ASSESSMENT OF CLIMATE CHANGE ADAPTATION STRATEGIES AMONG ARABLE CROP FARMERS IN NASARAWA STATE, NIGERIA

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NSU/AGR/M.Sc./AEX/012/15/16

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTDRADUATE STUDIES, NASARAWA STATE UNIVERSITY, KEFFI, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN AGRICULTURAL EXTENSION AND COMMUNICATION

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FACULTY OF AGRICULTURE, NASARAWA STATE UNIVERSITY KEFFI, NIGERIA

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DECEMBER, 2019

DECLARATION

I**,** Agwale A. Obadiah Matric Number, **NSU/AGR/M.Sc./AEX/012/15/16** hereby declare that except for the references and consultation made which, to the best of my knowledge, have been duly acknowledged, this research work title "Assessment of Climate Change Adaptation Strategies Among Arable Crop Farmers in Nasarawa State, Nigeria," is solely my efforts. The entire work was carried out under the supervision of Dr. E. S. Salau and Dr. N.D. Saingbe.

I, therefore, take full responsibility for errors and omission, that may be found in the research work.

…… ……..

AGWALE, Atala Obadiah Date

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CERTIFICATION

The dissertation **"Assessment of Climate Change Adaptation Strategies among Arable Crop Farmers in Nasarawa State, Nigeria"** meets the regulations governing the award of Master of Science (M.Sc.) Degree in Agricultural Extension and Communication, Faculty of Agriculture of Nasarawa State University, Keffi.

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DEDICATION

This research work is dedicated to Almighty God for granting me success in my studies.

ACKNOWLEDGEMENTS

My profound gratitude goes to my project supervisors, Dr. E.S. Salau and Dr N. D. Saingbe, for their thorough supervision. I wish to express my gratitude to the Head of Department, Dr. S.I. Audu. The effort of all the lecturers in the Department of Agricultural Economics and Extension, Nasarawa State University, Keffi, are also, acknowledged. Finally, I wish to acknowledge the effort of my wife, Mrs. Lami Obadiah for her moral and financial support which led to the success of this work. May God bless you all, Amen.

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ABSTRACT

The study assessed climate change and adaptation strategies among arable crop farmers in Nasarawa State, Nigeria. Purposive sampling technique was used to select two agricultural zones from the state namely; Central Agricultural Zone and Western Agricultural Zone. A sample of one hundred and two (102) respondents were selected using simple random sampling technique. Data were collected through the aid of structured questionnaire. Data analysis was done using simple descriptive statistics as well as a multiple regression model. The results revealed that majority (66.7%) of the respondents were aged between 21 and 40; majority (90.2%) had some form of formal education. Majority (88.2%) of them had between 1 and 10 hectares of land. The results also show that most (91.2%) of the respondents had radio as their major source of information on climate change. The respondents perceived bush burning as the major (80.4%) cause of climate change with swamp rice production as the least (4.9%) cause. Majority (96.1%) of the respondents adopted early planting of crops as their strategy to cope with climate change effects. The study further revealed that reduction in crop yield (88.2%), crop failure (83.3%), reduction in grain quality (79.4%), destruction of farm lands by flood and decrease in soil fertility (74.5%) were the observed major effects of climate change in the study area. The challenges faced in climate change adaptation include lack of government support (88.3%); inadequate information (79.4%); unfavourable land tenure system (71.6%); and high cost of technologies (69.6%) among others. The null hypothesis stated that there is no significant relationship between the socioeconomic characteristics of the respondents and their level of adoption of climate change adaptation strategies. The null hypothesis stated that there is no significant relationship between the socioeconomic characteristics of the respondents and their level of adoption of climate change adaptation strategies. The result show that the ANOVA was significant at F=30.75, p=0.001. It is recommended that government and non-governmental organizations should ensure effective policy formulation and implementation to reduce risks faced and improve adaptive strategies used by farmers. The Government and Non-Governmental organizations should organize trainings, workshops and seminars on the effective adaptive strategies on climate change.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Recent scientific findings have demonstrated that climate change is a reality and a primary environmental threat to sustainable development in the 21st century (Adams *et al.,* 2016). In the last few decades, cylic patterns between drought and floods have become more frequent, while the severity and spatial distributions have also changed with devastating impact. Similarly, heavy rainfall events over many areas have become more frequent and brought devastating consequences. The impact of these changes has manifested in decreased yields in agricultural crops, increased pest outbreak, rampant soil and water logging especially in coastal and humid areas.

It has been predicted that Africa will experience a rise in temperature of between 1 – 2.5^{o}C by 2030 (IPCC, 2007). This coincides within the period of Nigeria's vision 2020 development plan. Consequently, it is expected that there will be haphazard shift in crop growing seasons, poor crop productivity and abrupt outbreaks of disease vectors. The country's population will, therefore, be at greater health and life risk than before. One of the present major development problems facing Nigeria is the persistent and increasing food insecurity linked to poverty. Evidence shows that continued climate episodes may exacerbate the poverty level, leaving many local farmers, (mainly the subsistence or small holders) trapped in a cycle of poverty (Ejeh and Atti, 2014).

In spite of this, traditional people are only rarely considered in academic and public discourse on climate change, though the impact of impending changes of climate could be greater on them (Adefolalu, 1993).

Basically, amidst these climate vicissitudes, mankind still has to survive and live productively and for this purpose, adaptation strategies must be developed and adopted. Adaptation occurs at inter linking scales and can either occur in anticipation (anticipatory adaptation) or be a response to these changes (reactive adaptation).

The United Nation Development Programme (UNDP, 2007) stressed the need of "anticipatory adaptation" that is proactive than the reactive management of climate risks. The adaptive capacity in any case is important to assess in order to know the technical feasibility of any such adaptive technique.

From the climate analysis and vulnerability assessment, the need for adaptation is very obvious. Water supply from rain could reduce in many areas as evaporation losses increase and rainfall reduces. In other places, risks of floods are higher as rainfall increases. Furthermore, the vulnerability assessment shows that the country has weak adaptive capacity. For example, most farmers become completely helpless if any harvest fail. The Sokoto flood of 2010 which washed away large acreages of farm crops left many local farmers economically devastated as they had no significant alternative sources of livelihood (Francis and Theophilus, 2011).

Practicing policy through the implementation of different project encouraging vulnerable communities to take part in policy making process on climate related adaptation

strategies, revising climate change policy to enable local-level actions, continuous monitoring and analysis of predicted climate change by the meteorological department of government and empowerment of community to prepare themselves for climate induced hazards should be focused at the moment.

Climate change is one of the most significant challenges facing human society in the 21st century. Recent scientific findings have demonstrated that climate change is a reality and a primary environmental threat to sustainable development in the 21st century (Adams *et al.,* 2016). In the last few decades, cylic patterns between drought and floods have become more frequent, while the severity and spatial distributions have also changed with devastating impact. The phenomenon and directions of trends in weather and climate events has become increasingly from normal warmer and fewer cold days and nights, and more frequent hot days and night over most land areas (IPCC, 2007). Similarly, heavy rainfall events over many areas have become more frequent and brought devastating consequences. The impact of these changes has manifested in decreased yields in agricultural crops, increased pest outbreak, rampant soil and water logging especially in coastal and humid areas.

Traditional farmers will suffer greater impact from the emerging climate change related problems, such as increasing rainfall variability, extreme temperatures, shorter growing seasons, high solar radiation, greater moisture stress, called for adaptation strategies to offset negative impact of climate (Klien *et al.,* 2007, Adger *et al.*, 2007).

The United Nations Framework Convention on Climate Change (UNFCCC, 2007) defines climate change as a “change of climate attributed directly or indirectly to human

activity that alters the composition of the global and/or regional atmosphere and which in addition to national climate variability observed over comparable time periods". The UNFCCC used the term climate change to mean only those changes that are brought about by human activities (Oyeneke *et al.,* 2010). Climate change reflects variation within the earth's atmosphere, processes in other parts such as oceans and the effects of human activities (Miller and Edward, 2001). Broad scientific agreement now exists that, continued accumulation of heat-trapping in "green-house" gases in the atmosphere is contributing to changes in the global climate and in the climate regions around the world (Crosson, 1997).

The climate is said to have changed if there is a sustained change in the behavior of weather elements like rainfall, temperature and relative humidity (Shrotriya and Prakash,, 2010 in Salau *et al.,* 2012). Climate change refers to any change in the climate overtime, whether due to natural or human activity. It can also be attributed directly or indirectly to human activities that alters the composition of the global atmosphere and which are in addition to natural variability observed over comparable time periods (Intergovernmental Panel on Climate Change, IPCC, 2007).

Industrialization has led to the release of greenhouse gases (GHGs) into the atmosphere, with subsequent changes in the earth's temperature and weather systems. Mean global temperature is predicted to increase from between 1.4 – 5.8^{o}C over the coming century (IPCC, 2001 in Ejeh and Ati, 2014), which will cause changes in the distribution of rainfall, frequency and intensity of extreme weather events and sea level rise. Many human systems will be affected by these changes, particularly agriculture, water

resources, industry and human health. However, the impact of climate change will be uniform across the globe and considerable differences are expected among different regions (McCarthy *et al.,* 2001). Surprisingly, the poorest countries and communities who are the least contributors to global greenhouse gases emissions are amongst the most vulnerable to climate change. Poor communities are not only located in high-risk areas, but their lack of economic and social resources means, they are ill-equipped to adjust to the long-term changes in climate (Ejeh and Ati, 2014).

In general, in order to tackle the problem of food insecurity, the challenges and opportunities presented by climate change and innovative adaptation strategies must be related to the communities who interact directly with natural resources, especially the subsistence farmers who form the majority of the population and live in the rural areas.

Doss and Morris (2001) opine that the perspectives of the local people, the way they think and behave in relation to climate, as well as their values and aspirations have a significant role to play in addressing climate change. In spite of this, traditional people are only rarely considered in academic, and public discourse on climate change, though the impact of impending changes of climate could be greater on them (Adefolalu, 1993).

Basically, amidst these climate vicissitudes, mankind still has to survive and live productively and for this purpose, adaptation strategies must be developed and adopted. According to Wisner *et al.* (2004) vulnerability of agriculture is not determined by the magnitude of environmental stress perse, but by the combination of the societal capacity to cope with and recover from environmental changes, they are related to societal aspects such as land use and cultural practices. Adaptation occur at inter linking scales and can

either occurs in anticipation (anticipatory adaptation) or be a response to these changes (reactive adaptation).

