climate Change on Agriculture in Low-Income Countries" Household Level Evidence from the Nile Basin, Ethiopia. *Environmental and Resource Economics* Vol.52: pp 457-478.

- Diale, N.R, (2011). "Socio-economic indicators influencing the adoption of hybrid Sorghum" The Sekhukhune District perspective. South Africa Journal Agricultural Extension. Vol. (39), pp. 75–85.
- Draper, D. and Maureen, G. R., (2009). "Our Environment": A Canadian Perspective. United States: Nelson Education Ltd.
- Dumanski, J., Peiretti, R., Benetis, J., McGarry, D. and Pieri, C., (2006). "The Paradigm of Conservation Tillage". Proc. World Association of Soil and Water Conservation, P1: pp. 58-64.
- Durojaiye, A.D., (1995). "Dimension of Urban Poverty". A case study of Agbowo area in Ibadan Metropolis, Oyo State, Nigeria. An unpublished M.Sc Dissertation of the Department of Agricultural Economics. Nigeria: University of Ibadan.
- ECLAC, (2006). "Compendium of Best Practices in Poverty Measurement" Expert Group on Poverty Statistics, Rio Group. United Nations Economic Commission for Latin America and the Caribbean.
- Egwemi, V. and Odo L. O., (2013). "Rural Development and Poverty Eradication in Nigeria". JORIND Vol. 11(1). www.transcampus.org/journal; www.ajol.info/journals/jorind
- Ekong, E. E. (1988). "An Introduction to Rural Sociology" First Edition. Jumak Publishers Limited, Ibadan, Nigeria.
- Ekpoh, I.J., (2010). "Adaptation to the Impact of Climatic Variations on Agriculture by Rural Farmers in North-Western Nigeria". *Journal of Sustainable Development*. Vol. 3 (4): pp. 194-202.
- Ekpoh I. J. and Nsah E. (2010). "Extreme Climatic Variability in North-Western Nigeria: An Analysis of Rainfall Trends and Patterns. *Journal of Geography and Geology*, Vol; 3(1): pp 51-63.
- Englama, A., and Bamidele, A., (1997). "Measurement Issues in Poverty: In Poverty Alleviation in Nigeria", Selected Papers for the 1997 Annual Conference. The Nigeria Economic Society, Ibadan. pp. 141-56.
- Enujeke, E., and Ofuoku, A., (2012). "Determinants of Adaptation to Climate Change among Arable Crop Farmers in Edo state, Nigeria and its Implications for Extension Service". *International Journal of Advance Biological Research*. Vol.2: pp. 220-227.
- Etim, N. A. and Udofia, U. S., (2013). "Analysis of Poverty among Subsistence Waterleaf Producers in the Tropic". Implications for Household Food and Nutrition Security. *American Journal of Advanced Agricultural Research*. Vol. 1(2): pp. 62-68.
- Eze, C. C., Konkwo, S. O. Orebiyi J.S and. Kadiri F.A (2011). "Land Tenure System, Farm Size, Innovation and Agricultural Productivity in South-East Nigeria. *Contributed Paper for the Agricultural Economics Society's 85th Annual Conference Held at University of Warwick 18th -20th April, 2011*.
- Fanen, T. and Adekola O., (2014). "Assessing the role of climate-smart agriculture in combating climate change, desertification and improving rural livelihood in Northern Nigeria", *African Journal of Agricultural Research*. Vol. 9 (15): pp. 1180 – 1191.

- FAO, (2015). "Food and Agriculture Organization of the United Nations Rome"
Barriers, Incentives and Benefits in the Adoption of Climate-Smart Agriculture Lessons
from the MICCA pilot project in Kenya.
- FAO/WFP, (2007). "Crop and Food supply Assessment Mission to Swaziland". Special Report.
<http://www.fao.org/giews/>. Retrieved on 18/06/2010.
- Farauta, B.K; Egbule, C.L; Idrisa, Y.L and Agu, V.C (2011). "Climate Change and Adaptation
Measures in Northern Nigeria: Empirical Situation and Policy Implications" African
Technology Policy Studies Network. Working Papers Series No: 62.
- Fasona, M.J. & Omojola, A.S. (2005). "Climate change, human security and communal clashes
in Nigeria" *Paper prepared for Human Security and Climate Change*.
- Federal Office of Statistics (FOS, now National Bureau of Statistics), (1999). "Poverty and
Agricultural Sector in Nigeria-Poverty Incidence of Farmers by Region, FOS, Office,
Abuja, Nigeria". *Journal of Science and Technology Education Research* Vol. 1(4):s pp.
85 -91, September 2010 Available online <http://www.academicjournals.org/JSTER>
©2010 Academic Journals.
- Federal Office of Statistics, (FOS), (1999). "Poverty Profile for Nigeria" A Statistical Analysis
of 1996/1997 National Consumer Survey (With reference to 1980, 1985 and 1992
Surveys), FOS, Lagos.
- Food and Agricultural Organization (FAO), (2001). "Conservation Agriculture" A Case studies
in Latin America and Africa. FAO Soils Bulletin: 78. Rome, Food and Agriculture
Organization of the United Nations: pp. 69.
- Food and Agricultural Organization (FAO), (2005). "World Agriculture, towards 2015/2030.
- Food and Agricultural Organization (FAO), (2007). "The State of Food and Agriculture". Paying
Farmers for Environmental Services. Rome.
- Food and Agricultural Organization (FAO), (2009). "Increasing Crop Production Sustainably,
the Perspective of Biological Processes. Rome.
- Food and Agricultural Organization (FAO), (2010). "The State of Food and Agriculture 2010".
Food Aid for Food Security. Rome. <http://www.fao.org/catalog/inter-e.htm> Retrieved in
(2016).
- Food and Agricultural Organization (FAO), (2011). "Food and Agriculture Organization of the
United Nations, 2011. FAOSTAT Database. Available at www.fao.org/. FAO, Rome.
- Food and Agricultural Organization (FAO), (2013). "CSA Source book" Rome.
<http://www.fao.org/publications>. Retrieved 15/11/2013.
- Food and Agriculture Organization FAO, (2017). "Climate-Smart Agriculture" Source Book
Summary Second Edition. Food and Agriculture Organization of the United Nations Rome.