Global climate change is one of the most critical challenges facing the international community today. Climate change is threatening to undo decades of development efforts due to its negative impact on agriculture, health, environment, road and buildings especially in developing countries (IPCC, 2007, Stern, 2007 in Joshual *et al.,* 2013). From a food security perspective, Sub-Saharan Africa (SSA) is arguably the most vulnerable region to many adverse effects of climate change due to a very high reliance on rainfall agriculture for basic food security and economic growth and enhanced poverty (Dixon *et al*., 2001 Cooper *et al*., 2008 in Joshua *et al*., 2013).

In countries like Senegal, Nigeria, China, United States of America and Bangladesh, farmers have been mentioned to perceive and even adapt to changes in the climate (Mertz *et al*., 2009, Maharjan *et al*., 2011, Salau *et al*., 2012). Climate variability has recently attracted much attention, not only because of the globally unparalled persistence anomalously low rainfall, but also because of the low capacity of society and economical system to cope with climate change related risks as a result of this low capacity, extreme climate variability such as drought, frequently accompanied by ecological decline, decimation of livestock herds, wide spread food scarcity, mass migration and great loss of human life (Tarhule and Lamb, 2003). Climate change with expected long term changes in rainfall patterns and shifting temperature zones are expected to have negative effects on agriculture (Charles and Rashid, 2007).

The rural population, for whom agriculture is the primary source of food, direct and/or indirect employment and income, will be affected due to agriculture's vulnerability to climate changes. As the sector is the largest consumer of water resources, variability in water supply has a major influence on health and welfare of agriculture dependent poor, International Food Policy Research Institute (IFPRI, 2003).Although farmers have been adapting their agriculture to the changing climate since time immemorial, they are still vulnerable to climate and variability (Hulme *et al*., 2011 in Micheal *et al*., 2012).

As part of targeting farmers and solutions for climate change and variability, local knowledge of farmers become very important to enhancing their adaptive capacity. Local knowledge of farmers is a cumulative body of knowledge on weather and climate, developed and applied by the farmers, which shows how this knowledge is used to shape and interact with agricultural practices to enhance farmers adaptive capacity towards climatic variability. This knowledge is time, place and culture specific (Speranza *et al*., 2010).

Adaptation is adjustment in ecological, social, or economic systems in response to actual and/or expected climatic stimuli and their effects or impacts, as well as to the changes in processes, practices, and structures to moderate potential damages and/or to benefit from opportunities associated with climate change (Smit and Pilifosova, 2003). Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates, harm or exploits beneficial opportunities, Intergovernmental Panel on Climate Change (IPCC, 2001).

From the climate analysis and vulnerability assessment, the need for adaptation is very obvious. Water supply from rain could reduce in many areas as evaporation losses increases and rainfall reduces. In other places, risks of floods are higher as rainfall increases. Furthermore, the vulnerability assessment shows that the country has weak adaptive capacity. For example, most farmers become completely helpless if any harvest fail. The Sokoto flood of 2010 which washed away large acreages of farm crops left many local farmers economically devastated as they had no significant alternative sources of livelihood (Francis and Theophilus, 2011).

The adaptive capacity of farmers can be enhanced if national policies support climate change responses that are already being implemented by farmers (Thomas *et al.*, 2007). There are two major causes of climate change, namely, anthropogenic and natural causes (Ayoade, 2003 and Oni, 2001 in Iwuchukwu and Onyeme, 2012). Anthropogenic causes relates to those activities of man which help to change the chemical composition of the atmosphere as they relate to increasing the volume of greenhouse gases like Carbon dioxide (CO_2), Methane (CH_4), Sulphur dioxide (SO_2) etc that cause climate change while natural causes are associated with natural greenhouse warming and "greenhouse gases" such as Carbondioxide, Methane and Chloroflorocarbons (CFC) that cause the greenhouse effect (Iwuchukwu and Onyeme, 2012).

Man's socio-economic activities such as deforestation, cropping, irrigation, damming of rivers to create artificial lakes, farm animals, (e.g enteric fermentation by ruminants), destruction of carbon rich soils, addition of energy to the atmosphere through combustion of fossil fuels such as petrol, diesel and coal gas flaring, bush burning, manufacture of

cement from limestone and emission of gases by automobile exhausts, lead to the production of greenhouse gases (GHGs) that cause climate change (Iwuchukwu and Onyeme, 2012).

There are noticeable consequences of climate change in Nigeria such as intense thunderstorms, widespread floods and incessant drought. Climate change pose great dangers with consequences such as desertification, sea level rise, flooding, water Salinization, threat to health as rising in temperature could bring about diseases such as heat rashes, stroke, malaria, cerebra-spinal meningitis (CSM) and other related diseases. Climate change will affect every citizen, every part of our environment and our natural resources (Kotir, 2011).

Recent global warming has influenced agricultural productivity leading to declining food production (Kurukulasurriya and Mendelsohn, 2006). Therefore, many African countries that have their economics largely based on weather-sensitive agricultural productions systems like Nigeria are particularly vulnerable to climate change (Benhin *et al*., 2006).

Climate change which is attributable to natural climate cycle and human activities, has adversely affected agricultural productivity in African. This is particularly because African agriculture is predominantly rainfed and hence fundamentally dependent on the vagaries of weather (Lema and Majule, 2009).

Green House Gas (GHG) emissions from food and the agricultural sector account for about 18% of global greenhouse gas emission, deforestation also accounts for 18% carbondioxide emissions. The world's 130 million ha of rice paddies are estimated to

produce 50-100 million metric tons of methane annually. High emission of greenhouse gases accelerates the rate of global warming and the rapid depletion of the ozone layer. Agriculture is also the worst victim of climate change due to its vulnerability to extreme weather events. This is more pronounced in climes where agriculture still remains the main source of livelihood, especially in developing countries like Nigeria. This has exacerbated poverty and has become a major albatross to the attainment of the millennium development goal in reducing poverty and hunger by half the year 2015 (Agwu *et al.,* 2010; Shrotriy; Prakash, 2010 in Salau *et al*., 2012).

Studies of farm level adoption of adaptation strategies are important to provide information that can be used to formulate policies that will enhance adaptation as a tool for managing a variety of risks associated with climate change in agriculture. Examples of such adaptation options include: crop diversification, mixed cropping, livestock farming systems, using different crop varieties, changing planting and harvesting dates, and mixing less productive drought resistant varieties and high yield water sensitive crops (Bradshaw *et al*., 2004 in Salau *et al*., 2012). However, farmers adaptive capacity to climate change is undermined by several factors that range from limited understanding of the nature and consequences of climate, farm members health status, unemployment that is supposed to be both complement and supplement in agricultural incomes and poor rural infrastructure (Edward and Clark, 2001 in Salau *et al*., 2012).

Vulnerability to climatic change is highly correlated with poverty and living status of farmers determines their vulnerability to and adaptation with climatic changes. An

increase in the frequency of climate related hazards could lead households to lower poverty threshold (Shewake, 2008 in Dejene, 2011).

The profound impacts of climate change in Nigeria is in agriculture and food security, water resources, water induced disasters, biodiversity changes and human health. Increasing the resistance of communities to cope with climate change demand some effective strategies in state or national level and practical implementation and integration of those strategies in Nigeria's long term development plan. Practicing policy through the implementation of different project encouraging vulnerable communities to take part in the decision making process on climate related adaptation strategies, revising climate change policy to enable local-level actions, continuous monitoring and analysis of predicted climate change by the meteorological department of government and empowerment of community to prepare themselves for climate induced hazards should be focused at the moment. Consequently, adaptation is seen as a viable option in reducing vulnerability associated with anticipated negative impacts of climate change (Jones, 2010).

1.2 Problem Statement

Agricultural productivity depends largely on climatic factors. Mean global temperature is predicted to increase by between 1.4 – 5.8^{o}C over the coming century (Ejeh and Atti, 2014), which will cause changes in the distribution of rainfall, frequency and intensity of extreme weather events and sea level rise. Many human systems will be affected by these changes, particularly agriculture, water resources, industry and human health.

The rural population, for whom agriculture is the primary source of food, direct and/or indirect employment and income, will be affected due to agriculture's vulnerability to climate changes. As the sector is the largest consumer of water resources, variability in water supply has a major influence on health and welfare of agriculture dependent poor, International Food Policy Research Institute (IFPRI, 2003).Although farmers have been adapting their agriculture to the changing climate since time immemorial, they are still vulnerable to climate and variability (Hulme *et al*., 2011 in Micheal *et al*., 2012).

Though efforts have been made toward fighting climate change through scientific means, research and policies directed toward adaptation strategies are highly needed. Given the high level of illiteracy among rural farmers in Nasarawa State coupled with the poor nature of public extension service, Sources of information used on climate change by farmers and their impact on agriculture are not known. It is also not certain what adaptation strategies have been evolved by the farmers to ensure sustainable production. It is in line with this that this study is designed to address the following research questions:

i. What are the socio-economic characteristics of arable crops farmers in the study area?
ii. What are the sources of information on climate change frequently used by the respondents?
iii. What are the perceived causes of climate change by the respondents?
iv. What are the negative effects of climate change experienced by arable crops farmers in the area?

v. What are the types of climate change adaptation strategies adopted by the respondents?

vi. What are the challenges faced by the respondents in implementing the recommended adaptation strategies?

1.3 Objectives of the Study

The broad objective of the study is to assess the types of climate change adaptation strategies used by arable crops farmers in Nasarawa State, Nigeria. The specific objectives are to:-

(i) describe the socio-economic characteristics of the respondents;

(ii) identify the sources of information on climate change used by the respondents;

(iii) ascertain the perceived causes of climate change by the respondents;

(iv) identify the negative effects of climate change on arable crops by the respondents.

(v) identify the types of climate change adaptation strategies adopted by the respondents;

(vi) identify the challenges faced by the respondents in implementing the recommended adaptation strategies.