- Foster, J. E., Greer, J. and Thorbecke, E., (1984). "A Class of Decomposable Poverty Measures Econometrics" Vol. 52: pp. 761-76. Cornell University.
- Foster, J. E., Greer, J. and Thorbecke, E., (2010). "The Foster-Greer-Thorbecke (FGT) Poverty Measures. Twenty-Five Years Later. HEP-WP-2010-14" *Institute for International Economic Policy*. www.gwu.edu/~ilep.
- Fowler, R. and Rockstrom, J., (2001). "Conservation Tillage for Sustainable Agriculture" An Agrarian Revolution Gathers Momentum in Africa". *Soil and Tillage Research*, Vol. 61(1-2): pp. 93-107.
- Franklin E. N and Patience I. O, (2014). "Role of Farmers' Cooperative Societies in Rural Development in Nigeria" The Center for Agricultural Economic Research. The Hebrew University Magnes Press, Jerusalem. *Journal of Rural Cooperation*. Vol. 42, No. 2. 2014.
- FTF, (2016). "Climate Smart Agriculture in Feed for the Future Programme" The U.S Government's Global Hunger and Food Security Initiative, America.
- Gang, I. N., Sen, K., and Yun, M-S (2004), *Caste, Ethnicity and Poverty in Rural India*. (See: www.wm.edu/economics/seminar/papers/gang.pdf)
- Garcia, R. M., Kohl, R., Ruengsorn, A. and Zislin, J. (2006). "Nigeria: Economic Performance Assessment. Accessed from Washington D. C. United States Agency for International Development (USAID): <http://pdf.usaid.gov/pdfdocs/PNADF350.pdf>.
- Geist H, Lambin E, McConnell W, Alves D. (2005). "Causes, Trajectories and Syndromes of Land Use/Cover Change" UPDATE Newsletter of the International Human Dimensions Programme on Global Environmental Change, 03/2005, pp. 6-7.
- Global Multidimensional Poverty Index (2015). "Ranking of Nigerian States by Poverty Rates". Retrieved from: <http://www.nairaland.com/2418994/ranking-nigerian-states-poverty-rates>.
- Greene, W., (2003). "Econometric Analysis, 5th Edition" Englewood Cliffs, Prentice Hall.
- Hailemariam, T; Alemu, M; Gunna, K and Salvatore D.F (2016). "Environment for Development" Discussion Paper Series: Does Adoption of Multiple Climate-Smart Practices Improve Farmers Climate Resilience? Empirical Evidence from the Nile Basin of Ethiopia; pp 16 - 21.
- Harris, F., (1999). "Nutrient Management Strategies of Small-Holder Farmers in a Short-Fallow Farming System in North-East Nigeria". *The Geographical Journal*. 165 Vol. (3): pp. 275-285.
- Hassan D. I, Mbap S.T and Naibi S.A (2015). "Socio-Economic Characteristics of YANKASA sheep and West African Dwarf Goat's farmers and their production constraints in Lafia, Nigeria. *International Journal of Food, Agriculture and Veterinary Sciences*. Vol. 5 (1): pp. 82 -93 <http://www.cibtech.org/jfav.htm>
- IAASTD (2009). International Assessment of Agricultural Knowledge, Science and Technology for Development: Global Report. Island Press, Washington, DC. In "Making CSA Work for the Poor". www.worldagroforestry.org (policy brief, retrieved on 13th March, 2012).

- Ifelunini, I. A., Jonah, T. A., Wosowei, E. C. and Otene, S., (2013). "Multidimensional Poverty Incidence in Nigeria: Empirical Insight from Core Welfare Indicator Questionnaire (CWIQ) Survey. *Journal of Economics and Sustainable Development*, Vol4 (16).
- Ikhile, C.I, (2007). "Impacts of Climate Variability and Change on the Hydrology and Water Resources of the Benin-Owena River Basin". Ph.D. Thesis Submitted to the Department of Geography and Regional Planning, University of Benin, Benin City, Nigeria, pp 234-236.
- Intergovernmental Panel on Climate Change IPCC, (2001). "Climate Change: The Scientific Basis". Cambridge University Press. The Edinburgh Building, Cambridge CB2 2RU, United Kingdom.
- Inter-Governmental Panel on Climate Change, (IPCC), (2007). "Fourth Assessment Report: Climate Change 2007 (AR4)". Geneva: IPCC.
- International Federation of Red Cross (IFRC), (2000). "World Disasters Report 2000". Geneva. <http://www.ifrc.org> Retrieved in (2016).
- International Fund for Agricultural Development (IFAD), (1993). "The State of World Rural Poverty". A profile of Latin America and the Carib bean. International Fund for Agricultural Development. Discussion Paper 10.
- Isaac, C.L., (2009). "Contradictions in Post-War Education Policy Formulation and Application in Colonial Malawi 1945 – 1961. A Historical Study of the Dynamics of Colonial Survival
- Ismala, U., Gana A.S., Tswana, N.M. and Dogara. D., (2010). "Cereals Production in Nigeria Problems, Constraints and Opportunities for betterment. *African Journal of Agricultural Research Vol 5* (12): pp. 1341 – 1350.
- ITU, 2010. *Measuring the Information Society*, Available at: http://www.itu.int/newsroom/press_releases/2010/pdf/PR08_ExecSum.pdf [Accessed on February 18, 2011]
- ITU, 2010. *World Telecommunication/ICT Development Report*, Monitoring the WSIS Targets, Geneva, Switzerland
- Jadhav B, Manjunath L, and Patil B, L (2011). "Study on the Profile of Mango Growers in Dharwad District of Karnataka. *Research Journal of Agricultural Sciences Vol 2* (2): pp. 388-392.
- James, C., (2013). "Global status of commercialized biotech/GM crops" 2013. ISAAA Brief No. 45. Ithaca, New York: ISAAA.
- Joseph D. B and Ango I.N, (2014). "The Effect of Socio-Economic Characteristics of Cattle Farmers on the Adoption of Artificial Insemination Technology in Kaduna State of Nigeria. *IOSR, Journal of Agriculture and Veterinary Science*. www.iosrjournals.org
- Johnson, T.G. (1999). "The New Geography of World Trade: A Rural Perspective". Farm Foundation.

- Judy, C. B., (2007). "Women and Agriculture in Sub-Sahara Africa" Implication for Development. (An Exploratory Study). *The Journal of Development Studies*. Vol. 17 Issue (3): pp. 29 – 46.
- Kalat, P. D. and Adunni, S, (2015). "Family Farming and its Influence on Household Poverty: A case study of Northern Nigeria" Conference on International Research on Food Security, Natural Resource Management and Rural Development organized by the Humboldt-Universität zu Berlin and the Leibniz Centre for Agricultural Landscape Research (ZALF).
- Kalungu, J. W, and Filho, W. L and Harris, D, (2013). "Smallholder Farmer Perception of the Impacts of Climate Change and Variability on Rain-fed Agricultural Practices in Semi-arid and Sub-humid Regions of Kenya". *Journal of Environment and Earth Science*, Vol. 3 (7): pp. 129-140.
- Kehinde M.O, Adebayo M., Maria G. O., Funminiyi P. O, and Lois T. A, (2017). "Land Tenure and Property Rights Impacts on Adoption of Climate Smart Practices among Smallholder Farmers in Nigeria" Conference Proceedings of the 18th Annual National Conference of the Nigerian Association of Agricultural Economics Held at Federal University of Agriculture, Abeokuta, Nigeria.
- Khanal, U., Thapa, K. and Thapa, K. B., (2013). "Climate Change Adaptation Practices against Water Scarcity in High Mountain Areas". In: Udas, R., Thapa, K. and Lamsal, K. (eds.).
- Kijima, Y., Otsuka K. and Sserunkuma, D., (2011). "An inquiry into Constraints on a green revolution in Sub-Saharan Africa". The case of NERICA rice in Uganda. *World Development*. Vol. 39: pp. 77-86.
- Korsi, A., and David, R. S., (2001). "Livelihoods of the Poor in Ghana" A Contextual Review of Ghana-wide definitions and Trends of Poverty and the Poor with those of Peri-Urban Kumasi. Centre for the Development of People (CEDEP) Kumasi, Ghana.
- Landau, S. and Everitt B. S., (2004). "A Handbook of Statistical Analysis using SPSS. Chapman & Hall/CRC Press LLC. ISBN 1-58488-369-3.
- Lanjouw, P. and Ravallion, M. (1994). "Poverty and Household Size, Policy Research Working Paper 1332". World Bank, Washington, D. C.
- Levine, S., James, M. and Batana, Y. M. (2011). "A Robust Multi-Dimensional Poverty Proke for Uganda". SSRN eLibrary.
- Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M..., Torquebiau, E. F. (2014). "Climate-Smart Agriculture for Food Security Nature: Climate Change" Vol4, pp 1068–1072.
- Macaulay, B.M., (2014). "Land Degradation in Northern Nigeria: The Impacts and Implications of Human-Related and Climatic Factors" *African Journal of Environmental Science and Technology*. Vol. 8(5): pp. 267 -273.
- Magxinga, L.L., Alemu, Z and Van Schalkwykh, D. (2005). "Factors that Influencing Market Access for Smallholder Irrigators in South Africa. A paper presented at the 43th Annual AEASA Conference in Polokoane Limpopo, South Africa.