1.4 Significance of the Study

Climate change is a threat to agricultural production (Iliya *et al*., 2012). This reality implies that, there is need to explore the futuristic consequences of climate change to facilitate the mapping out of appropriate adaptation strategies, hence, this study is relevant in providing an analytical framework for those engaged in food production to

determine the extent of the implications of climate change on their production. It serve as reference material to academia and for policy makers in designing appropriate programme of adaptation to climate change to enhance food production in the study area and to curtail food insecurity in the country in general. It also add to the knowledge base of extension agents in informing and educating farmers. It is increasingly argued that many climate change studies, whilst effective in alerting policymakers to the possible effects of climate change, have had limited usefulness in providing local-scale guidance on adaptation. The study also brings to the fore small scale farmers' knowledge which can be shared and explored in developing adaptation strategies and action plans. It focuses on the local perception of a global problem and how local solutions are being directed to a global challenge.

1.5 Statement of Hypothesis

Null Hypothesis Ho: There is no significant relationship between the socio-economic characteristics of the respondents and their level of use of climate change adaptation strategies.

1.6 Definition of Terms

Adaptation to Climate Change

Adaptation to climate change is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates, harm or exploits beneficial opportunities.

Climate Change

Climate change refers to any change in the climate overtime, whether due to natural or human activity. It can also be attributed directly or indirectly to human activities that alters the composition of the global atmosphere and which are in addition to natural variability observed over comparable time periods.

Arable crop

Arable crop is a type of plant (crop) that has a life cycle from germination to seed production within one year.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual Framework

The conceptual framework of this research is built on those factors surrounding climate variability, types of adaptation strategies adopted by farmers and the challenges or constraints to the adaptation strategies of the farmers. In essence, the conceptual framework of this study is built on both biophysical and socio-economic factors that influence effects of climate.

According to FAO (2007), climate change impacts can be roughly divided into groups namely: biophysical and socio-economic factors.

2.1.1 Biophysical Factors

These are more or less environmental factors. The environmental factors relating to climate change which have direct influence on agricultural production. The major biophysical factors of interest are temperature and fluctuating rainfall. It is evidence that since 1901, the climate trends of Nigeria shows a warmer temperature; fluctuating rainfall distribution pattern and reduced relative humidity. The increase in temperature was gradual until between late 1960s and early 1970s when a Sharpe rise in air temperature was recorded. Since this period, the increasing trend in the air temperature has been continuous and technically beyond the control of the farmers. On the other hand, the rainfall pattern in Nigeria between 1901 and 2005 reveals a paradigm shift in pattern

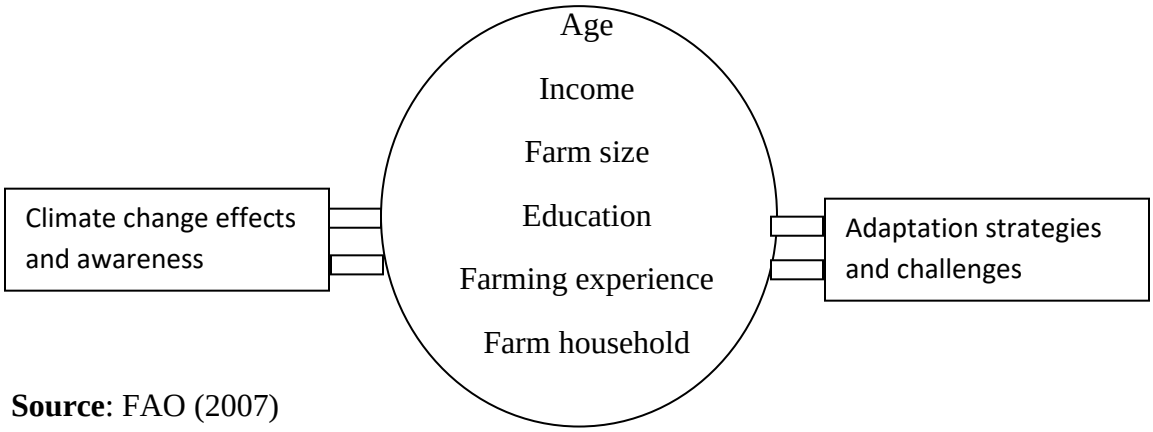
(commencement, cessation, distribution and amount) in the last few decades (Odjugo, 2010 and Uguru, 2011).

Most seriously, the issue of consideration of the implication of this change interms of agricultural production is the awareness levels or perception of the farmers concerning this change as according to Mohammed *et al.* (2013) how a phenomenon is perceived has serious implication for individual or group behavior toward it. In other word, the way a climate change is understood in the community determined the kind of personal or collective response it elicits. Adaptation of climate change requires that farmers must first perceive that climate has change, and then identify useful adaptations and implement necessary adaptations responses. That farmers ability to perceive the implications of climate variability change is a key preconditions for their choice of adaptation. (Maddison, 2006 and Nzeadibe *et al*., 2011).

2.1.2 Socio-Economic Factors

These socio-economic factors can be classified into micro and macro levels (Kandlink and Resbey, 2000). Micro level focuses on tactical decisions farmer make in response to seasonal variation in climate change, most of which are made at farm household level. Nkamachena and Hassan (2007) noted that these tactical decisions are influenced by a number of socio-economic factors that include household characteristics, household resources endowment, access to information (seasonal and long-term changes and agricultural production) and availability of formal institutions (input and output markets) for smothering production.

The schematic representation of the conceptual framework of biophysical and socioeconomic factors influencing farmers' decision on the adaptation strategies to climate change effects is represented in figure 2.1.



Source: FAO (2007)

Figure 2.1: Socioeconomic factors influencing farmers' farming decision. Farmers' adaptation strategies to the effects of climate change on agriculture are holistic perspective since many factors play a role. One of those factors is the level of the farmers' awareness about climate change which is shaped by a number of socio-economic factors such as extension agents, friends, radio/television, farmers, cooperative, newspaper and other printed materials. This may be grouped as technical and supportive services.

2.1.3 Technical Services

Technical services can be provided to farm households from different sources such as successful farmers, extension workers and private individuals. There is the need for technical information to combat climate changes, this is because climate change is technical complex for the nation education and research institutes to design and support capacity building of the major actors to combat climate change. Capacity building in this context refers to technical competence of farmers and other major actors in climate change adaptation.

2.1.4 Support Services

External support services are often required by farmers to take advantage of available adaptation technologies options. Farmers' access to support services such as credit facilities, farm inputs, and extension services influence their farming production (FAO, 2005). Agricultural extension, for instance, is a farmer support oriented service, as a non-formal system of education through which farmers are taught how to use agricultural innovations disseminated to them to improve their social and ecological conditions. Extension service increases the level of awareness of farmers about climate change, hence, a necessary pre-requisite for adaptation (Maddison, 2006).

It is in this light that Gbetibouo (2009) stated that farmers with access to extension service are likely to be aware to climate change and adopt adaptive strategies to cope with these effects as extension services provide information about climate and weather.

2.1.5 Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC, 2007) defines climate change as a "change of climate attributed directly or indirectly to human activity that alters the composition of the global and/or regional atmosphere and which in addition to national climate variability observed over comparable time periods". The UNFCCC use the term climate change to mean only those changes that are brought about by human activities (Oyeneke *et al.,* 2010). Climate change reflects variation within the earth's atmosphere, processes in other parts such as oceans and the effects of human activities (Miller and Edward, 2001). Broad scientific agreement now exists that,

continued accumulation of heat-trapping in “green-house” gases in the atmosphere is contributing to changes in the global climate and in the climate regions around the world (Crosson, 1997).

The climate is said to have changed if there is a sustained change in the behavior of weather elements like rainfall, temperature and relative humidity (Shrotriya and Prakash, 2010 in Salau *et al.,* 2012). Climate change refers to any change in the climate overtime, whether due to natural or human activity. It can also be attributed directly or indirectly to human activities that alters the composition of the global atmosphere and which are in addition to natural variability observed over comparable time periods (Intergovernmental Panel on Climate Change, IPCC, 2007).

Climate change which is referred to long term shift in climate pattern of a specific location, region or planet measurably by changes in features associated with average weather components of temperature, wind patterns and precipitations is a threat to food production in many regions of the developing world which is largely depended on rainfed and labour intensive agricultural production (Warrick and Barrow, 1991).

Climate change evidence in Nigeria was predicted by intergovernmental panel on climate change (2001) and confirmed by Odjugo (2010) who provided some prevailing indicators of climate change of the rising in temperature, which he stated that it is significantly higher than the global mean. Another compelling evidence of the spatial perspective of climate change over Nigeria landscape which shows that there has been significant reduction in the rainfall (Mubiru *et al.,* 2012).

Climate change poses a great threat to human security through erratic rainfall patterns and decreasing crop yields, contributing to increased hunger (Oluwakemi *et al.,* 2010). Intergovernmental panel on climate change IPCC, (2007) defined climate change as statistically significant variations that persist for an extended period, typically decades or longer. This includes variations in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. These variations simply put, affect the frequency, severity and duration of the elements.

Adejuwon, (2004) observed that climate change had become more threatening to human existence while King (2004) considered climate change a far more severe threat than terrorism. Though evidence abound that climate change has begun to take its toll on the planet earth as a whole, scientific studies predict for more effects (Odada *et al.,* 2008). Adger *et al*. (2007) predicted that Africa is likely to suffer more loses from climate change because of the likely result of combined effects of climate change with the continents characteristics poor infrastructure, poverty and low productivity.

It has been reported that there has been continuous sharp increases in temperature trend in Nigeria since the early 1970s'. A temperature increase of between 2.5^{o}C and 4.5^{o}C is predicted by the year 2100 as compared to 0.74^{o}C recorded in the 105 year period between 1860 and 1965 (Spore, 2008). The rainfall situation has been equally disturbing as the trend between 1901 and 2005 shows a general decline (Odugo, 2010). While rainfall amount dropped by 81mm over this period, the number of rain days dropped by as high as 53% in some parts of the country. While other parts such as the Coastal areas have been experiencing increased and detrimental volumes of rainfall. This is evidence

by the increased incidences of flood across the country with disastrous consequences on agricultural production and the general livelihood of the population (Matanmi *et al*., 2011).

2.1.6 Adaptation to Climate Change

The goal of adaptation is long-term resilience to create the condition in which society and managed ecosystems are highly able to absorb the impacts from climate variability and change such that any residual impacts beyond their coping capacity remains within (Socially defined) accepted limits of rises (Oluwakemi *et al.,* 2014).

Adaptation to climate change is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates, harm or exploits beneficial opportunities (IPCC, 2007). It also refers to all adjustments in behaviour or economic structure that reduces the vulnerability of society to changes in the climate system including its current variability and extreme events as well as long-term climate change (Smit *et al.,* 2000). According to Akinnagbe and Irohibe (2014), adaptation has three possible objectives which are to:

- to reduce exposure to the risk of change;
- develop the capacity to cope with unavoidable damage and
- take advantage of new opportunities

Adaptation to climate change necessitates that farmer first notice that the climate has changed and them identify useful adaptation and implement them (Maddison, 2006).

Adaptation is one of the policy options for reducing the negative effects of climate change on agricultural production.

In agricultural production, adaptation helps farmers to achieve food production, income and livelihood, security in the face of changing climatic and socio-economic conditions including climatic variability, extreme weather conditions such as droughts; floods and volatile short-time changes in local and large scale markets (Kandlink and Risbey, 2000). In addressing the global threat to climate change on agricultural production. Tubiello and Resenzweig (2008) stated that wide ranges of adaptation exist within farming system to maintain or increase crop and livestock yields under climate change. Examples improved crop varieties: crop diversification, change of planting date, irrigation, mixed crop/livestock farming, increased use of soil and water conservation techniques, crop rotation etc.

2.2 Empirical Review

2.2.1 Socio-Economic Characteristics of Arable Crop Farmers

Oluwakemi *et al.* (2014) study on factors influencing farmers' choice of adaptation to climate change in Ekiti State, Nigeria revealed that the following factors affect farmers' choice of climate change adaptation age of the farmer, gender of the household head, years of education, years of farming experience, household size, farmers information on climate change, farmers access to credit, farm income, non-farm income and extension contact have effect on adaptation. This implies that useful and better decision taking has to do with age, too young as well as too old cannot make any meaningful decision. A meaningful decision has to do with the active age of farmers. The same goes for the years of education. The more years of education the better the decision making process.

Olasimbo (2016) study on adaptation strategies to the effects of climate change on arable crops production in Southwestern, Nigeria revealed that majority of the respondents 26.0% had their aged between 31 and 40, which implies that the respondents were within the active age of production; 90.0% were male, and 79.2% were married. This implies that most of them were household heads that can take useful decisions. Some of the respondents (40%) had secondary school certificate, signifying that they can read and write. The higher the educational status of the respondents, the higher would be their productivity. With higher educational status, farmers would have access to agricultural information both in print and official language. They are exposed to meet other people either in conferences, workshops and association meetings where they can see production technologies which people with low educational status might not have access to. The results further showed that most of them (66.7%) belong to one form of association or the other. Farmers that belong to a social association or have a leadership status in the association will improve his productivity as relevant information can be shared within the group. More so, some of the respondents (29.2%) had one other income generating activity apart from arable crops production to support themselves when they are hit by the climate change effects.

Francis and Tsunemi (2016) study on the determinants of farmers' adaptation to climate change: A micro-level analysis in Lawra, Ghana revealed that, educational level household size, gender, annual household income, access to information and credit were the most important factors that influence farmers' adaption to climate change.

Luka and Yahaya (2012) study on sources of awareness and perception on effects of climate change among sesame producers in the Southern Agricultural Zone of Nasarawa State, Nigeria revealed that 40% and 37.8% of the respondents were within the active ages of 20 – 30 and 31 – 40 years respectively. It was found that age is positively related to the adoption of conservation measures and assumed that old age is associated with more experience and expect older farmers to have better understanding of the effects and adapt to climate changes. Young people have a long planning horizon to take up long adaptation measures. The gender shows higher percentage of males than the females (53.3% and 47.7%).

Higher educational level had better knowledge and understanding of the concept of climate change. More so, this knowledge is important for the adoption of technologies and behavioural change to adapt to climate change. Older farmer are more responsive to climate change than the young ones. Age may endow farmer with requisite experience that empower them to make better assessments of the prevailing risks. Income level is a key factor in influencing adoption of technologies (Nicholas *et al.*, 2012).

The study of Salau *et al.* (2012) on knowledge perception and adaptation strategies to climate change among farmers in southern agricultural zones of Nasarawa State, Nigeria, revealed that, older farmers had lower adaptive capacity than the younger ones. Higher farming experience increases the probability of uptake of many adaptation measures. This means that, highly experienced farmers are likely to have more information and knowledge on changes in climatic conditions and crop management practices. The study

further showed that, frequent contact with the extension agents also increases the probability of taking up adaptation measures.

2.2.2 Sources of Information on Climate Change adaptation strategies

In a research conducted by Emmanuel *et al.* (2016), the results in multiple responses revealed that the only available information sources and services that could be considered adequate for the farmers in the selected local government areas of the state were town crier 90%, relations 89% and film shows 82%. However other information sources and services such like conferences and workshop, extension workers contact, television, Non-Governmental Organization (NGOs), mobile phones were rated low; this implies that they are not adequately available to farmers in the area. This would mean that the only information sources and services available for utilization in production practices in the areas were town criers, relations and film show; while others like conferences, workshops and Non –Governmental organization were inadequate.

Iwuchukwu and Onyeme (2012) study using likert scale, percentage mean score and t-test revealed that, 100 percent of the respondents had heard and were aware of climate change mainly through formal sources. Tologbonse *et al*. (2010) study showed that the most important information source on climate change was personal experience, followed by radio and television. George (2010) revealed that, personal contact, family and friends were the main sources of information on climate change.

The study of Salau, E.S., Onuk, E.G and Ibrahim, A. (2012) using statistical package for social science (SPSS), simple descriptive statistics, standard deviation and a 3-point likert

scale revealed that, majority of the respondents relied on radio as their major source of information on climate change.

The empirical results of Aphunu and Nwabeze (2012) of inferential statistics showed that respondents sourced their information mainly from personal experience, radio/television, as well as neigbours/friends.

2.2.3 Perceived Causes of Climate Change

The study of Nwalleji and Uzuagbunam (2012) using percentage, mean score and mean statistic revealed that majority (68%) of the farmers attributed the cause of climate change to the natural phenomena; while a few perceived it to cause by the depletion of the Ozone layer.

Iwuchukwu and Onyeme (2012) study using percentage, mean score and t-test showed that, respondents perceived the cause of climate change to authropogenenic, which are those activities of man that help to change the chemical composition of the atmosphere. Nicholas *et al.* (2012) study using frequency, percentage, mean score, correlation and regression analysis revealed that, the perceived causes of climate change by the respondents include: industrial activities such as: construction, emission of gases, flaring of gases, petroleum, quarry, smoke from the diesel or petrol engines, use of chemicals, water pollution, farming activities such as: bush burning, chemicals, application such as herbicides, pesticides, fungicides, insecticides, deforestation, transportation such as: emission of dangerous gases, smoke from diesel or petrol engines, agro-chemical processing such as: agro-allied wastes, deforestation, pesticides, release of smoke,

smoking and urbanization such as: civilization, deforestation, emission of gases, improper disposal of waste discharge.

2.2.4 Types of Climate Change Adaptation Strategies

Luka and Yahaya, (2012) study observed that the following adaptation strategies were adopted by the respondents: mixed cropping, improved seed varieties, early planting, early harvesting, use of chemicals, increase soil and water conservation, as well as use of insecticide powder.

The study of Nicholas *et al*. (2012) using frequency, percentage, mean score, correlation and regression analysis revealed that respondent in the study area adopted the following adaptation strategies to the climate change: irrigation of farm land, change of crop varieties, tree planting, mulching, clearing around farm, green manure application, changing of farming dates, move from risk/unproductive farm land, use of indigenous weather forecasts as well as use of scientific weather forecasts.

The study by Mgbenka (2012) observed the following adaptation strategies to the climate change: shifting cropping patterns, crop diversification, organic farming such as: crop rotation, cover crops, maturing and application of organic amendments to restore degraded soils.

Olasimbo (2016) revealed that respondents in the study area adopted the following types of adaptation strategies to the climate change; mixed cropping, intercropping, crop rotation, use of resistance varieties as well as crops diversification.

Francis and Tsunemi (2016) study using logistic regression model and weighted average index revealed the following adaptation strategies to the climate change: irrigation, improved crop varieties, crop diversification, farm diversification, change of planting dates, and income generating activities.

A study of Moradeyo and Anselm (2016) using descriptive statistics and principal component analysis (PCA) showed the following adaptation strategies: Mulching, soil management practice, multiple planting dates, use of cover crops, use of farm plots fragmentation as land management practice as well as fertilizer application.

The study of Oluwakemi *et al.* (2014) using multinomial logic (MNL) and descriptive statistics opened the following types of adaptation strategies to the climate change: improved crop varieties, crop diversification, mixed cropping change of planting dates, diversification from farm to non-farm activities, increased use of soil and water conservation techniques, changed use of capital and labour, as well as tree planting.

The study of Onyeneke and Madukwe (2010) using descriptive statistics observed the following types of adaptation to climate change: use of improved crop varieties, irrigation, crop diversification, adoption of mixed crop, farming systems, changing plant dates as well as soil conservation.

Ajani and Igbokwe (2012) study of percentage, mean score and standard deviation opined that majority of the respondents were involved in enterprises such as: marketing of farm produce, processing of cassava into gari and dough (fermented flour), processing of maize into pap and flour, making of confectioneries such as cake, chin-chin, meat pie,

and buns, making of soap and pomade, making of hand fans and beads, making of baskets and brooms, hair dressing/weaving of hair, tailoring/making of dresses as well as petty trading on food items such as rice, beans, gari and palm oil as adaptation strategies to the climate change effects.

Joshua *et al*. (2013) revealed the following types of adaptation strategies to the climate change adopted by the respondents: storing food, income diversification, digging drainage channels, planting trees, planting high yielding crops, planting early maturing crops, use of drought tolerant crops, use of disease and/or pest-resistant varieties, planting at onset of rains, increased and pesticide/fungicide application.

2.2.5 Effects of Climate Change

Olasimbo (2016) revealed that reduction in crop yield, pests and diseases infestation, late maturity of crops, extinction of crops, irrigation and relocation of arable crops were identified as effects of climate change on arable crops in the study area.