- Makhura, M.T (2001). "Promoting Market Participation in Small-Scale Agricultural in the Northern Province. An outline paper presented at a seminar organized by NIEP, LAPC and the University of Pretoria on market access. Agrivillage, Northern Province Department of Agriculture, Pietersburg.
- Malik, S.J., (1999). "Rural Poverty and Land Degradation" Consultative Group on International Agricultural Research Report prepared for the Technical Advisory Committee of the (CGIAR) Vienna, Virginia.
- Malthus, T.R. (1798). "An Essay on the Principle of Population, 1st edition. Pickering Press, 1986, London.
- Manyatsi, A.M., (1999). "Spatial Analysis of Soil Erosion in Swaziland". UNISWA J. Agricultural Science and Technology Vol 3: pp. 5-12.
- Manyong, V.M; Douthwaite, B; Coulibaly, O and Keatinge, J.D.H. (2009). "Participatory Impact Assessment at the International Institute of Tropical Agriculture; Functions and Mechanism (Annex)" .The future of impact assessment in the CGIAR: needs, Constraints and options. *Proceedings of a workshop organized by the standing panel on Impact Assessment of Technical Advisory committee*, FAO. Rome Italy: pp. 69-74.
- Mason I.L (1982), "The Role of Protected Areas in the In-Situ Conservation of Animal Genetic Resources".
- Mathonzi, T.M (2000). "Effect of Market Orientation on Income and Food Security of Small-Scale Irrigation Farmers in South Africa's Northern Province. University of the North, South Africa.
- Maurice, D.C., Amaza, P.S.and Tella, M.O. (2005). "Analysis of Technical Inefficiency of rice-Based cropping patterns among dry season farmers in Adamawa state, Nigeria" *Nigeria Journal of Tropical Agriculture*. Vol7 (1):pp. 125-130.
- Mbow, C., Van, N. M., Luedeling, E., Neufeldt, H., Minang, P.A., Kowero, G., (2014). "Agroforestry Solutions to Address Food Security and Climate Change Challenges in Africa". *Current Opinion Environmental Sustainability*. Vol. 6: pp. 61-67.
- McCrory, D.F. and Hobbs P.J., (2001). "Additives to Reduce Ammonia and Odor Emissions from Livestock Wastes" *A review, Journal of Environmental Quality*. Vol. 30: pp. 345-355.
- Mc Fadden, D. (1973). "Conditional Logit Analysis of Qualitative Choice Behaviour" in P. Zarembka, Editor, *Frontiers in Econometrics*, Academic Press.
- McKay, A., and Lawson, D., (2002). "Chronic Poverty" A Review of Current Quantitative Evidence. CPRC Working Paper (15). Manchester: IDPM, University of Manchester.
- McMillan, J.H and Schumacher, S., (2006). "Research in Education. Evidence-based inquiry (6th ed.)". Boston: Pearson Education, International.
- Mnkeni, P. and Mutengwa, C., (2014). "A Comprehensive Scoping and Assessment Study of CSA Policies in South Africa".

- Mohammad R. A. (2009). "Nigeria: Stemming the Impact of Climate Change" Daily Trust, 21st July, 2008.
- Mohammed N, U, Wolfgang B, and Jason S, E., (2014). "Factors Affecting Farmers' Adaptation Strategies to Environmental Degradation and Climate Change Effects: A Farm Level Study in Bangladesh" *MDPI Journal*. Vol. 2, pp 223-241. www.mdpi.com/journal/climate
- Morton, J.F., (2007). "The Impact of Climate Change on Smallholder and Subsistence Agriculture. Proceedings" National Academy of Science USA: 104: pp. 19680–19685.
- Mouton, J., (2005). "How to Succeed in your Master's and Doctoral Studies". *A South African Guide and Resources Book*. Pretoria: Van Schaik Publishers.
- Moyo, S., and Veeman M, (2004). "Analysis of Joint and Endogenous Technology Choice for Protein Supplementation by Smallholder Dairy Farmers in Zimbabwe". *Agro Forestry System Vol. 60: pp 199-209*.
- Mtsor, Y. G. and Idisi P.D., (2014). "Gender Inequality and Women Participation in Agricultural Development in Nigeria". *Merit Research Journals of Education*. Vol 2(11) pp. 296 – 301. <http://www.meritresearchjournals.org/er/index.htm>
- Nambuya, I. S., Bashasha, B. and Adipala, E (2005). "Factors Affecting Adoption of Improved Sorghum Varieties in Eastern Uganda and their Implication for Policy Intervention. African Crop Science Conference Proceedings, Kampala Vol. 7 pp 697 – 703.
- National Bureau of Statistics (2005), "Poverty Profile for Nigeria", Abuja.
- National Bureau of Statistics. (2007). "Nigerian Statistical Fact Sheets on Economic and Social Development".
- National Bureau of Statistics (2010). "Nigerian Poverty Profile Report 2010". Retrieved from: <https://www.proshareng.com/news/Nigeria%20Economy/Nigerian-Poverty-Profile-Report-2010---NBS/16302>.
- National Bureau of Statistics, (2013). "In Uduma Kalu, (2015). February 18". Sokoto is the Poorest State. Vanguard Retrieved from <http://www.vanguardngr.com>
- National Population Commission (NPC), (2010). "Federal Republic of Nigeria, (2006). Population and Housing Census", Priority Table Volume IV, Population Distribution by Age and Sex. Abuja: National Population Commission (NPC).
- Neufeldt, H., Jahn, M., Campbell, B., Beddington, J. R., De Pinto, A., and Zougmore, R., (2013). "Beyond CSA: toward Safe Operating Spaces for Global Food Systems". *Agriculture & Food Security*. Vol. 2(12).
- Nganga T.K.W (2009). "Family Size, Economics and Child Gender Preference in the Nyeri District of Kenya. 18th Annual IAFFE Conference at Simmons College, Boston, Massachusetts, USA. 26th – 28th June, 2009 University of Nairobi. pp: 1 – 40.

- Ngigi, S.N., Savenije H.H.G, Thome, J.N. Rockstro J; De Vriesd F.W.T.P, (2005). "Agro-hydrological Evaluation of on-farm Rainwater Storage Systems for Supplemental Irrigation in Laikipia District, Kenya". *Agricultural Water Management Vol.73*: pp 21-41.
- Ngigi, S.N., (2009). "Climate Change Adaptation Strategies". Water Resources Management options for Smallholder Farming Systems in Sub-Saharan Africa. The MDG Centre for East and Southern Africa, the Earth Institute at Columbia University, New York. 189.
- NIMET (2008). Nigeria Climate Review Bulletin 2007. Nigerian Meteorological Agency. February 2008. NIMET - P. 001.
- Njoku, J.E. (1991). "Factors Influencing the Adoption of Palm Production Technologies by Small Holder Farmers in Imo State of Nigeria, In: Appropriate Agricultural Technologies for Resource Poor Farmers: pp. 207-218.
- Nnandi, Stanley E. (2008) "The Impact of Globalization on the Nigerian Economy", Minneapolis, Minnesota: Walden University, Dissertation; available at: <http://gradworks.umi.com/33/36/3336742.html>.
- Nwafor, J.C., (2007). "Global Climate Change". The Driver of Multiple causes of Flood Intensity in Sub-Saharan Africa. *Paper presented at the International Conference on Climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria*. Pp. 67-72.
- Obadan, M., (1997). "Analytical Framework for Poverty Reduction" Issue of Economic Growth Versus other Strategies. In NES opcit.
- Obayelu, O.A., (2010). "Spatial Dimension of Inequality and Poverty in Rural Nigeria. *Journal of Economic Development*. Vol. 39(4): pp 77.
- Obayelu, O. A., and Awoyemi, T. T., (2010). "Spatial Dimension of Poverty in Rural Nigeria" *Journal of Development and Agricultural Economics*. Vol. 2(6): pp 231 – 244.
- Obayelu O, A., and Olufunke R, O. (2015). "Rural Livelihood and Food Poverty in Ekiti State, Nigeria" *Journal of Agriculture and Environment for International Development - JAEID* 109 Vol. (2). pp 307-323.
- Obioha, E., (2008). "Climate Change, Population Drift and Violent Conflict over Land Resources in North Eastern Nigeria" *Journal of Human Ecology*, Vol. 23(4): pp. 311-324.
- Oduro, A. D., and Aryee, I., (2003). "Investigating Chronic Poverty in West Africa", Chronic Poverty Research Centre Working Paper (28). Manchester: Institute of Development Policy and Management/CPRC.
- Oduwole, J.A. and Fadeyi, A.O., (2013). "Gender, Economic Activities and Poverty in Nigeria. *Journal of Research in Peace, Gender and Development*, Vol. 2(7): pp. 106-125.
- OECD (2016). "Poverty and Climate Change Reducing the Vulnerability of the Poor through Adaptation". Retrieved from: <http://www.oecd.org/env/cc/2502872.pdf>.

- Ofuoku, A.U. and Isife, B.I., (2009). "Causes, Effects and Resolution of Farmers-Nomadic Cattle Herders Conflict in Delta State, Nigeria" *International Journal of Sociology and Anthropology*. Vol1 (2): pp. 047 -054.
- Ogbalubi, L.N. and Wokocha, C.C., (2013). "Agricultural Development and Employment Generation" The Nigeria Experience. *IOSR Journal of Agriculture and Veterinary Science*. Vol 2(2): pp. 60 – 69. www.iosrjournal.org
- Ogwumike, F. O., (1987). "Poverty and Basic Needs" An Approach to Development in Nigeria. Ph.D. Thesis, Department of Economics, University of Ibadan.
- Ojo, J. S., (2010). "An assessment of Gender Inequality in Democratic Politics in the Fourth Republic in Nigeria (1999-2003). *International Non-Governmental Organization (NGO) Journal*. Vol 8(7): pp. 138-145.
- Okediji, G.O., (2014). "The Effect of Information Technology on Farmers Productivity". An Unpublished M.Sc Thesis. Department of Library and Archival Information University of Ibadan.
- Okeke, A.K.I and Onogwu, G.O (2014). "Determinants of Farmers Adoption Decisions for Improved Pearl Millet Variety in Sahel Savanna Zone of Northern Nigeria. *Journal of Development and Agricultural Economics Vol. 6 (10) pp 437 -442*.
- Okoli I.C., Ogechi, R., Alaoma, M.N., Opara, M.C., Uchegbu, C.T., Ezeokeke, C.S., Durunna, F.N., Iheukwumer and Okeudo, N.J., (2009). "Socio-Cultural Characteristics of Educated Small Holders Pig Farmers and the Effects on their Feeding Practices on the Performance of Pigs in Imo State, Nigeria.
- Okpachu, A.S., Okpachu, O.G. and Obijesi, I.K., (2014). "The Impact of Education on Agricultural Productivity of Small Scale Rural Female Maize Farmers in Pstiskum Local Government, Yobe State". A Panacea for Rural Economic Development in Nigeria. *International Journal of Research in Agriculture and Food Science* Vol 2 (4): pp. 26 – 33.
- Okulona, R. A., and Ikuomola, A. D, (2010). "The Socio-Economic Implication of Climate Change, Desert Encroachment and Communal Conflicts in Northern Nigeria". *American Journal of Social and Management Sciences*. <http://www.scihub.org/AJSMS>. Retrieved 14/06/2015.
- Okunmadewa, F., (1999). "Overview of the Measurement of Poverty and Inequality" Centre for Econometric and Allied Research, University of Ibadan, Ibadan Nigeria.
- Okunmadewa, F.Y., Yusuf, S.A. and Omonona, B.T., (2005). "Social Capital and Poverty Reduction in Nigeria". Research Report Submitted to the African Economic Research Consortium (AERC), Nairobi for the Second Phase Collaborative Poverty Research Project.
- Oladele, O. I., (2006). "A Tobit Analysis of Propensity to Discontinue Adoption of Agricultural Technology among Farmers in Southwestern Nigeria. *Journal of Central European Agriculture*, 6(3), 249-254. *International Journal of Peace and Development Studies*, Vol1 (3): pp. 8-12.

- Olaitan, S.O., Ali, A., Onyemachi G. A. and Nwachukwu, C., (2000). 'Poverty Alleviation Initiative in Nigeria'. *Nigeria Educational Research Association, Nigeria*: pp. 66 – 68.
- Olaitan, S.O., Ali, A., Onyemachi, G. A. and Nwachukwu, C., (2004). "Poverty Alleviation Initiatives in Nigeria". *Nigeria Educational Research Association, Nigeria*: pp.48– 50.
- Olapojo, V., (2012). "Transforming Agriculture in Nigeria". URL: <http://saharareporters.com/2012/04/09/transforming-agriculture-nigeria>
- Olayemi, J.K (1998). "Elements of Applied Econometrics. A Publication of the Department of Agricultural Economics" Ibadan, Nigeria: University of Ibadan.
- Olawale, E.O., Isaac K.T. and Labode, P., (2016). "The Differential Impacts of Rainfall and Irrigation on Agricultural Production in Nigeria any Lessons for Climate Smart Agriculture". *Agricultural Water Management*: 178: pp. 30–36. Centre for Sustainable Development, University of Ibadan, Nigeria.
- Okwa, W. O., and Okwa, A. O., (2010). "Sources of Technical Efficiency among Smallholder Maize Farmers in Osun State, Nigeria". *Research Journal of Applied Sciences* 5(2): pp. 115 – 122.
- Oluade, E.A. and Seriki I.O., (2013). "Assessment of Ethnic Involvement in Agricultural Activities in Atisbo Local Government Area, Oyo State.
- Oluranti, I.O. and Alege, P.O., (2016). "Micro-Credit and Micro-Enterprise Development" An Analysis of some Rural based Enterprises in Nigeria. Covenant University, Ota, Ogun State, Nigeria. <https://www.researchgate.net/publication/215447834>
- Oluwatayo, I. B. (2008) "Explaining Inequality and Welfare Status of Households in Rural Nigeria: Evidence from Ekiti State", *Humanity & Social Science Journal*, Vol 3, No. 1, pp. 70-80; available at: [http://www.idosi.org/hssj/hssj3\(1\)08/9.pdf](http://www.idosi.org/hssj/hssj3(1)08/9.pdf)
- Oni, O., Ephraim, N., John, P., Philips, D. and Edward K., (2009). "Trends and Drivers of Agricultural Production in Nigeria." *International Food Policy Research Institute. (IFPRI). Nigeria Strategy Support Program (NSSP) Report 001*. December, 2009.
- Onyenechere, E.C., (2010). "Climate change and spatial planning concerns in Nigeria" Remedial measures for more effective response. *Journal of Human. Ecology*. Vol 32 (3): pp. 137-148.
- Osuala, E.C. (1982). "Introduction to Research Methodology". New York Exposition Vocational Education, University of Nigeria, Nsukka, UNN.Com/Osuala-publications.
- Oyekale, A.S. (2009). "Climatic Variability and its Impact on Agricultural Income and Households' Welfare in Southern and Northern Nigeria. *Electronic Journal of Environmental, Agricultural and Food Chemistry*. Vol 8 (1): pp. 13-34.
- Oyekale, A.S. and Oyekale T.O., (2010). "An Assessment of Income Shocks and Expected Poverty Dynamics in Nigeria". *The Icfai University Journal of Agricultural Economics*. Vol 7 (3): pp. 18-50.