Aphunu and Nwabeze (2012) study using of inferential statistics and Pearson correlation coefficient model opened the following effects of climate change to arable crops farmers; poor harvest, excessive sunshine, increased incidence of drought, high temperature and heat wave, increased incidence of pests and diseases infestation, incidence of erosion and washing away of farm land/arable crops resulting from heavy rain and wind storm, increased cost of production, as well as food insecurity and hunger.

Francis and Tsunemi (2016) showed that high temperature had resulted in reduced crop yields, increasing incidence of drought, late rains, floods and decreasing annual precipitation were the effects of climate change on the arable crops in the study area.

Nwalieje and Uzuegbunam (2012) observed that the negative effects of climate change on arable crops production include: reduction in grain quality, loss of crops due to floods, loss of income, food unavailability, instability, inaccessibility and poor utilization, incidence of pests and diseases, higher food prices, aggravation of rural poverty, decrease in soil fertility, soil erosion, incidence of drought, high winds, high incidence of weeds, change in production calendar as well as excessive rainfall.

Umar, (2012) observed these effects of climate change: decreased rainfall amount, unusual heavy rainfall, unexpected rainfall, changes in rainfall pattern, increased cases of flooding, decreased soil moisture, prolonged drought, high temperature and heat, heavy winds, increased in pests and diseases, extension of some crop species, reduction in crop yield, poor quality of storage of farm produces as a result of heat, increasing drying up of seedlings after germination, stunted growth of crops as well as increased health problems.

2.2.6 Challenges Faced in Adopting the Adaptation Strategies to the Climate Change

Furthermore, Olasimbo (2016) observed that poor infrastructure, economic poverty and reduced crop yields constitute important challenges for Nigeria in particular.

Joshua *et al*. (2013) observed the following challenges to the adaptation of climate change: poverty (inability to pay for farm inputs, equipment and services like labour) unreliable weather forecast and shortage of food to store.

According to Onyeneke and Madukwe (2010) the main constraints to adaptation to climate change effects include: lack of information on appropriate option, lack of finance and shortage of labour.

Dejene (2011) observed these challenges: untimely rain, frequent drought, lack of modern early warning information system, inflexible cropping calendar as well as narrow choice of crop varieties.

2.3 Theoretical Framework

A theory is a set of statements that are to give a meaning to an event. Theoretically, this study is focused on the theory of rational choice and utility theories of household decision-making.

2.3.1 Rational Choice theory

This theory is anchored on people's comparison of the costs and benefits of certain actions. In this context, the rational choice approach to the problem of climate variability and change effects and adaptation decision making is based on the fundamental premise that best help them achieve their farm objectives given all relevant factors that are beyond their control. The basic rational choice theory is that, people do their best under prevailing circumstances to get the best satisfaction. Farmers always want to get the best result at the lowest cost of adaptation practices. In general, farmers will prefer adaptive actions that provide the greatest benefit at the lowest cost. For example, if a farmer is to adopt using either planting of drought resistant crop or irrigation farming or change completely to fish farming, the set of possible alternative to plant drought- (Placeholder1)

resistant crop, irrigation, change to fish farm. An important element of this rational choice theory process is the presence of constraints (Green and Salkind, 2010). It is believed that a typical farmer could be faced with the constraints of how much of his farm budget goes for adoption to drought-resistant crop as opposed to some other production activity. The presence of constraints makes choice necessary and one virtue of rational choice theory is that it makes the trade-off between alternative choice very explicit (Witt and Waibel, 2009).

2.3.2 Utility theory

This refers to the satisfactions that each choice provides to the decision makers. That is, farmers play the role of the decision makers that must decide how much each of the many available climate change adaptation strategies to use so as to secure the highest possible level of satisfaction, subject to his/her available resources. That is the satisfaction that a farmer gets from selecting a specific choice of climate change and adaptation strategy is measured by preference of various choices. For example, if a farmer prefers adaptative option of planting drought-resistant crop over irrigation farming.

In this case, it could be inferred that planting drought-resistant crop as an adaptative strategy is preferred over changing to irrigation and fish farming. The climate change adaptation strategies adopted by the farmer will be influenced by level of his/her preference or satisfaction.

CHAPTER THREE

3.0 METHODOLOGY

3.1 The Study Area

The study was conducted in Nasarawa State, North-central, Nigeria. Nasarawa State is located between latitude 8^{o} 21^{1} 58" North of the equator and longitude 7^{o} 51^{1} 58" East of green which meridian. Majority of the population are rural dwellers that mostly engage in agricultural production (Shuaib *et al.,* 1997). The state is characterized by two major seasons, dry and wet seasons. The wet season ranges from April to October, while the dry season ranges from November to March (Nigeria Meteorological Agency, 2008). The rainfall per annum ranges from 1000 to 1,500mm with the average of 187 to 220 rainy days with average monthly temperature ranges from 21^{o}C and 37^{o}C. The vegetation of the state is of the northern guinea savannah. Geographically, the state is characterized by varying land forms extensive and swampy features which are common in the lowland areas along the valleys of Benue deep valleys, large hills, mountains and Plateaus. Soil and weather patterns are favourable for the production of wide spectrum of agricultural food, industrial and cash crops of different types. The major crops grown in the state include rice, maize, yam, cassava, millet, sorghum among others.

Nasarawa State has an estimated population of 2,823,965 million people by 2017, with land mass area of 27,117km^{2} (National Population Census, 2006). Nasarawa State is divided into three agricultural zones namely: The Western Agricultural Zone with

headquarters at Keffi, the Central Agricultural Zone with headquarters at Akwanga and the Southern Agricultural Zone with the headquarter at Obi respectively.

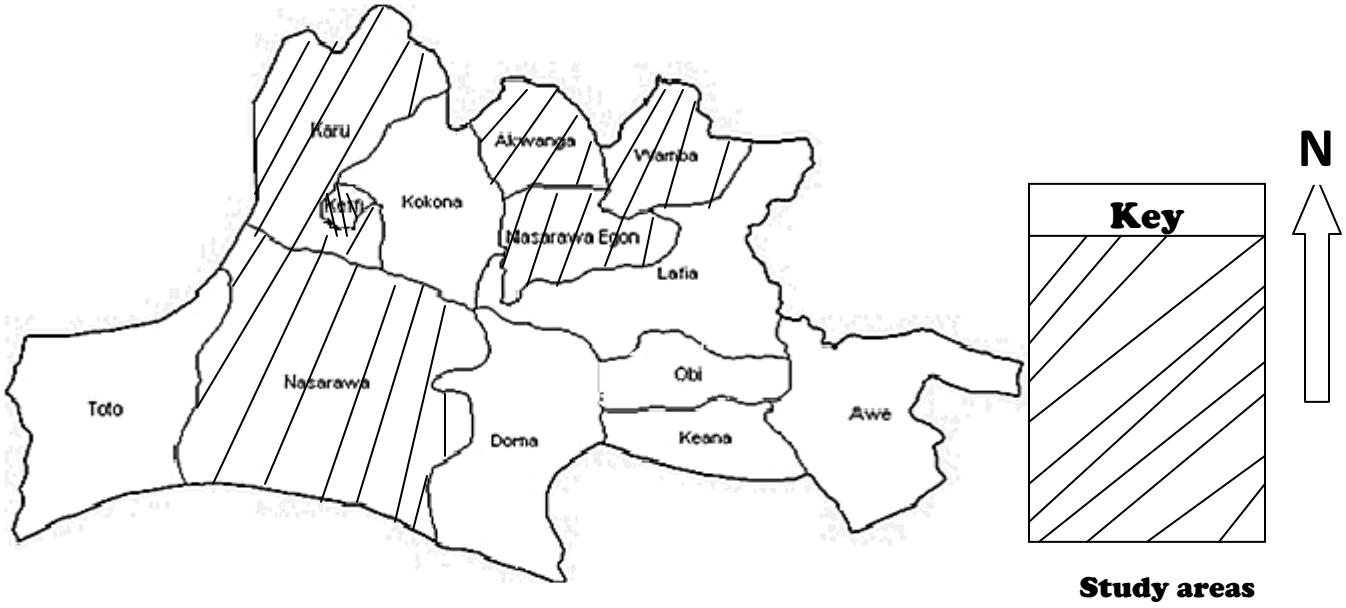


Fig. 2: Map of Nasarawa State showing the study area

3.2 Sampling Procedure and Sample Size

The target population for this study was all arable crops farmers in Nasrawa state. A multi-stage sampling procedure was used to select the sampled respondents.

Stage 1: Random sampling technique was used to select two agricultural zones from the three agricultural zones of the state namely; Central Agricultural Zone and Western Agricultural Zone.

Stage 2: This stage involved the random selection of three Local Government Areas each from each of the two selected agricultural zones to give a total of six LGAs selected.

Stage 3: Random sampling technique was used to select 4 communities from each of the selected 6 LGAs to give 24 communities that were used for the study. Stratified random sampling technique was used to select one hundred and two (102) respondents from the 24 communities for the study. The stratified random sampling technique was done to sample only respondents that were be able to recall temperature and rainfall patterns in their communities.

TABLE 1: Sampling Frame for assessment of climate change and adaptation strategies among arable crop farmers in the study area

Selected LGA	**Selected communities**	**Number of Farmers able to recall temperature and rainfall patterns in each community**	**Number of farmers selected in each community**
Karu	Ado-kasa	13	6
	Kugaru	12	6
	Barku	10	4
	Aso pada	10	4
		45	**20**
Akwanga	Anchor-Sarki	13	6
	Rinze	11	5
	Andaha	10	5
	Ninga	6	3
		40	**19**
Nasarawa Eggon	Alogani	10	5
	Gale	10	5
	Kagbu	8	4
	Gidan-waya	7	3
		35	**17**
Wamba	Sinsinbaki	10	5
	Agamati	10	5

	Marara-gongon	8	4
	Wujung	7	3
	Dansa	11	6
Nasarawa		**35**	**17**
	Gudiga-sabo	8	4
	Ara	6	3
	Gudiga-tsoho	5	2
		30	**15**
Keffi	Gauta	10	5
	Tsohon-barrack	8	4
	Gitata	7	3
	Gunduma	5	2
6	**24**	**30**	**14**
Total		**215**	**102**

SOURCE: Preliminary Survey data (2018)

3.3 Method of Data Collection

Primary data were used for this study. Data were collected using structured questionnaire to capture information related to all the objectives of the study. Data were collected on socio-economic characteristics of the respondents, the perceived causes of climate change by the respondents, sources of information on climate change, the negative effects of climate change, types climate change adaptation strategies adopted and constraints faced in adopting the adaptation strategies.