- Oyekale, A.S. (2012). "Intensive Land Use, Land Management and Efficiency of Food Production in the Niger Delta Region of Nigeria" *Electronic Journal of Environmental, Agricultural and Food Chemistry*, Vol 11 (3), pp. 188-204.
- Ozor, N., Urama K. and Mwangi, W., (2013). "Climate Change Vulnerability and the use of Indigenous Technologies for Adaptation among Smallholder Farming Communities in Sub-Saharan Africa". *Journal of Agricultural Extension*, Vol 16 (2).
- PAR, (2010). "The Use of Agrobiodiversity by Indigenous Peoples and Rural Communities in Adapting to Climate Change" A Discussion Paper Prepared by the Platform for Agrobiodiversity Research. Available at: http://www.agrobiodiversityplatform.org/blog/wp-content/uploads/2010/05/PAR-Synthesis_low_FINAL.pdf
- Philip, D, Ephraim N., John, P. and Omoboale, A.O., (2009). "Constraints to Increasing Agricultural Productivity in Nigeria" Nigeria Strategy Support Program (NSSP). No: 006.
- Pound Sterling Live, (2016). <https://poundsterlinglive.com>
- Prasad Mande, Setu Goyal, Vijo Theeyattuparampi and Sachin Magar (2006). "Progress of India's National Solar Mission and perspectives on the competitive bidding" Masdar Institute of Science and Technology, Abu Dhabi, UAE.
- Quayum, M.A.; Ali, A.M. (2012). "Adoption and diffusion of power tiller in Bangladesh." *Bangladesh Journal of Agricultural Resources*. Vol 37 pp 307–325.
- Rank, M. (2004). "One nation underprivileged: Why American Poverty affects us all" New York: Oxford Press.
- Raufu, M. O. (2010), "Pattern of Land use among Selected Crop Farmers in Osun State" *Research Journal of Soil and water management*. Vol1 (1): pp 1-4.
- Ravallion, M. (1996). "Issues in Measuring and Modelling Poverty". *The Economic Journal*, 106: pp. 1238 – 1343.
- Reddy, K.R. and Hodges, H.F., (2000). "*Climate Change and Global Crop Productivity*" (CABI).Publishing, Wallingford. Oxon, UK. CABI Press. pp 1 – 6.
- Regmi, B. R., Thapa, L., Suwal, R., Khadka, S., Sharma, G. B. and Tamang, B. B., (2009). "Agro- Biodiversity Management". An Opportunity for Mainstreaming Community-based Adaptation to Climate Change. *Journal of Forest and Livelihood Vol. 8(1). Forest Action Nepal*.
- Rekwot G. Z. (2014). "The Contribution of IAR Groundnut Varieties to Poverty Alleviation among Farming Households in the North West Zone of Nigeria" Department of Agricultural Economics and Rural Sociology, Faculty of Agriculture, ABU, Zaria, Nigeria.

- Robert, Z., Samuel, P. and Timothy. T., (2016). "Toward CSA in West Africa". A Review of Climate Change Impacts Adaptation Strategies and Policy Developments for the Livestock, Fishery and Crop Production Sectors.
- Rogers E.M. (2003). *Diffusion of Innovations (5th edition.)* New York: The free press.
- Sadiq, M.S., Singh, I.P., Kolo, M.D., Maude, A.M and Kudu, M.A (2015). "Resource optimization in sorghum production in Niger state, Nigeria" *International Journal of Advanced Multidisciplinary Research*. Vol2 (2): pp 53–59.
- Saiful Islam, A.K.M., Hossain, M.M. and Saleque, M.A. (2014). "Conservation Agriculture options for a Rice–Maize Cropping System in Bangladesh. *Bangladesh Rice Journal* Vol 18 (1&2): pp.44–53.
- Samuel, G.E., Tamarauntari, M.K. and Steve, S.T., (2014). "Income Poverty in Nigeria: Incidence, Gap, Severity and Correlates". *American Journal of Humanities and Social Sciences*. Vol2 (1): pp. 1 – 9.
- Scherr, S. J., Shames, S. and Friedman, R. (2012). "From Climate-Smart Agriculture to Climate-Smart Landscapes." *Agriculture and Food Security* Vol.1 (1): pp 1-15.
- Seo, N., and Mendelsohn R. (2008). "Measuring Impacts and Adaptations to Climate Change" A Structural Ricardian Model of African Livestock Management. *Agricultural Economics* Vol. 38: pp 151-165.
- Sileshi, G., Akinnifesi, F.K., Ajayi, O.C. and Place, F., (2008). "Meta-Analysis of Maize Yield Response to Woody and Herbaceous Legumes in the Sub-Saharan Africa". *Plant and Soil* 307: pp. 1-19.
- Smith, M. D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., McCarl, B., Ogle, S.O., 'Mara, F., Rice, C., Scholes, B. and Sirotenko, O., (2007). "Agriculture. In": Metz, B., Davidson, O.R., Bosch, P.R., Dave, R., Meyer, L.A., (Eds) *Climate Change (2007): Mitigation. Contribution of working group III to the Fourth Assessment report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, United Kingdom and New York, USA: pp. 497 – 540.
- Sokoya, G., Oluwalana, E.O and Irekhore, O.T (2006). "Men's Lesisure and Women's Multiple Role involvement in Rural Agribusiness: Implications for Gender Sensitive Management Approaches. *Gender and Behaviour* Vol. 4(2): pp. 882 – 895.
- Soludo, C.C. (2006). "Can Nigeria be the China of Africa?" Being a Lecture Delivered at the Founder's day of the University of Benin, Nigeria. Nov. 23. pp. 10.
- Stephen, P. B., (2010). "Towards Sustainable Agricultural Systems in the 21st Century". Workshop organized by Bill and Melinda Foundation and the N.K Kellogg Foundation.
- Streeten, A., (1979). "From Growth to Basic Needs" *Finance and Development*, pp. 5-8.
- Stern, N. (2006). "The Economics of Climate Change" *The Stern Review*, http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_report.cfm (accessed 8/12/2010).