3.4 Data Analysis

Descriptive statistics like mean, percentage, standard deviation and coefficient of variation were used to analyzed objectives I,II,III,IV, V and VI. F-test statistical model was used to test the hypothesis at 5%.

Formula for ANOVA (f-test statistics)

$$F = \frac{MST}{MSE}$$

Where: F = ANOVA coefficient
MST = Mean sum of square due to treatment
MSE = Mean sum of square due to error

3.6 Justification of Method

Descriptive statistics are used to summarize data in an organized manner by describing the relationship between variables in a sample or population. Calculating descriptive statistics represents a vital first step when conducting research and should always occur before making inferential statistical comparisons. Descriptive statistics include types of variables (nominal, ordinal, interval, and ratio) as well as measures of frequency, central tendency, dispersion/variation, and position. Descriptive statistics condense data into a simpler summary, they enable researchers and decision-makers to assess specific populations in a more manageable form while the process of examining the relationship between variables, researchers can use t-test or ANOVA to compare the means of two groups on the dependent variable (Green and Salkind, 2010). The main difference between *t*-test and ANOVA is that t-test can only be used to compare two groups while ANOVA can be used to compare two or more groups. The advantage of

ANOVA over *t*-test is that the post-hoc tests of ANOVA allow for better controlling type 1 error (Green and Salkind,2010).

3. 7 Validity of research Instrument

Validity is the extent to which an instrument measures what it is supposed to measure and performs as it is designed to perform. The instrument for this study was a structured questionnaire. It was designed to capture all the six (6) specific objectives of the study. The instrument for data collection in this study was validated by passing it through the supervisors and other experts in the Department of Agricultural Economics and Extension, Faculty of Agriculture, Shabu-Lafia Campus, Nasarawa State University, Keffi, whose independent opinions on the adequacy and relevance of the research instrument ensured that it possessed both face and content validity. Their observations were harmonized and necessary corrections effected on the instrument before data collection commenced.

3.8. Instrument reliability

The instrument was subjected to a test re-test reliability to ascertain its consistency.

The instrument was administered to Twenty (20) respondents drawn from two (2) communities of Deddere and Agyaragu in the Southern Agricultural zone of Nasarawa State. It was computed by calculating the correlation coefficients of the test scores that were obtained at two different times on the same respondents. The reliability coefficient range from 0.00 to 1.00, with values of 0.70 or higher indicating acceptable reliability (George and Mallery, 2003). The product-moment correlation coefficient (r) of 0.753, 0.768, 0.885, 0.711, 0.872 and 0.761 for clusters A, B, C, D, E and F. The grand

reliability coefficient of 0.791 (79.1%) was obtained. This is an indication that the instrument can be considered highly reliable.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socioeconomic characteristics of respondents

4.1.1 Age of Respondents

Table1 shows the socioeconomic characteristics of the respondents as follows: Majority (66.7%) of the respondents were aged between 21-40 years, 22.5% aged between 41-60 years, 7.8% aged less than 21 years while those aged 61 years and above were 2.8%. The mean age of respondents in the study area was 35 years. This shows that farmers in the study area were mostly young people who are still strong and energetic and are most likely to adopt more techniques to cope with climate change events. Salau, E.S., Onuk, E.G. and Ibrahim, A. (2012) conducted a research on knowledge perception and adaptation strategies to climate change among farmers in southern agricultural zones of Nasarawa State, Nigeria. Their findings showed that most (36.7%) of the respondents were aged between 41 – 50 years with a mean age of 48 years. This shows that farmers were mostly middle aged people who are still strong and energetic and are most likely to adopt more techniques to cope with climate change.

4.1.2 Sex of the Respondents

The results in table 1 shows that majority (75.5%) of the respondents were males while 24.5% were females. This implies that more males were engaged in arable crops farming than the females in the study area. The finding agrees with that of Aphunu and Nwabeze (2012) which found that male dominance implies the laborious nature of farm operation which are very tedious for females to handle.

4.1.3 Marital Status of the Respondents

A greater proportion (62.7%) of the respondents in the study area were married. This shows that most of the respondents had wives and husbands is an indication that family labour could be available to support in arable crops farming.

4.1.4 Years of Farming Experience of Respondents

Most (41.2%) of the respondents had between 1-10 years of farming experience, 29.4% had between 11-20 years, 14.7% had between 21-30 years and 31 years and above. The mean years of farming experience of the respondents was 17 years. This implies that most of the farmers in the area were not new in farming occupation. They must have had significant experience in climate change phenomenon and must have evolved various adaptation strategies to cope with the impacts. Olasimbo (2016) observed that experienced farmers are likely to have knowledge on changes in climatic conditions and crop management practices.

4.1.5 Level of Education of Respondents

Majority (90.2%) of the respondents had some form of formal education. A few of them 9.8% had primary education, the results further revealed that 35.3% had secondary education, while 45.1% attained tertiary education and only 9.8% had no formal education. This shows that farmers in the area were mostly literates. This high level of education is capable of aiding their access to accurate information on climate change and hence their adaptive capacity might be very high. This is in line with the findings of Luka and Yahaya (2012). Results of their findings in the southern agricultural zones of Nasarawa State revealed that majority of the respondents (34.4%) had secondary school

education while 22.2% had primary school education. Education facilitates farmers understanding and use of improved technologies.

4.1.6 Farm Size (in ha) of Respondents

Majority (88.2%) of the respondents had between 1-10 hectares of land, 9.8% had between 11-20 hectares while 2.0% had between 21-30 hectares. The mean farm size of the respondents was 4.8 ha. This shows a greater portion of small scale farmers in the study area. Small scale farmers generally have inadequate capital to adopt technologies that require huge capital. This will likely affect their adaptive capacity to climate change. This is in line with the findings of Francis and Tsunemi (2016) in their study on the determinants of farmers' adaptation to climate change. The results of their findings showed the mean farm size of the respondents was 3.5ha. This shows a preponderance of small scale farmers in the study area.

4.1.7 Household Size of Respondents

The mean household size of the respondents was 7. This implies that most of the respondents had small household sizes. Family size has implication on the size of the hired labour employed because the higher the size of the family the lower the hired labour and vice versa. Yusuf (2016) in a research titled "Comparative analysis of gender accessibility to productive resources in ginger production for poverty alleviation" in Kaduna State asserted that the significance of household size in agriculture however suggest the availability of labour for agricultural production. The total area cultivated to different crops, amount of farm produce retained for domestic consumption and the marketable surplus are all determined by the size of the farm household.

4.1.8 Number of Contact with Extension Workers

Table 1 also shows that the mean number of extension visits per year for the respondents was 2. With the maximum of 6 – 10 times and a minimum of 1 – 5 times. This implies that farmers in the zone had fewer visits by extension workers. Frequent extension contact enhances rapid dissemination of recommended practices and increases the adoption capacity of the farmers. This results agrees with the findings of Barbier *et al.* (2009) on a research conducted titled "Analysis of youth involvement in rice production" in Lafia Local Government Area in Nasarawa State. Their findings revealed that (65%) of the respondents had no contact with extension workers. They opined that low level of contact with extension agents inferred less likelihood of adoption of new farm practices and less effectiveness through the loss of the contacts. This findings is however, contrary to findings by Salau *et al.* (2012). Findings revealed that farmers in the zone had an average of two extension visits per month which is in line with recommended visit schedules of village extension agents under the T & V system. Frequent extension contact enhances rapid dissemination of recommended practices and increases the adoption capacity of the farmers.

4.1.9 Membership of Social Group

Majority (60.8%) of the respondents belonged to social organizations such as agricultural cooperatives, religious organization thrift and credit society while 39.2% did not belong to any social organization. This implies that most of the farmers participated in social organizations. This will provide avenue for information sharing thereby enhancing adoption capacity.

4.1.10 Annual Income of Respondents

Majority (75.5%) of the respondents had annual income of between N1, 000-N500, 000:00. The mean annual income was N603, 235:29. This implies that farmers in the study area were mainly low income earners. Hence, they may not be willing to take risk on technologies adoption. According to Nicholas *et al.* (2012), income level is a key factor in influencing adoption of technologies. The higher the income level of farmer the lesser he or she will be disposed to fear of taking a risk in respect of adopting a given technology.

4.1.11 Amount of Loan Received (in naira)

Majority (63.9%) of the respondents did not used any credit facility. Only 25.5% of the respondents received between N1,000 – N200,000 as credit during the 2016/2017 farming season with the maximum of N1,000 and a maximum of N200,000. This implies that most of the respondents that could not use or access credit facility may not be able to either integrate, diversify or adopt adaptation strategies that are capital intensive.

4.1.12 Mode Land of acquired by Respondents

Majority (56.9%) of the respondents inherited their farm lands while 16.7%, 9.8%, 8.8% and 7.8% used purchased land, community land, hired land and lease land respectively. Majority of the respondents acquired their farmlands through inheritance implying that female respondents may be disadvantaged in this process due to the cultural practices guiding land inheritance in the study. In Nigeria, and other vulnerable societies for instance, women lack independent rights to land. Land rights are only allocated through men, either sons or husbands. Kabana (2010) argues that constraints which are faced by women farmers differ from country to country and culture to culture. He opined that in

Nigeria, Afghanistan and other patriarchal societies for instance, women lack independent rights to land. Land rights are only allocated through men, either sons or husbands

Table 1: Socio-economic characteristics of respondents (N = 102)

Variable	Frequency	Percentage (%)	Mean
Age (years)			
Less than 21	8	7.8	
21-40	68	66.7	
41-60	23	22.5	
Above 61	3	2.8	
Sex			**35 years**
Female	25	24.5	
Male	77	75.5	
Marital status			
Single	30	29.4	
Married	64	62.7	
Divorced	3	2.9	
Widowed	5	4.9	
Farming experience (in years)			
1-10	42	41.2	**17 years**
11-20	30	29.4	
21-30	15	14.7	
Above 30	15	14.7	
Level of education			
Non-formal	10	9.8	
Primary	10	9.8	
Secondary	36	35.3	
Tertiary	46	45.1	
Farm size (in ha)			**4.8 hectares**
1-10	90	88.2	
11-20	10	9.8	
21-30	2	2.0	
Household size (no. of persons)			
1-10	82	80.4	**7 persons**
11-20	20	19.6	
Number of contact with extension workers			
Had no contact	42	41.2	
1-5 times	54	52.9	
6-10 times	5	4.9	**2 times**
Above 10 times	1	1.0	
Membership of social group			
No	62	60.8	
Yes	40	39.2	
Annual income (in naira)			
1,000-500,000	77	75.5	**603,235:29 naira**
501,000-1,000,000	11	10.8	
1,001,000-1,500,000	6	5.9	
Above 1,500,000	8	7.8	
Amount of loan received (in naira)			
Did not received loan	65	63.9	**201,475:49 naira**
1,000-200,000	26	25.5	
201,000-400,000	1	1.0	
Above 400,000	10	9.8	
Mode land of acquisition			
Inheritance	58	56.9	
Lease	8	7.8	
Purchased	17	16.7	
Hired	9	8.8	
Family/community land	10	9.8	

Source: field survey 2018
N = Sample size

4.2 Sources of information on climate change adaptation strategies

The results in Table 2 show that majority (91.2%) of the respondents got their information about climate change and adaptation strategies through radio, followed by 84.3% of the respondents who used friends and fellow farmers, 77.5% of the respondents' source of information about climate change and adaptation strategies from television and 67.6% of the respondents' source of information was from extension workers. It was observed that the use of other mass media sources like electronic and print media were highly patronized with 81.3%. This might be as a result of the high educational level of the respondents in the study area. This result is in line with the findings of Salau *et al*. (2012) and Aphunu and Nwabeze (2012) who revealed that farmers sourced their information mainly from radio, television as well as neighbours/friends.

Table 2: Sources of information used by respondents (n=102)

Source of information	Frequency*	Percentage (%)
Radio	93	91.2
Friends/fellow farmers	86	84.3
Television	79	77.5
Extension workers	69	67.6
Newspapers	13	12.7
Town crier/village/town meetings	7	7
Self initiative	3	2.9
Cooperative societies	3	2.9

Source: Field survey, 2018
*Multiple responses allowed

4.3 Perceived Causes of Climate Change by the Respondents

The results in Table 3 show that majority (85.3%) of the respondents perceived bush burning as the cause of climate change, 80.4% of the respondents perceived cutting down of tree (deforestation) as the cause of climate change and 77.5% of the respondents perceived burning of fire wood for cooking as the cause of climate change. The results further revealed that, 71.6% of the respondents perceived high temperature due to Ozone layer depletion as the cause of climate change, 65.7% of the respondents perceived overgrazing of farm lands by livestock as the cause of climate change, 60.8% of the respondent's perceived natural phenomenon and application of chemical fertilizers, pesticides and herbicides as the cause of climate change.

Others were 12.7% of the respondents perceived burning of fossil fuel from vehicles and generating engines as the cause of climate change, 8.8% of the respondents perceived methane emissions from domesticated ruminant animals as the cause of climate change, 7.8% of the respondents perceived industrialization as the cause of climate change and 6.9% of the respondents perceived urbanization as the cause of climate change.. This agrees with the findings of Iwuchukwu and Onyeme (2012) which revealed that, respondents perceived the cause of climate change to anthropogenenic, which are those activities of man that help to change the chemical composition of the atmosphere.

Table 3: Perceived causes of climate change

Cause of climate change	Frequency*	Percentage (%)	Rank
Bush burning	87	85.3	1
Cutting down of tree (deforestation)	82	80.4	2
Burning of fire wood for cooking	78	77.5	3
High temperature due to Ozone layer depletion	73	71.6	4
Overgrazing of farm lands by livestock	67	65.7	5
Natural Phenomenon	62	60.8	6
Application of chemical fertilizers, pesticides and herbicides	62	60.8	6
Burning of fossil fuel from vehicles and generating engines	13	12.7	8
Methane emissions from domesticated ruminant animals	9	8.8	9
Industrialization	8	7.8	10
Urbanization	7	6.9	11

Source: field survey 2018
*Multiple responses allowed

4.4 Types of climate change adaptation strategies adopted by the respondents

The results in Table 4 show that majority (96.1%) of the respondents adopted early planting of crops as their strategy to cope with climate change, 8.4% of the respondents adopted practice of crops rotation as their strategy to cope with climate change and 79.4% of the respondents adopted planting of early maturing varieties as their strategy to cope with climate change. A reasonable percentage (73.5%) of the respondents adopted mulching and practice of organic farming as their strategy to cope with climate change, 63.7% of the respondents adopted minimum soil tillage as their strategy to cope with

climate change, 9.8% of the respondents adopted enterprise diversification and planting of resistant varieties as their strategy to cope with climate change, while 8.8% of the respondents adopted adoption of irrigation techniques as their strategy to cope with climate change. These measures are aimed at maximizing yields and ensure food security. Crop diversification which implies growing a number of different crops in the same plot or in different plots reduces the risk of complete crop failure as different crops are affected differently by climate events. This finding agrees with the finding of Salau *et al*. (2012) who revealed that the types of adaptation strategies adopted by farmers were enterprise diversification, early planning of crops, minimum soil tillage, use of mulching, use of cover cropping, planting early maturing varieties, planting resistant varieties, adoption of irrigation techniques as well as practice of organic farming.

Olasimbo (2016) in a study of climate change adaptation by farmers in the South-western, Nigeria reported that some of the adaptation strategies to the climate change included mixed cropping, intercropping, crop rotation, use of resistance varieties as well as crops diversification. In another study still in the South-western Nigeria by Moradeyo and Anselm (2016) using descriptive statistics and principal component analysis (PCA), the results showed the following adaptation strategies: Mulching, soil management practice, multiple planting dates, use of cover crops, use of farm plots fragmentation as land management practice as well as fertilizer application.

Table 4: Types of climate change adaptation strategies adopted by the respondents

Adaptation strategy	Frequency*	Percentage (%)
Early planting of crops	98	96.1
Practice of crops rotation	82	80.4
Planting of early maturing varieties	81	79.4
Use of mulching	75	73.5
Practice of organic farming	75	73.5
Minimum soil tillage	65	63.7
Use of cover crops	63	61.8
Enterprise diversification	11	10.8
Planting of resistant varieties	10	9.8
Adoption of irrigation techniques	10	9.8
	9	8.8

Source: Field survey 2018
*Multiple responses allowed

4.5 Effects of climate change on arable crops by the respondents

Table 5 shows the various negative effects of climate change on crop production in the study area. These include the reduction in crop yield/Destruction of farm lands by flood/Decrease in soil fertility (88.2%), High incidence of pests and diseases (83.3%), Change in production calendar (79.4%), Loss of income (74.5%) and Incidence of droughts in the field (74.5%) among others. The negative effects of climate change on crop production are capable of leading to increased poverty level and food insecurity in rural areas. This finding agrees with that of Francis and Tsunemi (2016) and Olasimbo

(2016) who revealed that climate change has caused a serious bottleneck in farmers' effort to adopt a sustainable food production system.

Table 5: Negative effects of climate change on arable crop production by the respondents

Variable	Frequency*	Percentage (%)
Reduction in crop yield/Destruction of farm lands by flood/Decrease in soil fertility	90	88.2
High incidence of pests and diseases	85	83.3
Change in production calendar	81	79.4
Loss of income	76	74.5
Incidence of droughts in the field	76	74.5
High temperature	70	68.6
Excessive rainfall	68	66.7
High incidence of weeds	60	58.8
Food unavailability, instability, in accessibility and poor utilization	58	56.9
Loss of crops under preservation	58	56.9
Higher food prices	58	56.9
High winds	13	12.5
Surges of infectious diseases such as malaria, cholera and rashes	13	12.5

Source: field survey 2018
*Multiple responses allowed

4.6 Challenges Faced in adopting climate change adaptation strategies

Results in table 6 show that majority (85.3) of the respondents indicating lack of government support, inadequate information (79.4%), unfavourable land tenure system (71.6%), high cost of adoption of the technology (69.6%), traditional agricultural

practices and poor extension services (64.7%), low level of education (11.8%), small Farm size (5.9%), cultural barriers (3.9%) and religious belief (1.0%) were indicated by the respondents as challenges Faced in adopting the adaptation strategies among the respondents in table 6. These factors constitute setback to any effort to adopt sustainable adaptation measure to climate change. Since most small scale farmers in the study area were low income earners, they lack the finance and other inputs to acquire the necessary adaptation measures to cope with climate change, especially those requiring huge capital investment and high technical skills. This result agrees with the findings of Salau *et al.* (2012) and Francis and Tsunemi (2016) who revealed that farmers were faced with constraints such as low level of income, poor technology, low level of education, in adequate information, poor extension services, unfavourable land tenure as well as no government support.

Table 6: Challenges Faced in adopting climate change adaptation strategies

Challenges	Frequency*	Percentage (%)	Rank
Lack of government support	87	85.3	1st
Inadequate information	81	79.4	2nd
Unfavourable land tenure system	73	71.6	3rd
High cost of the technologies	71	69.6	4th
Traditional agricultural practices	66	64.7	5th
Poor extension services	66	64.7	5th
Low level of education	12	11.8	6th
Small Farm size	6	5.9	7th
Cultural/religious barriers	4	3.9	8th

Source: field survey 2018
*Multiple responses allowed

Test of hypothesis

H_0: There is no significance relationship between the socio-economic characteristics of the respondents and their level of adoption of climate change adaptation.

The null hypotheses stated that there is no significance relationship between the socio-economic characteristics of the farmers and their level of adoption of climate change adaptation. The result of the F-test statistical analysis used to test the hypothesis in table 7 shows that there is a statistically significant and strong relationship between the socio-economic characteristics of the respondents and their level of adoption of climate change adaptation. The ANOVA was significant $F=30.75$, $p=0.001$.