- Subedi, K.D., (1993). "Search of Indigenous Green Manuring Species in the Western Hills of Nepal. LARC review paper No: 93/2.
- Sulaiman, J., Azman, A., and Abdelhak, S., (2013). "Vulnerability to Poverty among Paddy Farmers in Perlis, Malaysia" What Institutions Can Do? Background Paper for the Poverty Reduction in Asia: Drivers, Best Practices and Policy Initiatives. Sogang University, Seoul.
- Tadross, M., Suarez, P., Lotsch, A., Hachigonta, S., Mdoka, M., Unganai, L., Lucio, F., Kamdonyo, D, and Muchinda, M, (2009). "Growing Season Rainfall and Scenarios of Future Change in Southeast Africa: Implications for Cultivating Maize, Climate Research. Vol. (40) pp. 147 – 161.
- Teklewold, H., Kassie, M; Shiferaw, B and Köhlin G, (2013). "Cropping System Diversification, Conservation Tillage and Modern Seed Adoption in Ethiopia" Impacts on Household Income, Agrochemical Use and Demand for Labor. *Ecological Economics*. Vol. 93: pp 85-93.
- Thompson L. G, Brecher H. H, Mosley-Thompson E., Hardy D. R and Mark B. G. (2009). "Glacier loss on Kilimanjaro continues unabated. Proceedings of the National Academy of Sciences; Vol. (106): pp. 19,770–19,775.
- Thornton P., Herrero M., Freeman A., Mwai O., Rege E., Jones P. and McDermott J., (2006). "Vulnerability, Climate Change and Livestock Research Opportunities and Challenges for Poverty Alleviation". International Livestock Research Institute (ILRI) P.O. Box 30709, Nairobi, Kenya.
- Thornton, P.K, and Herrero, M., (2010). "Potential for Reduced Methane and Carbon Dioxide Emissions from Livestock and Pasture Management in the Tropics". Proceedings of the National Academy of Science of USA, 107: pp. 19667–19672.
- Thornton, P, and Cramer, L. (2012). "Impacts of Climate Change on the Agricultural and Aquatic Systems and Natural Resources within the CGIAR's Mandate" CCAFS Working Paper No: 23 (CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark.
- Tiwari, T. P., (2001). "Participatory Crop Improvement for Maize/Millet Intercropping in the Middle Hills of Nepal". Thesis (M. Sc.) - University of Wales. School of Agricultural and Forest Sciences, Bagnor, UK.
- Townsend, P. (1979). "Poverty in the United Kingdom". Penguin.
- Ukeje, M.F. (2008). "Agricultural Development Issues, It's Sustainability and Food Security in Nigeria" Paper presented at the 2008 Annual Conference of the Development Finance Department of Central Bank of Nigeria (CBN), held at Orchid Hotel Asaba, Delta State. 15th-8th, October.
- Umar, H. S., (2009). "Comparative Economic Analysis of Organic and Conventional Sesame (Sesamum indicum L.) Production Systems in Nasarawa State, Nigeria". Department of Agricultural Economics, University of Nigeria, Nsukka, Enugu State.

- United Nation (UN), (2007). "Rural Household Livelihood and Well-Being" Statistics on Rural Development and Agriculture Household Income. The Wye Group Hand Book. United Nations, New York and Geneva.
- United Nations Development Programme. UNDP, (2004). "Reducing Disaster Risk: A Challenge for Development" United Nations Development Programme, Bureau for Crisis Prevention and Recovery. New York, 2004. URL <http://www.undp.org/cpr/disred/rdr.htm>.
- United Nations Development Programme. UNDP, (2006). "Poverty in Focus" International Poverty Centre. Brasilia DF. Brazil. www.undp-povertycentre.org
- United Nations Development Programme. UNDP, (2007). "Human Development Report 2007/2008. Fighting Climate Change" Human Solidarity in a Divided World, New York.
- United Nations Development Programme. UNDP, (2010). "Human Development Report" The Real Wealth of Nations" Pathways to Human Development. Report, UNDP.
- United Nations Development Programme. (UNDP), (2011). "Swaziland. Empowered Lives Resilient Nations" <http://www.undp.org.sz/index.php/focus-areas/hiv-and-aids>. Retrieved on 09/01/2013.
- Vanguard News, (2017). "A Nigerian Newspaper and Online Version of Vanguard a Daily Publication in Nigeria. (17th August, 2017). <http://www.vanguardngr.com>
- Veerakumaran, S. (2005). "Role of cooperatives in food security: A case study of Ethiopia. Department of cooperative "Faculty of Dryland. Agriculture and Natural Resources. Makeke University.
- Vierling, L. A., and Wessman, C. A. (2000). "Photosynthetically Active Radiation Heterogeneity within a mono dominant Congolese rain forest canopy. Agricultural and Forest Meteorology. Vol103, pp 265–278.
- Walker, B. and Meyers J. A., (2004). "Thresholds in Ecological and Social-Ecological Systems": a developing database. *Ecology and Society*. Vol 9(2): p 3. [Online] URL: <http://www.ecologyandsociety.org/vol9/iss2/art3>.
- Wezel, A., Steinhilber, N. and Friederichsen, J. R. (2002). "Slope Position Effects on Soil Fertility and Crop Productivity and Implications for Soil Conservation in Upland Northwest Vietnam." *Agriculture, Ecosystems and Environment* Vol 91(12): pp 113-126.
- Witt, M. A., and Lewin, A. Y., (2007). "Outward Foreign Direct Investment as Escape Response to Home-Country Institutional Constraints" *Journal of International Business Studies* Vol. 38 (4): pp 579 – 594.
- World Agroforestry Centre, (2013). "Agroforestry System and Practices". <http://www.worldagroforestry.org/units/Library/Books/Book%2032/an%20introduction%20to%20agroforestry/html/3> Classification of Agroforestry Systems.htm?n=10.

- World Bank, (1995). "Distribution and Growth: Complements, not compromises". *Policy Research Bulletin*. 6(3). (May-July).
- World Bank, (1996). "Nigeria in the midst of Plenty". The challenge of growth and inclusion. Report N014733 UNI. The World Bank, Washington D. C., pp 25 – 32.
- World Bank, (2006). "Enhancing Agricultural Innovation: how to go beyond the Strengthening of Research Systems" World Bank, Washington, DC.
- World Bank 2008. *Ghana: Meeting the challenge of accelerated and shared growth*. Report No. 40934GH. Washington, DC: World Bank. < http://www.wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2007/12/21/000310607_20071221111024/Rendered/PDF/Pages0from04091635403volumes0ER01GH.pdf>. Accessed July 9, 2010.
- World Bank, (2011). "Information and Communication Technologies: A Sector Strategy Approach" Paper. Available at: http://siteresources.worldbank.org/INTICTSTRATEGY/Resources/2010-12-27_ICT_Sector_Strategy_Approach_Paper_EN.pdf [Accessed on October 07, 2010].
- World Bank, (2011). "Opportunities and Challenges for Climate-Smart Agriculture in Africa, World" Bank. http://climatechange.worldbank.org/sites/default/files/documents/CSA_Policy_Brief_web.pdf
- World Bank, (2012). "Data by Country": Swaziland. <http://data.worldbank.org/country/swaziland>. Retrieved on 09/01/2013.
- World Bank (2016). "The Uganda Poverty Assessment Report 2016. Farms, Cities and Good Fortune: Assessing Poverty Reduction in Uganda from 2006 to 2013. www.worldbank.org/uganda
- Yusuf, H. A, Omokore, D. F, Akinola, M. O. and Omolehin, R. A. (2011). "Socio-Economic Characteristics Influencing Farm Household Participation in Gandu system in Charanchi Local Government Area of Katsina State, Nigeria. *Journal of Agricultural Extension and Rural Development* Vol. 3(12), pp. 220-223. Available online <http://academicjournals.org/JAERD>
- Zalkuwi, J., (2013). "Comparative Analysis of Technical Efficiency of Sole Sorghum and Sorghum Mixed with Cowpea Production Systems in Guyuk Local Government Area of Adamawa State, Nigeria. *International Journal of innovative Research and Studies*. Volume 2(12): pp. 558-566.
- Zitha, M., (2007). "Role of Families in Social and Economic Empowerment of Individual". Human Science Research Council of South Africa.
- Zoellick, S, and Robert, B.A (2009). "Climate Smart Future. The Nation Newspapers" Vintage Press Limited, Lagos, Nigeria, pp. 18.