The results of the ANOVA allowed to rejecting the null hypothesis H_0 and re-state that there is significance relationship between the socio-economic characteristics and the level of adaptation strategies used by the farmers to cope with the climate change effects.

Table 7: test of homogeneity of variances

Variable	levene statistic	df1	df2	sig.	sig.
Age	2.000[a]	13	78	.031	.000
Education	1.260[b]	13	78	.255	
Farm size	3.429[c]	13	78	.000	
Farm experience	1.376[d]	13	78	.190	
Extension contact	4.205[e]	13	78	.000	
Cooperative	5.275[f]	13	78	.000	
Annual income	2.939[g]	13	78	.002	

NB: P= < 0.05%

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	187.157	5	37.431	30.745	.000
Within Groups	11.798	97	.122		
Total	198.956	102			

NB: Sample size = 102

P = < 0.05

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study assessed climate change and adaptation strategies among arable crop farmers in Nasarawa State. Purposive sampling technique was used to select two Agricultural zones namely; Central Agricultural Zone and Western Agricultural Zone from the state followed by random sampling technique to select three local government areas from each of the two agricultural zones selected to give a total of six LGAs. Seventeen 17 farmers were selected from the six (6) selected local government areas to give a sample size of one hundred and two (102) respondents for the study.

The data collected were analyzed using analytical tools such as descriptive statistics and multiple linear regression model. The farming households identified the following perceived causes of climate change; bush burning, cutting down of trees (deforestation), burning of fire wood for cooking, high temperature due to ozone layer depletion, over grazing of farm lands by livestock, natural phenomenon, application of chemical fertilizers, pesticides and herbicides, methane emission from domesticated ruminant animals, industrialization, urbanization, swam price production. Among these, bush burning, cutting of tree, burning of five wood for cooking and high temperature due to ozone layer depletion were ranked and chosen as the highest causes of climate change.

The findings could be useful in designing intervention programmes in an integrated manner that would address climate change adaptation strategies, boost output on arable crop production on a large scale and enhance its productivity.

The result on the sources of information on climate change and adaptation strategies also showed that radios, friends and fellow farmers, television sets, extension workers, newspapers were the major sources of their information on climate change.

The result also showed that early maturing varieties, use of mulching, practices of organic farming, minimum of soil tillage, late planting of crops were the adaptation strategies on climate change adopted by the respondents.

The study also revealed that the negative effects on climate change on arable crop production includes: reduction in crop yield, failure in crop yield, reduction in grain quality, destruction of farm land by flood, decrease in soil fertility, loss of crop due to flood, soil erosion, aggravation of rural poverty, high incidence of pest and diseases, change on production calendar, loss of income among other are the major negative effects affecting arable crop production.

The study also showed that lack of government support, inadequate information, unfavourable land tenure system, high cost of land, traditional agricultural practices, poor extension services among others were the major challenges faced in adopting climate change adaptation mitigation strategies in the study area.

Results in show that lack of government support (85.3), inadequate information (79.4%) and unfavourable land tenure system (71.6%) were the majority faced by farmers in adopting climate change adaptation mitigation strategies in the study area.

5.2 Conclusion

The study has shown that arable farmers in Nasarawa State with higher education and enough farming experience tend to be more responsive and adaptive to the effects of climate change. The result on the sources of information on climate change and adaptation strategies also showed that radios, friends and fellow farmers, television sets, extension workers, newspapers were the major sources of their information used on climate change. Early maturing varieties, use of mulching, practices of organic farming, minimum of soil tillage, late planting of crops were the adaptation strategies on climate change adopted by the respondents. Results revealed that the major negative effects on climate change on arable crop production includes: reduction in crop yield, failure in crop yield, reduction in grain quality, destruction of farm land by flood, decrease in soil fertility and loss of crop due to flood. Lack of government support, inadequate information and unfavourable land tenure system were the major constraints faced by farmers in the study area.

5.3 Recommendations

This study recommends the following;

(i) The study recommends that enough awareness programmes should be carried out by both Government and Non-Governmental Organizations (NGOs).

(ii) Analysis of existing series of observed rainfall and temperature data is very important. Such knowledge is pertinent to the introduction of new and more productive crop varieties that can cope with soil water and temperature stress, and for introduction of improved farming systems as adaptation strategies.

(iii) Capacity building and advisory services that enhance complementing the use of indigenous and modern strategies against climate change particularly in areas of information accessibility and weather prediction by the relevant government agencies. This should target both the extension personnel and the farmers.

(iv) Farmers pooling resources in form of cooperative groups could help farmers to access loans from government and commercial banks easily. Cooperatives organizations also helps in easy access to better and quick information which helps to curb the negative effects on climate change on arable crop production.

(v) The Government and Non-Governmental organizations should organize trainings, workshops and seminars on the effective adaptive strategies on climate change.

(vi) The findings regarding the perceived cause of climate change should be useful for agribusiness firms in expending and developing more arable crop input firms and also government institutions providing more robust and adaptive inputs.

(vii) Extension workers should encourage farmers to diversify their farming system.

5.4 Limitations of the Study

This study was limited to Nasarawa State, Nigeria as well as financial constraints and time factor to carry out the study.

5.5 Contribution to Knowledge

The study revealed that education level was high among farmers and contributed significantly to access to information and adaptation strategies to cope with the climate change. This implies that higher level of education is significant to adaptation strategies to cope with the climate change.

Hence, this study has made significant contribution to knowledge in the area studying of farmers' adaptation to strategies to cope with the climate change and to alleviate poverty and reduce food insecurity in the study area.

5.6 Suggestion for Further Study

Study of this nature should be carried out on climate change vulnerability and mitigation to further create awareness and add more knowledge on the climate change effects.

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QUESTIONNAIRE

Nasarawa State University,
Faculty of Agriculture,
Shabu-Lafia Campus
Department of Agricultural
Economics and Extension.

Dear Respondents,

I am an MSc. Student of the above name institution undertaking a research on the topic: "Assessment of Climate Change and Adaptation Strategies among Arable Crop Farmers in Nasarawa State, Nigeria." Your kind assistance is required in order to make this research a success by supplying answers to the following questions.

Section A: Socio-Economic Characteristics of Respondents

1. Gender: (a) Male (b) Female
2. What is your age?:……..
3. Marital status: (a) Married (b) Single (c) Divorced (d) Widow
4. What is your household size (number)?.....
5. What is your level of education? (a) Primary (b) Secondary (c) Tertiary (d) No formal education
6. What is your farm size in hectare?.....
7. How long have you been farming (years)?:……
8. What are the arable crop you produced? (a) Maize (b) Rice (c) Guinea corn (d) Melon (e) Any others, specify…….
9. How many times do you have extension visits in a year?:……
10. Do you belonged to any social organization? (a) Yes (b) No

11. What is the name(s) of your social organizations?……

12. How do you acquired land in your area? (a) Inheritance (b) Leased (c) Purchased (d) Hired (e) family/community

13. What is your annual income in Naira?:……..

14. What was the amount of credit received for the past five years in Naira?.....

Section B: Perceived causes of climate change by the respondents

1. Which of these are the likely causes of climate change in your community (a) Bush burning (b) Burning of fire wood for cooking (c) Cutting down of tree (deforestation) (d) Natural Phenomenon (e) Swamp rice production (f) Burning of fossil fuel from vehicles and generating engines (g) Overgrazing of farm lands by livestock (h) Methane emissions from domesticated ruminant animals (i) Application of chemical fertilizers, pesticides and herbicide (j) High use of irrigation (k) High temperature due to Ozone layer depletion (l) Industrialization (m) Urbanization

Section C: Sources of Information on climate change by the respondents

1. Have you ever received any information on climate change? (a) Yes (b) No

2. Which of these are your sources of information on climate change? (a) Radio (b) Television (c) Extension workers (d) Newspapers (e) Friends/fellow farmers (f) Town crier/village/town meetings (g) Self initiative (h) Cooperative societies (i) All of the above

3. Which of the above sources do you receives information most?

4. How often do you receive the information? (a) Regularly (b) occasionally

5. Are the information received relevant to your production needs? (a) Yes (b) No

Section D: Adaptation Strategies Adopted by the Respondents

1. What are the adaptation strategies adopted to cope with the climate change effects in your area? (a) Early planting of crops (b) Late planting of crops (c) Use of mulching (d) Enterprise diversification (e) Use of cover crops (f) Plant of early maturing varieties (g) Planting of resistant varieties (h) Minimum soil tillage (i) Practice of organic farming (j) Adoption of irrigation techniques (k) Practice of crops rotation.
2. Is the types of the adaptation strategies adopted profitable (a) Yes (b) No
3. If no, why? (a) Adaption strategies adopted, not fully understood (b) It is difficult to adopt
4. Which of the above adaptation strategies adopted do you use most?

   ……

   ……

Section E: Negative effect of climate change by the respondents

1. Which of these are the negative effects of climate change on your arable crops production? (a) Failure in crop yield (b) Reduction in crop yield (c) Reduction in grain quality (d) Loss of crop due to flood (e) Destruction of farm lands by flood (f) Soil erosion (g) Decrease in soil fertility (h) Incidence of droughts in the field (i) High incidence of weeds (j) High incidence of pests and diseases (k) Excessive rainfall (l) High winds (m) Change in production calendar (n) Aggravation of rural poverty (o) Loss of income (p) Food unavailability, instability, in accessibility and poor utilization (q) Higher food prices (r) Loss of crops under preservation (s) Surges of infectious diseases such as malaria, cholera and rashes (t) High temperature (u) All of the above

Section F: Challenges Faced in adopting the adaptation strategies

1. What are the challenges faced in adopting the adaptation strategies of climate change effect? (a) Unfavourable land tenure system (b) Inadequate information (c) No government support (d) Traditional agricultural practices (e) Low level of education (f) Poor extension services (g) Cultural barriers (h) Religious belief (i) Household size (j) Small Farm size (k) High cost of adoption of the technology (l) All of the above

2. Do you have any assistance from the Government, non-governmental organizations, or philanthropy? (a) Yes (b) No
3. If yes in which form? (a) Cash (b) Kind
4. Is the assistance regular? (a) Yes (b) No
5. In which way can you suggest to the government to improve its effort on assistance to the adaptation strategies of the climate change effects?.....
   ……
   ……
   ……