APPENDIX 1

Summary Table of the Study Objectives

S/N	OBJECTIVES	DATA USED	ANALYTICAL TOOL
1	Analyses the constraints on the use of climate smart agricultural techniques.	The five points scale type will be graded as: Very serious = 5 Serious = 4 Undecided = 3 Not serious = 2 Not very serious = 1	Liker scale techniques (On SPSS version 20).
2	Determine factors influencing indicators of CSAP within different crops and livestock enterprises.	The Principal Component Analysis of the crops and livestock climate smart agricultural indices regressing with the socio-economic characteristics.	Principal Component Analyses and Ordinary Least Square Regression Model (On STATA version 13 Software).
3	Determine poverty status for low-users and high-users of climate agricultural techniques.	Low-users are respondents who used two or less CSAP while high-users are respondents who used three or above CSAP.	Foster, Greer and Thorbecke (1984) which is widely known as the FGT poverty measurement.
4	Determine the effect of CSAP on poverty status of farmers.	The respondents who are poor = 1 while the non-poor = 0.	Instrumental Variable of a Probit Model Regression (On STATA version 13 Software).
5	Determine the effect of CSAP on MPI of the households.	The respondents who are poor = 1 while the non-poor = 0.	MPI of (2SLS) regression model (On STATA version 13 Software).

Source: Authors Computation, 2016

APPENDIX 2
QUESTIONNAIRES

**QUESTIONNAIRE ON CSAP AND POVERTY STATUS OF SMALL HOLDER
FARMING HOUSEHOLDS IN NORTH WEST NIGERIA.**

State:

LGA:

Identification:

Dear Sir/Ma,

I am EKPA, Daniel currently enrolled in a Ph.D. programme. This questionnaire was drawn to elicit information on effect of CSA practices on poverty status among farmers in North West Nigeria. The exercise is designed for research only. We therefore plead for your cooperation in supplying the accurate information. Your input is considered very important. We promise to treat your contribution with absolute confidentiality. Thank you.

BACKGROUND INFORMATION:

Name of Enumerator.....Name of Supervisor.....

Please identify with a tick (✓)

A. Socioeconomic Characteristics of Farmers

1. What is your age?
2. Gender? (a) Male ☐ (b) Female ☐
3. Educational level attained? (a) Arabic education ☐ (b) Primary education ☐ (c) Secondary education ☐ (d) Tertiary Education ☐
4. What is your marital Status?
 - a) Married-monogamy ☐
 - b) Married-polygamy ☐
 - c) Divorced ☐
 - d) Single ☐
 - e) Widowed ☐
5. What is your Religion?

- a) Christian ☐
- b) Muslim ☐
- c) Traditional Religion ☐
6. How many persons live in your household on a regular basis?
7. What is your estimated personal monthly expenditure (₦)?
8. What is the size of your farm land (ha)?
9. How long have you been involved in farming activities (years)?
10. Are you ownership of farm land? Yes ☐ , No ☐
11. Land acquisition methods (a) Rent ☐ (b) inherited ☐ (c) Purchased ☐ (d) Gift ☐
12. Type of labour (a) Family ☐ (b) Hired ☐ (c) both ☐
13. Membership of any farm group/association? (a) Yes ☐ (b) No ☐
14. Means of transportation (a) Bicycle ☐ (b) Motorcycle ☐ (c) Car ☐ (d) Pickup van ☐ (e) Animals ☐
15. Types of housing materials (a) Mud/thatched ☐ (b) Mud/zinc ☐ (c) Brick/zinc ☐ (d) concrete block zinc ☐
16. What is your communication equipment? (a) Radio ☐ (b) Television ☐ (c) GSM ☐ (d) Video ☐
17. How many times do you have contact with extension agents per year?
18. Kindly indicate the source(s) and the use of water as indicated in the table below:

Source of Water	Irrigation	Drinking	Washing	Watering crops/animals
Stream/river				
Deep well				
Borehole				
Public water				

19. What is the quantity of your crop production that were produce using the six smart index as follows, zero if not?
- (i) Use of organic manure:
 - (ii) Agro-forestry:
 - (iii) Conservation agriculture:
 - (iv) The use of improved varieties and breeds:
 - (v) Integrated crop/ livestock management
 - (vi) Irrigation for small-holder farmers:

S/No:	Crops	Hectares (ha)	Yield (kg)	0	(i)	(ii)	(iii)	(iv)	(v)	(vi)
I	Maize									
Ii	Sorghum									
Iii	Millet									
Iv	Ground nut									

20. What is the quantity of your animal production on the average using the CSAP, zero if not?

S/No:	Livestock	Herds (#)	0	(ii)	(iv)	(v)
I	Cattle					
Ii	Sheep					
Iii	Goat					
Iv	Donkey					
V	Camel					

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

S/No:	Sources of credit	Amount (₦)
I	Bank	

Ii	Micro-Finance	
Iii	Non-Governmental Organisation	
Iv	Cooperative society	
V	Family/Relations	

B. Constraints in implementing the use of CSA

S/N	Description	Yes	No	Very Serious	Serious	Neutral	Not Serious	Not Very Serious
1	Lack of access to market							
2	Lack of access to credit							
3	Lack of access to education							
4	Lack of access to extension services							
5	Lack of access to improved crop varieties							
6	Lack of access to high quality breeds							
7	Lack of time to practise CSA							
8	Lack of technical knowledge							
9	Lack of information from radio							

10	Lack of awareness of CSA practices							
11	Cost of labour is high							
12	Cost of input is high							
13	Lack of social interaction							
14	Lack of willingness							
15	Lack of demonstration of CSA techniques							
16	Lack of processing technology							

C. CSAP and non-practices (a).

Do you practise CSA on your farm? (a) Yes (b) No.

/No	Description		
		YES	NO
1.	Do you use organic manure?		
2.	Do you practise agro-forestry?		
3.	Do you practise conservative agriculture		
4.	Do you use improved drought resistant seeds varieties?		
5.	Do you use improved breeds of livestock?		
6.	Do you practise crop/livestock management?		
7.	Do you practise irrigation in your farm?		
8.	Do you practise mulching on your farm?		

9.	Do you practise crop rotation on your farm?		
10.	Do you practise intercropping on in your farm?		
11.	Do you based your farm activities on information about weather forecast for planting periods?		
12.	Do you vaccinate or use medication on your livestock against diseases?		
13.	Do you have any mechanism in your farm to reduce or remove greenhouse gas emissions (via plants that absorb carbon dioxide)?		
14.	Do you experience sustainable increase in output over the last few years?		
15.	Do you practise conventional tillage on your farm?		
16.	Do you use inorganic manure (fertilizers) on your farm?		
17.	Do you use local varieties of crops during planting season?		
18.	Do you use local breeds of animals as livestock?		
19.	Do you cut down trees for firewood from the forest in your area?		
20.	Do you burn grass residue materials on your farm before cultivation?		
21.	Do you rely on history and experiences to determine your farming activities?		

C. What are the household farmers' expenditure on monthly bases?

S/No	List of expenditures	Amount (₦)
1.	On food	
2.	On health	
3.	On education	
4.	On improved seeds	
5.	On improved animal breeds	
6.	On organic manure	
7.	On agro-forestry	

8.	On crop/livestock management	
9.	On irrigation	
10.	On forecast information	
11.	On vaccination of livestock against diseases	
12.	On tillage process	
13.	On inorganic manure (fertilizers)	
14.	On local seeds varieties	
15.	On local animal breeds.	

Thank you for your contribution to this survey. We hope to use these results to determine how best to provide affordable and desirable service to the people of your community.

APPENDIX 3

LIST OF PUBLICATION

1. Evaluation of Factors Influencing Indicators of Climate Smart Agricultural Practice on crops in North-West Nigeria. *World Journal of Agricultural Research* 2017. Vol. 5, No: 5, pp 273 – 278.

Authors: Ekpa Daniel, Oyekale Abayomi Samuel and Oladele Oladimeji Idowu.

Candidate's Contribution: The researcher designed the study, searches for the materials, managed the literature review and wrote the first of the manuscript.

American Journal of Rural Development, 2017, Vol. 5, No. 5, 138-143 Available online at <http://pubs.sciepub.com/ajrd/5/5/3> ©Science and Education Publishing DOI:10.12691/ajrd-5-5-3

2. Poverty Status of Climate Smart Agricultural Farmers in North West Nigeria: Application of Foster Greer and Thorbecke model. *American Journal of Rural Development*, 2017, Vol. 5, No: 5, pp 138 – 143.

Authors: Ekpa, D, Oladele O. I and Akinyemi, M.

Candidate's Contribution: The researcher designed the study, searches for the materials, managed the literature review and wrote the first of the manuscript.

(1) Evaluation of Factors Influencing Indicators of Climate Smart Agricultural Practice on Crop in North-West Nigeria.

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ABSTRACT: The current state of poverty in Nigeria is alarming and climate change threatens food security and increases poverty directly and indirectly. This research established a link that exists between CSAP and poverty status of small household farmers in North-West geopolitical zone of Nigeria; and based on this, examined CSAP and poverty status of small holder farming households in the zone. The specific objective of the study was to determine factors influencing indicators of CSAP on crop enterprise in the study area. Multi-stage, purposive and random sampling techniques were used to select three hundred (300) farming households in the study area, and using a set of pre-tested structured questionnaires, relevant data were collected. The study employed Ordinary Least Square (OLS), regression models to ascertain the objective. The regression analysis of maize enterprise shows that age, gender, marital status and household size were significant ($p < 0.10$), with age positively significant inferring that a unit increase in age will result in corresponding increase in the practice of climate smart agriculture for maize enterprise by 0.0264; also, the results showed that many more male farmers used climate smart agriculture in the maize enterprise than their female counterparts by 0.6001. Education, housing materials, lack of time and State option were significant ($p < 0.01$). The study concludes that crop production is greatly influenced by climate Smart Agriculture in the study area. The results suggest that those who had informal education (Arabic education) had significantly lower indices of climate smart agriculture for maize production than their counterparts who had formal education primary,

secondary and tertiary. Housing material was also negatively significant ($p < 0.01$), meaning that the farmers with mud/thatched and mud/zinc houses had significantly lower usage of climate smart agriculture in the production of maize when compare with those with brick/zinc and concrete block zinc houses. The study concludes that socio economic variables influenced climate Smart Agriculture in the study area. It therefore recommends that women be encouraged to develop interest in climate smart agricultural farming activities through women empowerment programme instituted by government and private bodies because men dominate the CSAP in the study area; Government, Non-Governmental Organizations and farmer associations should create a conducive learning environment to encourage the farmers of climate smart agriculture in the study area to embrace formal education which can improve their performance rapidly; and finally, policy on informal education should be enriched and developed in the curriculum to meet the current climate smart agricultural challenges. **Keywords:** *climate, smart, agriculture and poverty in north-west Nigeria.*

1. Introduction

The earth is warming. This is the unequivocal conclusion of the Fourth Assessment Report of the Inter-Governmental Panel on Climate Change (IPCC) in 2007 [1], which offers a complete investigation into how climate change is affecting natural and human systems.

(2) Poverty Status of Climate Smart Agricultural Farmers in North West Nigeria.- Application of Foster Greer and Thorbecke Model

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Abstract This research established a link that exists between climate smart agricultural practices and poverty in North-West geopolitical zone of Nigeria. The study was motivated by the increasing consequence of climate change and its impact on poverty status among farmers in the study area. Farming households changing agricultural practices as a result of global observation of climatic and environmental changes. It was based on this that the study examines the impact of climate smart agricultural practices on poverty status among farmers in North West Nigeria. A multi-stage sampling techniques was used to select two hundred and ninety four (294) farming households in the study area who provide the relevant primary data information for the study through a set of pre-tested structured questionnaires. The objective was to decompose poverty status for high-users and low-users of climate smart agricultural techniques in the study area. Foster Greer and Thorberk model, Watt's index, Sen, Shorrocks and Thon index were used to ascertain the objective. Poverty head count according to the FGT index for the total population is 35.89% for absolute poverty and 9.12% for relative poverty. This means that the average climate smart agriculture farmers had about 36% deprivation of basic human needs such as food, safe drinking water, health, shelter, education and information. On the other hand, for the absolute poverty of 9%. It means the average climate smart agricultural farmers had 9% deprivation to maintain the average standard of living. It connotes that the average climate smart agricultural farmers had 33% deprivation of food and 13% deprivation of average standard of living. Analysis of health poverty reveals that the absolute poverty is 42.38% and relative poverty 27.64%. It implies that the average climate smart agricultural farmers were deprived of health by 42% and by average standard of living by 28%. Further, analysis on education poverty reveals the absolute poverty and relative poverty value of 47.10% and 28.26%. This signifies that about 47% of the climate smart agricultural farmers were

deprived of basic education and about 28% of climate smart agriculture farmers were deprived of average standard of living. The study concludes that poverty is evident in the study area. It therefore recommends that Government, Non-Governmental Organizations and farmer associations should create a conducive knowledge exchange environment to encourage the low-users of climate smart agriculture to improve on their performance. Spouses especially should develop interest in climate smart agricultural farming. Women empowerment programme can be embarked upon by government and private individual. Policy on formal education should be enriched and developed in the curriculum to meet the climate smart agricultural challenges.

Keywords: *climate-smart-agriculture, poverty, North-West, Nigeria*

1. Introduction

Climate change equally leaves many more people vulnerable to poverty. [21], estimated that above half of the world's population as well as most of the productive lands and urban areas are situated in coastal and delta regions where the climate related disasters are prominent.



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Date: 20 November, 2017

Prof. A. S. Oyekale,
Department of Agricultural Economics and Extension,
Faculty of Natural and Agricultural Sciences,
North-West University, South Africa.

Dear Prof. Oyekale,

EDITORIAL REPORT ON THE MANUSCRIPT: "Climate Smart Agricultural Practices and Poverty Status of Smallholder Farming Households in North West Nigeria"

The above manuscript was received for editing on Thursday, 16th November, 2017 with the following details:

Type of manuscript: Ph.D. project

Author: D. Ekpa

Institution: North-West University, South Africa

Number of pages: 165

Total word size: 51,712

The manuscript was thoroughly edited for grammatical and stylistic errors. The details of the corrections are provided below:

Categories of errors found: Concord, spelling, omissions and wrong use of grammatical words, articles and connecting items, tautology, wrong word choices, wrong phrasing of expressions and punctuation.

Broad report on corrections done: Corrections were effected on spelling; grammatical words; and punctuation marks, and articles that were omitted were inserted, and the wrong ones were equally corrected. Connecting items were corrected, as well as inserted where necessary. Errors of concord, including subject-verb agreement and pronominal agreement were also corrected.

Method of correction: All corrections are effected as track changes in the manuscript, and are attached as document, in addition to a clean, submittable copy of the same document. Two versions of the edited works are prepared: a version showing the changes made, and a clean version in which the changes have been accepted.

Concluding remarks: Generally, the candidate demonstrates an average level of competence in English. With the errors corrected, the manuscript reads well and can be subjected for examination.

Yours sincerely,

Taiye Odionkhere.